Research Institute of Animal Production Nitra, Slovak Republic
Slovak University of Agriculture Nitra, Slovak Republic
NutriVet Ltd., Pohořelice, Czech Republic

11th INTERNATIONAL SCIENTIFIC SYMPOSIUM

FORAGE CONSERVATION

9th September - 11th September 2003

NITRA - SLOVAK REPUBLIC

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Proceedings

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Forage Conservation

Research Institute of Animal Production in Nitra
9th - 11th September 2003

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FOREWORD

From the agriculture and its scientific and research basis is expected that it will contribute to the improvement of the conditions of human life (e.g. health, environment, etc.) by the rational management of natural resources in accordance with the principles of sustainability, improving the conditions and efficiency of utilization of soil, water, unrenewable resources of energy, flora and fauna at the same time.

The shift towards the sustainable systems of food production of plant and animal origin is one of the main tasks the Slovak agriculture is confronted with. The need to minimize the negative environmental effects and to preserve the ecological resources (sufficient level of biodiversity and quality of nature of landscape) as well as the existential need to produce sufficient amount of good quality resources of human and animal nutrition – foodstuffs and feed, follows from the above mentioned.

At present the estimates suggest that almost one half of the human effects on environment, as for instance the loss of biodiversity, are directly or indirectly connected with production and food consumption. If the society wants to reduce this influence it is necessary to aim the desirable changes in agricultural production mainly at the management of the agricultural basic production. In the multifunctional farm systems it is necessary to pay attention to questions of utilization of innovative technologies, development of viable expert systems, maximization of profit in systems with low inputs, management and technologies of farm waste.

The objective of the 11th International Symposium „Forage Conservation“ originates in the above mentioned thesis, and its goal is to concentrate new knowledge, examine the technological viewpoints of feed production, optimum structure and choice of feeds for particular localities and production objectives, technical and agrotechnical questions of growing, treatment, harvest and conservation, microbiological control of the fermentation process as well as improvement of nutritional value of feeds and feeding technique.

The research in the sphere of feed conservation and its application in production systems represents, in line with international trends, an illustration of the so called research focused on practice, devoted mainly to the needs of basic agricultural production, creation and protection of landscape.

I am convinced that this international symposium will contribute to the development of professional knowledge and speed up the transfer of new information from research into basic production and services.

Nitra, 11th August, 2003

Prof. Ing. Ladislav Hetényi, PhD.
Managing Director of the Research
Institute for Animal Production in Nitra

PLENARY PAPERS

FORAGE MADE OF PROTEIN FORAGE CROPS GROWN ON ARABLE LAND: PROBLEMS OF PRODUCTION AND QUALITY

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SUMMARY

An analysis is made of trends and development of fodder base sources such as growing acreages and the share of individual groups in total annual volume of forage production. Possibilities are discussed to improve the sward quality of clover crops and clover-grasses on arable land as related to species composition, selection of suitable grass constituent, improvement of sward and forage quality through additional sowing of legumes and grasses.

Key words: fodder base, structure, clover-grass communities on arable land

INTRODUCTION

Similarly as in other neighbouring Central-European countries, fodder base sources in the Czech Republic can be characterized by pronounced changes both in the size of growing areas and in the share of individual groups of forage crops in the total volume of forage production due to markedly reduced numbers of farm animals (BUCHGRABER, HRABĚ 2001; HEJDUK, HRABĚ 2001). The changes severely affect the whole system of agriculture. Basing on the analysis of the ratio between the growing of primary forage crops, i.e. stabilizers (clover crops, clover-grasses, permanent grass stands) and cummulators (ensilage "acidic" crops such as maize for silage etc.) KOHOUTEK (2002) points out a necessity of increasing the acreage of perennial and permanent swards and reducing the acreage of maize for silage both with respect to cattle health and due to the impact on carbon balance within the system of agricultural production. Apart from issues concerning the intensity of growing clover crops and clover-grasses on arable land, attention should also be paid to improve the quality of forage made of these communities by choosing a suitable grass component or variety in order to optimize forage maturity, increase energy content (NEL/MJ) or WSC concentration (HRABĚ et al. 1996; KUNCL and ČURN 1993; HOUDEK, VORLÍČEK 2001; BUCHGRABER et al. 1998). Effect of this grass component or variety on forage ensiliging capacity was exactly assessed by WEISSBACH et al. (1992), DOLEŽAL, HEJDUK (2002) in connexion with the extensified use of permanent meadows and pastures and with an ever increasing share of the herbaceous component and weed species (*Rumex*). Effectiveness of increasing forage quality and ensiliging capacity by applying plough-free additional sowing of suitable grass and clover crop species was studied by KOHOUTEK (2002b), HRABĚ et al. (2002) and SKLÁDANKA (2003).

RESULTS AND DISCUSSION

Composition and structure of the fodder base sources

Growing acreage of fodder crops

Primary sources of fodder base for ruminants are fodder crops on arable land and sward resources (meadows and pastures). According to data published in the 2001 Yearbook of Statistics – Czech Republic (2002), the area of fodder crops grown on arable land amounted to 672.5 thousand hectares, i.e. 21.9% of which the area of perennial clover crops such as alfalfa, red clover and clover-grasses was 375.5 thous.ha (12.2%) and that of annual fodder crops (with practically dominating maize for ensilage) amounted to 297.1 thous.ha (9.7%). The share of fodder root and tuber crops in the production of farm forage was negligible – only 6 thousand hectares.

Data on the dynamics of area changes in the respective crops are presented in Tab. 1. Since 1995, a very marked reduction is seen in the acreage of pure stands of alfalfa from 155.8 thous.ha to the existing 99 thous.ha and red clover from 192.7 thous.ha to the existing 83.7 thous.ha. The acreage of clover-grasses nearly doubles from 119.0 thous.ha in 1995 to the existing 192.6 thous.ha. Clover-grasses are at a smaller extent of the character of short-term 2-3-year intensive swards; the share of temporary clover-grass swards (5-6 years) with a lower production level is increasing.

A similar trend, i.e. decreasing acreage, is also seen in annual fodder crops whose growing area was reduced from 595.0 thousand hectares in 1995 to the existing 297.1 thous.ha – of this maize for ensilage taking up as many as 225.5 thous.ha , i.e. 3/4 of the total acreage of annual fodder crops.

Sward resources (meadows and pastures) exhibit increasing growing acreages. Their existing area of 971.2 thous.ha represents 22.7% of agricultural land. Development of acreages of permanent grasslands is illustrated in Tab. 2. Their area is expected to further considerably increase in order to fulfil non-crop-producing environmental, landscape enhancement and recreational functions. The share of pastoral swards is 6.9% of rural land (297.4 thous.ha).

Production characteristics of forage crops

Data on forage crop production per hectare are presented in Tab. 3. General trend to be observed in perennial forage crops is a steady decrease of yield per hectare, which is resulting from the low levels of nutrients from mineral fertilization. Average supply of major nutrients NPK in 2001 was 92.2 kg/ha – of this 12.3 kg and 7.3 kg P_2O_5 and K_2O, respectively, i.e. less than 50% of their amounts in 1990. The trend showed particularly in clover-grass swards in which the existing yield of about 4.7 t hay from 1 hectare indicates a decrease by 7.5 t (63%) as compared with the year 1990. Also, the low production intensity from 1 ha of meadows (3.27 t/ha) and pastures (2.37 t/ha) results from nearly an absence of the mineral nutrients supply and from dependence on the supply of organic carbon from the symbiosis of clover crops with nodule bacteria.

Production of maize for ensilage and green fodder ranges about 30 t green fodder from 1 hectare which is considered a rather low standard with respect to the quality of well-established technology of cultivation and level of nutrition.

Share of individual fodder crops in total production of dry forage

According to the data published in the Yearbook of Statistics (2002), the total volume of dry forage production amounted to 6,713.3 mil. tons with the production and share of individual crops being as follows:

Table 3. Representation of individual fodder crops in annual production of roughage in 2001

Forage crops on arable land – TOTAL	*3 893.3 t*	*58.0%*
of which: alfalfa	760.7 t	11.3%
red clover	669.1 t	10.0%
clover-grasses	820.3 t	12.2%
maize for ensilage + other annual forage crops	1 643.3 t	24.5%
Meadows and pastures – TOTAL	*2 870.0 t*	*42.0%*
of which: meadows	2 148.3 t	32.0%
pastures	671.7 t	10.0%
TOTAL (arable land + sward resources)	6 713.3 t	100.0%

The conspicuous decrease of production volumes since 1990 is documented in Tab. 4. As compared with the year 1990, the reduction of total acreage of fodder resources in 2001 amounted to 289.3 ha, i.e. rel. 15.0%, and the decrease of dry forage production volume to a level of 6 713.3 t represents a reduction by 3 982.8 t, i.e. rel. 37.2%.

Variances in the proportion of respective crops in the total production volume of dry forage are significant, too. The share of fodder crops on arable land fell from 75.1% to 58.0%, particularly so the proportion of annual fodder crops (from 41.7% to 24.5%). The existing production of forage from meadows and pastures amounts to 42% of total volume while it was only 24.9% in 1990.

Beef cattle and forage requirements

Stock

It follows out from the survey presented in Tab. 5 that stock culminations fall into the period of years 1985-1990. In 1990, total stock of farm animals was 3.5 mil. heads – of these 1.236 mil. and 429.7 thous. were dairy cows and sheep. Comparing the current numbers of farm animals in 2003 with the above mentioned year 1990, the stock experienced the following reductions:

Beef cattle	– total	by 2 032.4 mil.	heads	i.e. - 58.0%
of this	– dairy cows	by 645.9 thous.	heads	i.e. - 62.3%
Sheep	– total	by 345.6 thous.	heads	i.e. - 76.0%
Pigs	– total	by 1 427.1 mil.	heads	i.e. - 29.8%
Poultry	– total	by 5 107.7 mil.	heads	i.e. - 16.0%

The dramatic reduction in the stock of ruminants and particularly the low loading of arable (agricultural) land by cattle reflected with all possible consequences into the extensive use of mainly permanent grass stands. The pronounced reduction of mineral fertilizers on meadows shows in the decreasing number of harvests from three to two and consequently also in the impaired quality of forage (hay, haylage). In pastures, the extensive system of continuous grazing (rearing dairy cows without market production of milk and meat beef cattle breeds) on swards with nutrients supplied only in the form of animal excrements is observed to expand. The number of cows without MPM was 72 thous. and 98.2 thous. heads in 2000 and 2001, resp. All-year cattle rearing on pastures with additional feeding of animals with conserved forage or exceptionally the system of “winter grazing“ are seen to be applied to a lesser extent up to now.

As to the "global" balancing of farm fodder requirements for beef cattle and the current production of farm fodder (year 2001), we can see a certain equilibrium.

With respect to the annual requirement per 1 production cattle unit (PCU), i.e. 5.2 t DM, the annual production of 6 713.3 mil. tons dry forage suffices for the nutrition of 1 291 mil. PCU. The existing load of farmland being 30.6 PCU/100 ha, it is possible to ensure the production of roughages for as many as 1 309 PCU.

A different situation exists in the assessment of forage production ratio standard, i.e. the ratio between stabilizers (forage from the swards of perennial clover crops, clover-grasses and permanent meadows and pastures) and cummulators (forage from silage of annual crops, esp. maize).

According to the EU standard, the requirement of roughages in feedable weight amounts to 2.59 t for stabilizers and 0.709 t/PCU/year for cummulators. According to the analysis made by Kohoutek (2002), the value of this parameter in the Czech Republic is (éta$_o$) = 0.55 which is a double optimum in terms of carbon balance (éta$_o$=0.274). It follows from his calculations that the change of unsuitable ratio bounds to the reduction of production volume by nearly 1 mil. tons and acreages in the ecologically less acceptable but economically and technologically precisely mastered growing of maize for ensilage to the benefit of forage from clover-grass swards, which would mean expansion of their growing acreage with ecologically and economically significant contribution. On the other hand, their growing connects with some risk to forage quality as related to the course of weather at harvest and higher demands of forage conservation.

Farm roughage quality: Current situation and possibilities of solution

Trends in the restructuring of agricultural production indicate that a further reduction of growing acreages can be expected in forage crops on arable land. At the same time, the pure stands of clover crops and maize for ensilage will be subjected to intensive management with high qualitative and dietary requirements being met. A part of short-term clover-grass swards on arable land will also be grown by methods of intensive management, i.e. with a higher proportion of productive clover crop species and capacity of multiple cut aimed at the production of conserved fodder (hay, haylage). The other part of clover-grass stands, i.e. temporary grasslands, will be of production-ecological character with mainly extensive pastoral management.

The acreage of permanent meadows and pastures will expand with their extensive use being further kept, i.e. mainly 2 cuts per year for hay, and with the application of continuous grazing system at a load of about 1.0 PCU/ha in pastures. Harvest time of swards should be chosen so that an optimum "qualitative" crop can be achieved; it is usually a compromise between high production and acceptable forage quality. A comparison of forage quality under operating conditions is presented in Tab. 6. Qualitative characteristics of haylage in operating conditions of the Czech Republic are presented in Tab. 7. The lower values of NEL concentration apparently result from the later harvest of swards.
The importance of NEL/MJ concentration for milk production is obvious from the following calculation: Ensilage of clover-grass at a concentration of NEL energy 5.26 MJ.kg^{-1} dry matter requires for a dairy cow with a production of 24 l milk/day a supplement of 11.1 kg concentrate. Provided that the NEL content is by 0.5 higher, i.e. 5.8 MJ/kg^{-1} DM, the concentrate supplement would be only 7.5 kg/day.

Methods to improve quality of forage made of clover crops and clover-grasses and its ensilaging capacity

Methods to enhance the quality of forage in the growing region, and its suitability for the course of ensilaging are as follows:

- selection of suitable fodder species
- selection of suitable variety
- selection of suitable partner species in the mixture
- increased share of clover crops
- decision on an optimal term (phenophase) of the beginning of esp. 1st cut according to the character of the community.
- Important factors affecting the quality of forage and feed in the technological region are as follows:
- method and speed of herbage treatment after cut aimed at accelerated process of wilting
- herbage processing with respect to final product as related to the method and quality of conservation.

Selection of suitable fodder species

As compared to clover grasses, pure swards of alfalfa and red clover are more suitable for conservation by drying. Conditions for classical conservation by ensilaging through biological fermentation are not optimal with respect to the composition of nutrients (nitrogen/carbohydrate component ratio). Ensilaging clover crops, the attention will apparently be focused on the usage of organic acids since the nutrient losses due to the course and duration of biological fermentation of herbage are lower.

In drier conditions, an addition of red clover (at about 20% in sowing) proves well in alfalfa swards. Red clover combined with alfalfa for better production is mostly applied in 1st cuts which are used to make haylage. An addition of grass component to alfalfa comes into consideration only on wetter localities. In practice, a superficial additional sowing of perennial (winter) rye-grass in the autumn of the 2nd production year proves very beneficial since it fills gaps in the alfalfa stand and improves forage ingestion by cattle.

The register of alfalfa varieties contains a total of 15 varieties of which 8 are Czech. The varieties exhibit neither any significant variances in earliness or lateliness, nor in the forage quality (Tab. 8). Attention at selecting the variety should be focused rather on variances in endurance since varieties originating from climatically milder regions may be less endurable.

A higher attention should also be paid to the selection of red clover varieties. The current range of 7 diploid and 12 tetraploid varieties offers itself for choice both with respect to continuous and gradual forage maturity and with respect to the method or suitability for final use of the fodder, i.e. for hay production (mainly diplo-varieties) or haylage making (diplo x tetra combination). Some differences in the quality of varieties can be seen in Tab. 9. At the present time, the attention is focused on an additional sowing of red clover into temporary pastoral swards in which its endurance is enhanced.

The register of white clover (*Trifolium repens* L.) varieties contains 15 varieties with different growth and developmental characteristics. For pastoral swards, preference is advised to be given to the more endurable type of medium growth (hollandicum). Shorter application in the production is characteristic for the holl. x giganteum hybrid. The wild clover variety (silvestre) finds application in extensive types of grasslands. A question often discussed in connexion with forage quality is that of the effect of increased content of HCN-compounds in some varieties of white clover and their possible influence on digestion disorders and health condition of grazing animals. According to Lampetr (1967), the danger may occur with a proportion of white clover exceeding 40% (in dry matter) of daily consumed forage. Possible bonds are illustrated in Tab. 10.

Selection of suitable partner grass species for the clover-grass community

The choice of suitable partner grass species into the clover-grass community is important not only for the production itself (competition) but also for palatability and ingestion by animals, and for the concentration of nutrients, esp. the carbohydrate component. Variances and contents of WSC, NL and other parameters of intensive grass species are presented in Tab. 11. Reflections of suitable partner grass species into the quality of clover-grass or alfalfa-grass forage are illustrated by data presented in Tab. 12. As compared with alfalfa-grass, clover-grass with a suitable hybrid (red clover + intergeneric hybrid var. Perun) shows a significantly higher WSC concentration and a lower concentration of N-substances. The introduction of intergeneric hybrid var. Felina into alfalfa-grass considerably enhanced the quality of forage as compared with the introduction of intergeneric hybrid var. Perun.

Harvest time of the clover-grass community

The correlation between harvest time (i.e. phenophase) and intake of forage and energy, and consequently the generation of milk production from the forage follow out from Fig. 1. The latest possible time of harvesting the sward for intensive milk production is the ear stage of the dominant grass species. Variances in the rate of energy loss in some grass species are documented by results presented by Kohoutek et al. (2002) in Fig. 2. In addition to the phenophase, it is also the sward type that significantly reflects into milk production (Tab. 13). Forage made of clover-grass communities is more readily accepted by animals, which favourably shows in higher milk production.

Additional sowing of clover crops and grasses as an intensification qualitative measure

With respect to ecological, economic and qualitative viewpoints the additional sowing of clover crops and grasses appears to be a very effective pratotechnical measure. Apart from improving the production, the additional sowing rapidly enhances the sward density, the share of clover-grasses and grasses. According to Kohoutek et al. (2002), the qualitative effect consists in a partial increase of NEL energy in forage dry matter and especially in the increased dry matter production, which significantly contributes to higher milk production from 1 ha (Tab. 14).

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Table 1. Dynamics of acreage changes and share in total production of perennial clover plants forage in CR for 1990-2001

Forage crop	Acreage in thous. ha			
	Year 1990		Year 2001	
	Acreage in thous. ha	% in annual production	Acreage in thous. ha	% in annual production
Medicago sativa	155.8	11.2	99.0	11.3
Trifolium pratense	192.7	14.9	83.8	10.0
Clover-grasses	119.0	7.3	192.7	12.2
Other (swards for seed production)	37.9	-	-	-
TOTAL	505.4	33.4	375.5	33.5

Table 2. Changes in acreage of permanent grasslands in CR (1935-2001), production from 1 ha and share in total production of roughage

Indicator	Acreage ($t.ha^{-1}$) and share in total agricultural land (%)					
	1935	1949	1960	1980	1990	2001
PGL acreage - total	1 063	1 093	999	851	833	971
of this meadows	745	726	697	578	577	674
pastures	318	367	302	273	256	297
% share in agricultural land	21.3	23.0	21.8	20.8	19.4	22.7
Harvest year	1980	1990	1997	1999	2001	x
Dry forage yield (t/ha)	3.35	3.19	2.75	2.56	2.92	x
Share in total annual production in %	29.4	24.9	31.8	32.0	42.0	x

Table 4. Changes in the share of fodder base sources in CR in 1990-2001

Crop	Acreage and share (in %)				Production volume and share (in %)			
	1990		2001		1990		2001	
	ha	%	ha	%	t/mil.	%	t/mil.	%
Forage crops on arable land	1 100	33.3 [1)]	672.5	21.9 [1)]	8032.8	75.1	3 893.3	58.0
- perennial	505	15.3	375.5	12.2	3572.5	33.4	2 250.1	33.5
- annual	595	18.0	297.0	9.7	4460.3	41.7	1 643.3	24.5
Sward resources	833	19.4 [2)]	971.2	22.7 [2)]	2663.3	24.9	2 820.0	42.0
- meadows	577	13.4	673.8	15.8	-	-	2 148.3	32.0
- pastures	256	6.0	297.4	6.9	-	-	671.7	10.0
TOTAL	1 933	100.0	1 643.7	100.0	10 696.1	100.0	6 713.3	100.0

Note: 1) in arable land
2) in agricultural land

Table 5. Stock development in 1980-2003 (source: Zemědělec 22/2003)

Species (mil., heads)		Year					
		1980	1985	1990	1995	2000	2003
Beef cattle	total (mil.)	3 428.9	3 602.7	3 506.2	2 029.8	1 573.5	1 473.8
of this	cows (thous.) [1)]	1 318.9	1 285.9	1 236.2	768.2	614.8	590.3
Sheep	total	290.1	372.9	429.7	165.3	84.1	103.1
Pigs	total (mil.)	4 796.9	4 299.0	4 789.9	3 866.6	3 687.9	3 362.8
of this	sows (thous.)	364.6	281.6	310.9	295.3	296.8	282.7
Poultry	total (mil.)	31 926.1	31 898.6	31 981.1	26 688.4	30 784.4	26 873.4
of this	laying hens (mil.)	14 590.7	16 069.6	15 437.4	12 028.6	11 739.2	7 044.4

Note: 1) Cows without market production of milk (i.e.nursing cows), in 2000 - 72 thous. heads, in 2001 – 98.2 thous. heads
2) Production cattle units/meadow of agricultural land in 1995 – 37.7 PCU, 2000 – 30.2 PCU

Table 6. Comparison of qualitative production of fodder crops from the production (haylage) and experimental plots

Forage and fodder crop	Production t/ha of dry forage	Concentration		Production from 1 ha	
		N-substances g/kg	energy NEL/MJ/kg	N-substances g/kg	energy NEL/MJ/kg
Silage (haylage) [1)]					
- alfalfa	7.71	212/215	5.02/5.10	1.646	39 013
- red clover	8.02	107/148	5.04/5.26	0.681	41 303
- clover-grass – extensive	4.20	148/167	5.29/5.30	0.661	22 239
Dry forage [2)]					
- alfalfa	14.07	195/215	5.32/6.26	2.927	81 465
- red clover	13.90	201/207	5.24/6.51	2.849	81 662
- clover-grass – intensive	14.46	123/143	5.02/5.36	1.924	75 047
Grass species [3)]					
- Haylage from PGL – extensive	3.27	131/143	5.30/5.39	0.447	17 478
- winter rye-grass	8.90	82	5.75	0.730	51 175
- intergeneric hybrid Perun	9.74	81	5.04	0.788	44 090
- intergeneric hybrid Hykor	16.21	122	5.30	1.977	85 913
- intergeneric hybrid Felina	16.15	135	5.53	2.180	89 304

Note: [1)] Calculation of yields according to the 2001 Yearbook of Statistics and haylage qualities according to AK Žamberk
[2)] Artificially dried forage from experimental plots in Hladké Životice and according to NIRS analyses
[3)] PGL according to 1; Grass species according to 2.

Table 7. Quality of perennial fodder crops haylage in CR in the year 2001 (according to AK Žamberk)

Fodder crop	Number of analyses	DM %	N-subst. %	NEL MJ/kg^{-1}	CF	pH	KVV	Acid			Class		NH_3
								Lac.	But.	Ace.	Fer.	total	
Medicago sativa	256	36.8	21.5	5.09	23.2	4.78	1 488	2.68	0.95	0.09	2.09	1.90	0.15
Trifolium pratense	354	31.6	18.0	5.26	24.6	4.40	1 479	2.68	0.79	0.08	1.59	2.19	0.09
Clover-grass	245	34.0	16.7	5.29	25.4	4.45	1 454	2.35	0.83	0.12	1.93	1.97	0.10
Permanent grassland	477	35.6	14.3	5.35	27.2	4.44	1 319	1.92	0.65	0.09	1.95	2.02	0.08
Maize for ensilage	459	32.6	8.3	6.32	19.9	3.82	1 461	1.97	0.58	0.00	1.18	1.38	0.05

Table 8. Production and forage quality of *Medicago sativa* L. varieties - Hladké Životice, 1995

Variety	Dry forage yield $t.ha^{-1}$/year	Concentration of nutrients – 1st cut			
		Digestible N-subst. (g/kg)	NEL (MJ/kg)	WSC (g/kg)	PDIN (g/kg)
Zuzana	14.07	126.4	6.26	35.4	107.3
Kometa	13.48	143.2	6.36	31.4	116.2
Niva	13.50	143.8	6.35	35.6	132.3

Table 9. Dynamics of changes in nutrient concentrations of *Medicago sativa* L. a *Trifolium pratense* L. - Hladké Životice, 1995 (Houdek, 2001)

Nutrient	Species	Variety	Harvest time; nutrient concentration – 1st cut				
			4 May	11 May	12 May	18 May	12 May. /25 May*
Digestibility of org.matter (DOM g/kg)	Medicago sativa	Zuzana	857	-	720	*	*
	Trifolium pratense	Vesna	899	-	-	357	807
		Start	909	886	-	837	804
		Beskyd	908	898	-	872	*
		Radegast	897	891	-	878	*
Concentration of N-subst. (g/kg)	Medicago sativa	Zuzana	266.5	-	205.0	*	*
	Trifolium pratense	Vesna	259.0	-	-	201.0	173.0
		Start	260.0	224.0	-	207.0	181.0
		Beskyd	273.6	221.1	-	204.8	181.5*
		Radegast	279.0	233.0	-	220.0	190.0*
Concentration of fibre (g/kg)	Medicago sativa	Zuzana	190.0	-	263.9	*	*
	Trifolium pratense	Vesna	156.0	-	-	183.0	200.0
		Start	156.0	170.0	-	189.0	198.0
		Beskyd	152.9	145.6	-	177.3	204.1*
		Radegast	152.0	155.0	-	167.0	185.0*
WSC concentration (g/kg)	Medicago sativa	Zuzana	54.8	-	31.4	*	*
	Trifolium pratense	Vesna	71.0	-	-	75.0	61.0
		Start	105.0	99.0	-	79.0	65.0
		Beskyd	107.8	106.9	-	95.0	628.0*
		Radegast	84.0	75.0	-	95.0	-

Table 10. Theoretical limits of dietary and beginning of toxic content of HCN-compounds in pastoral sward as related to its weight share in forage (dry)

Weight proportion of white clover in dry forage (%)	Unit mg/kg DM	Forage intake kg/den green and in dry matter (at 18 % DM in green forage)								
	green forage DM	28 5	33 6	39 7	44 8	50 9	55 10	61 11	67 12	83 15
Cattle categories		calves up to 300 kg live weight *			heifers up to 400 kg l.w. **		other ***			
20 %	DM kg	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	3.0
	HCN – 210	210	252	294	336	378	420	462	504	630
	HCN – 350	**350**	**420**	**490**	**560**	**630**	**700**	**770**	**840**	**1 050**
	HCN - 750	**750**	**762**	**1 050**	**1 200**	*1 350*	*1 500*	*1 650*	*1 800*	*2 250*
40 %	DM kg	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	6.0
	HCN – 210	420	**504**	**588**	**672**	**756**	**840**	**924**	**1 008**	**1 260**
	HCN – 350	**700**	**840**	**980**	**1 120**	**1260**	*1 400*	*1 540*	*1 680*	*2 100*
	HCN - 750	*1 500*	*1 800*	*2 100*	*2 400*	*2 700*	*3 000*	*3 300*	*3 600*	*4 500*
60 %	DM kg	3.0	3.6	4.2	4.8	5.4	6.0	6.6	7.2	9.0
	HCN – 210	**660**	**756**	**882**	**1 008**	**1 134**	**1 260**	**1 386**	**1 512**	**1 890**
	HCN – 350	**1 050**	**1 260**	*1 470*	*1 680*	*1 890*	*2 100*	*2 310*	*2 520*	*3 150*

Note:

*	calves 300 kg l.w. x 18 kg fresh fodder/100 kg l.w. = 54 kg g.f./head/day, ie. 0.72 kg DM (- 30 % grazing leftovers) = 6.8 kg DM total/day
**	heifers 400 kg l.w. x 18 kg green fodder/100 kg l.w. = 72 kg g.f./head/day, ie. 12.96 kg DM (- 30 % grazing leftovers) = 9.07 kg DM total/day
XXX	hygienic limit for HCN in diet
XXX	limit for HCN toxicity

Table 11. Qualitative characteristics of some grass species suitable for intensive clover-grass community (Houdek, 2001)

Species	Variety	Nutrient concentration						
		WSC g/kg	N-subst. g/kg	Fibre	DOM g/kg	NEL MJ/kg	NEV MJ/kg	PDIN g/kg
Dactylis glomerata	Niva	62	147	259	799	6.03	5.95	94.0
Festuca arundinacea	Kora	84	134	254	767	5.45	5.26	84.4
intergeneric hybrid – fest.	Felina	72	135	264	769	5.53	5.34	91.8
intergeneric hybrid – fest.	Hykor	103	122	253	771	5.30	5.10	75.7
intergeneric hybrid – loloid.	Perun	214	81	247	788	5.64	5.52	45.2
Lolium perenne	Mustang	194	82	221	802	5.75	5.68	46.1

Table 12. Forage quality of alfalfa-grasses, clover-grasses and alfalfa-clover-grasses (Houdek, 2001)

Species	Var.	Nutrient concentration						
		WSC g/kg	N-subst. g/kg	Fibre	DOM g/kg	NEL MJ/kg	NEV MJ/kg	PDIN g/kg
alfalfa intergeneric hybrid	Zuzana Perun	44	160	226	786	5.99	5.90	93.9
red clover alfalfa intergeneric hybrid	Vesna Zuzana Perun	125	139	236	806	5.29	5.09	88.9
red clover alfalfa intergeneric hybrid	Vesna Zuzana Felina	118	180	205	830	5.89	5.82	113.0
red clover intergeneric hybrid	Vesna Hykor	153	111	271	805	/	/	/ **
red clover intergeneric hybrid	Beskyd Perun	173	133	229	908	/	/	/

Note: ** shadowed values are from the harvest of 3rd production year 1999

Table 13. Sward type, forage consumption and milk production (according to AFF Schweiz, 1995)

Sward type	Forage consumption kg DM and milk production (NEL) in litres per 1 dairy cow.day^{-1} at ear phenophase		Milk production (rel. %)
Grass – rye grass	15.5	19.0	100.0
Grass - multispecies	14.6	17.0	89.0
Clover-grass (> grasses)	15.2	19.0	100.0
Clover-grass (> clover crops)	15.8	21.0	110.0
Herbs	14.9	18.0	95.0

Table 14. Effect of additional sowing of clover crops and grasses on NEL concentration in milk production (Kohoutek et.al., 2002)

Additionally sown species and fertilization		Dry matter production (t/ha)	NEL concentration (MJ/kg)	Milk production (kg/ha)
Red clover (Kvarta)	N_0PK	6.39	6.19	6 600
White clover (Huia)	N_0PK	5.18	6.21	5 300
Permanent grassland - Control	N_0PK	4.07	6.16	4 120
Tall fescue (Kora)	$N_{150}PK$	7.14	6.24	7 290
Intergeneric hybrid (Felina)	$N_{150}PK$	6.64	6.23	6 770
Intergeneric hybrid (Bečva)	$N_{150}PK$	6.50	6.20	6 640
Permanent grassland - Control	$N_{150}PK$	5.95	6.17	6 030

Figure 1. Changes in DM production of perennial fodder crops on arable land in the Czech Republic (1990-2002)

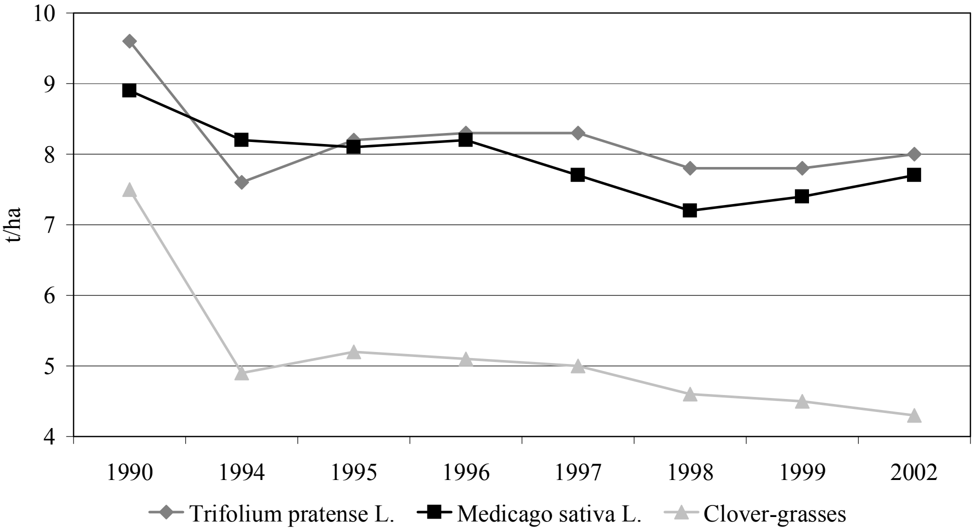


Figure 2. Correlation between harvest time (phenophase), forage and energy intake, and milk production (Buchgraber et.al. 1997)

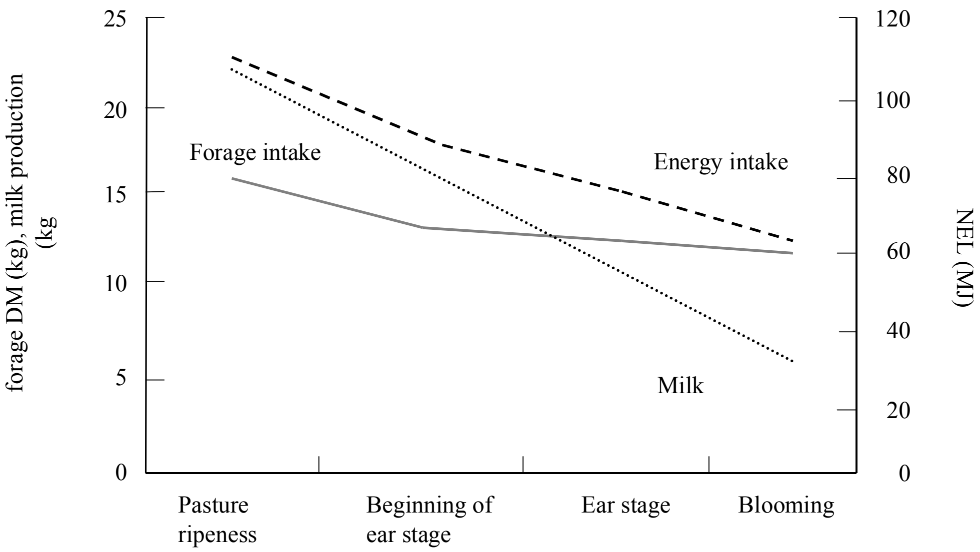
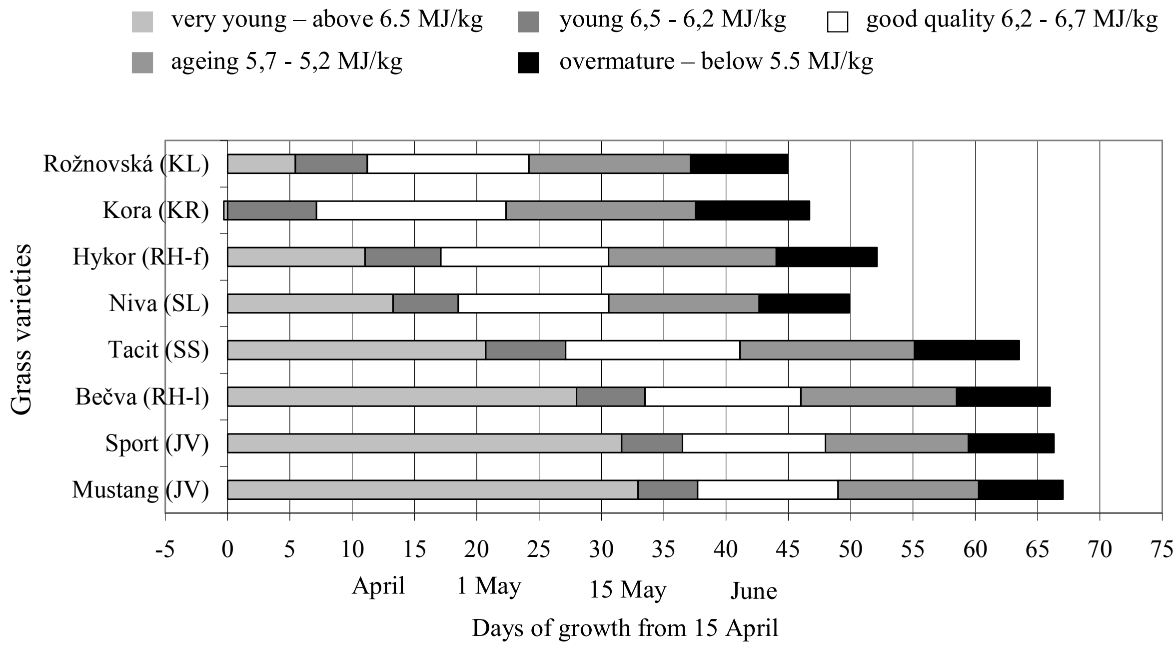


Figure 3. Forage quality classification (NEL in $MJ.kg^{-1}$ DM) in some grass species and varieties during the growth of the 1st cut (Kohoutek et. al. 2002)



THEORY AND PRACTICE OF ENSURING GOOD QUALITY OF SILAGES FROM GRASS AND LEGUMES

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ABSTRACT

The importance of silage quality for a profitable cattle farming and the need to improve it is described. Then the scientific basis for the regulation of the course of fermentation in silages by wilting and application of different types of silage additives is reviewed. The knowledge on the utilisation and efficiency of silage additives is summarised and future perspectives are discussed. By means of comparing comprehensive experimental data, the effects and limits of biological versus chemical silage additives are evaluated and recommendations for the future in practical farming suggested.

Just like in any other branch of production, the money can be earned in cattle farming depends on the achievable price and the individual costs per unit of product for sale. Increasing liberalisation of the agricultural market and reduction of the product-related subsidies lead to lower prices and increasingly strong pressure to reduce production costs. Besides increasing the farms, where too small herds restrict competitiveness, increasing the yield from the individual animals remains the most important method of reducing the costs per unit of product. Therefore, many dairy farms require to increase the yield per cow and, as experience over recent years has shown, a great potential for this still exists.

1. Silage quality requirements

High levels of milk yield per cow can only be achieved by constantly full use of the conversion capacity of the cow’s digestive system. This is best achievable with TMR (Total Mixed Ration) and this requires good quality of all silages. Gradual or only temporary quality deficiencies in a silage can no longer be tolerated here. A rather big variations in the silage quality, however, has continued to be common practice up to now in many farms and is mostly caused in grass and legume silages by faults during preparing and in maize silages by faults during feeding out.
All the characteristics that determine the feeding value are summarised by the term silage quality. Namely:

- The energy concentration,
- The content of particular nutrients and
- The complex of feed intake-related and feed hygiene characteristics.

The energy concentration, expressed for dairy cows in MJ NEL/kg DM, is a very important but by far not the only quality characteristic. Many advisors and farmers identify the quality of silage directly with its energy concentration and let control silages only on parameters that are required for estimating the energy concentration.

It is true, the highest possible level of energy concentration is a prerequisite for successful feeding high yielding cows. But the possibilities for increasing the cows’ energy intake by increasing the energy concentration are limited. It is difficult to exceed energy concentrations of about 7.2 MJ NEL/kg DM, even in complete TMRs, without running the risk of metabolic disturbances in the rumen. The very large amounts of energy required for high yields can only be obtained by achieving simultaneously a very high levels of feed intake. Therefore, silage characteristics related to feed intake play an increasingly important role, when yield expectations increase.

Another aspect also becomes more important. The higher the milk yield, the more interesting is not only the energy intake but also the form of nutrients from which the energy is provided. Silage quality therefore also means a high content of particular nutrients and the lowest possible microbial decomposition of them within the silo, like protein and amino acids in the grass and legume silages and starch in maize silages. In order to ensure the highest possible silage quality with regard to all three aspects, high-quality plant material is required, harvest at its optimal stage of development and a proper conservation. Much can still be done in many farms for a better preservation of nutrients from harvesting the forages to feeding. Malfermentation and avoidable microbial nutrient decomposition within the silo often remain unrecognised, among other reasons, because the fermentation quality is seldom investigated by laboratory tests.

As Table 1 shows, there is a close relationship between the fermentation quality of silage and the amount of decrease of the energy concentration from the green fodder to the final silage. Furthermore, there will be a greater loss of particular nutrients, such as protein and amino acids in grass and legume silages when there are deficiencies in the fermentation quality. Silages with poor fermentation quality levels are also eaten less willingly and endanger the animal’s health and the quality of milk because of the occurrence of harmful microbes (Clostridia, Listeria and moulds). More laboratory tests on the fermentation quality are therefore recommended in order to reveal problems in the fermentation process and eliminate them in the future. This applies, above all, to grass and legume silages.

Table 1. Decrease of energy concentration during ensiling in dependence on fermentation quality

Fermentation quality score	Expected decrease from green fodder to silage MJ NEL/kg DM
1 (very good)	0.2
2 (good)	0.3
3 (to be improved	0.4
4 (bad)	0.5
5 (very bad)	> 0.5

2. Improving grass and legume silages

Although there is sufficient need in many areas, as there has been in the past, to think about improving the sward quality and harvesting the plants at the right time, the following pages deal, above all, with the possibilities for ensuring a good fermentation quality of grass and legume silages. The problems with fermentation quality are caused here, primarily in the variable quality of the green fodder. This variability is created by the weather-dependent wilting process and also by the different levels of intensity of grassland utilisation. The effects of weather dependence on the ensiling process increase the larger the areas to be harvested and the larger the silos to be filled.

In principle, there are three different strategies for preparing grass and legume silages:

- Direct cut silage with chemical preservation (DM content = 150 ... 200 g/kg)
- Wilted silage with controlled fermentation (DM content = 250 ... 400 g/kg)
- Haylage made from heavily wilted material (DM content = 450 ... 600 g/kg)

Direct cut silage is still widely prepared in northern Europe by the use of large amounts of formic acid but is not practised for good reasons (silo effluent problems, high expenditure on silage additives) in other parts of Europe. Haylage was previously prepared in tower silos but this is scarcely feasible any longer for reasons of very high costs. Nowadays this form of preservation continues in the procedure of making big bale silage.

The production of big bale silage is an advantageous solution for the conservation of small feed lots as these either generally result in small farms or occasionally in larger farms when it is not worthwhile or effective to make silage in very small clamps. As a supplementary technique to other ensiling procedures, preparing big bale silage has already become of significant practical importance, which could increase still further in future.

The main strategy and procedure nowadays in use is making wilted silage in clamps or bunker silos with controlled fermentation. In practice, the technological advantages of this procedure are obvious and quite clear. Only that, in addition, there is also a need for specific control of the fermentation process and which measures are appropriate in order to ensure a good quality silage regularly, different opinions exist.

Prevention of malfermentations must be tackled at their sources. Good professional practice in ensiling technology, such as short wilting time, short silo filling time, good compacting and rapid and careful covering the stack should be self-evident. If, nevertheless, malfermentation problems still occur, these are due to one of the two following causes:

- Insufficient degree of acidification or
- Too low acidification rate.

The following pages will deal with both these causes.

2.1. Degree of acidification

As known, the preserving effect in silage is obtained by suppressing the aerobic microbes by exclusion of air and eliminating the remaining harmful anaerobic microbes, which require no oxygen, through reducing the pH value by means of enrichment of lactic acid. Whether the harmful acid-sensitive microbes can be eliminated, particularly the Enterobacteria and Clostridia, depends on the green fodder's potential for acidification. This potential is given by the ratio of sugar content to buffering capacity. Table 2 shows data about the acidification potential of some important forage types.

Table 2. Acidification potential of some plant species

	Sugar content g/kg DM (Z)	Buffer capacity g MS/kg DM (PK)	Z/PK quotient
Silage maize	120	32	**3.8** (2.8 ... 6.2)
Lolium species	160	55	**2.9** (1.8 ... 4.4)
Other grasses	95	47	**2.0** (1.2 ... 2.2)
Lucerne	65	74	**0.9** (0.5 ... 0.9)

According to this, a Z/PK quotient of 2.9 can be expected for Lolium-dominated swards on average. This means that these grasses contain about three times as much sugar as would be required for acidification down to pH 4.0, if the sugar could be transformed without losses to lactic acid and the formed lactic acid could be kept away from further fermentation to other metabolic products. Both are only very limited feasible but can be affected by measures to control the fermentation process, such as, for instance, silage additives. Suitable silage additives cause that the available sugar is effectively transformed to lactic acid and that the lactic acid already formed is preserved from further fermentation, so that it accumulates in the silage.

On the other hand, the acidification potential, could be increased by adding sugar-containing materials, such as molasses. In grass with a high sugar content, like such with a high proportion of Lolium species, it is much more practical, however, to care for an efficient utilisation of the available sugar from the grass through other measures than to add molasses and expose the sugar it contains to additional fermentation losses.

The most important measure for controlling the fermentation process in grass and legume silages is and remains wilting the plant material before its ensiling. As is well known, by increasing the DM content, good silages can be produced even from grass or legumes with low acidification potential. The biological explanation why wilting improves the fermentation was found out decades ago and becomes the key for understanding the microbial processes taking place in the silage and the possibilities for controlling it. Unfortunately, however, this knowledge was not adopted by all the agricultural colleges. Instead, the simple fact that the sugar content as a percentage of the fresh material increases as the DM content increases, for example doubling as DM increases from 200 to 400 g/kg, has been assumed as the cause of the positive effect of wilting. However, the lactic acid fermentation does not depend on the fresh material’s sugar concentration in the size range concerned here. Besides, the fresh material-related buffer capacity also changes to the same extent as the sugar content through increase in the DM content. The potential for acidification therefore remains consequently the same.

Wilting reduces the risk of malfermentation for entirely another reason. Namely, the undesirable bacteria that must be eliminated become more and more acid-sensitive, the less water is available to them. From this results that the pH value required for their elimination becomes less deep, the higher the silage DM content is. The critical pH values for the production of anaerobic stable silages are shown in Table 3. Whereas at 200 g DM/kg the pH value must be reduced to 4.2 or lower, at 400 g DM/kg acidification to a pH of 4.75 is sufficient. This is the reason why it is possible to produce good silages even from grass or a legume whose acidification potential does not permit the achievement of a lower pH value.

Table 3. Critical pH values for silage (WEISSBACH, 1968)

DM content g/kg	Silage stability provided at pH
200	4.20
250	4.35
300	4.45
350	4.60
400	4.75

The necessary degree of wilting depends on the acidification potential of the plant material. The lower the potential, the more heavily the plant material must be wilted. The relationship between the Z/PK quotient and the minimum dry matter content ($DM_{min,}$ as g/kg) is described by the following equation:

$$\mathbf{DM_{min} = 450 - 80\ Z/PK}$$

Because of the changeability of the weather, it is not always possible to achieve this minimum DM content in the appropriately short wilting time. The difference between the DM achieved and the DM_{min} actually required can fortunately be compensated for by specific silage additives. These silage additives lead to a larger output of lactic acid during fermentation or they prevent the subsequent metabolization of lactic acid and ensures in this way an anaerobic stable silage, even at a pH value somewhat higher than the critical level. Such silage additives can therefore replace the missing wilting level.

Table 4 shows the result from the analysis of very extensive silage experiments. It shows that the risk of malfermentation is reduced strongly as the DM content increases. But this risk can also be reduced in a similar extent by a good silage additive, shown here, for instance, by a chemical preparation. The chemical silage additive tested here proved to be strongly effective, compatible with the wilting effect and much more easy to handle than any acid. It is successful applied in many European countries nowadays and consists of a neutral aqueous solution of two preserving substances (sodium nitrite and hexamethylenetetramine) which are well known as harmless substances from the long-time use as food preservatives. Both measures – wilting and application of a good silage additive which is compatible with wilting – can therefore supplement or, in certain limits, replace each other.

Table 4. Risk of the occurrence of butyric acid* (Z/PK = 2,0)

DM content (g/kg)	Risk of malfermentation in %	
	Without additives	With silage additive**
200	70	24
250	46	12
300	18	4
350	3	1
400	1	0

* Source: Weissbach, reuter & Kruse, 1989; ** KOFASIL® LIQUID

2.2. Acidification rate

As the figures in Table 4 show, with such a complex microbial process as takes place in the silo it is virtually impossible to achieve absolute certainty for the desired result. But what is easily achieved is minimisation of the risk of malfermentation through the elimination of all its possible causes.

An initially unknown risk to fermentation quality first came about with the introduction of the procedure of making wilted silage. Only very few osmotolerant ecotypes occur among the epiphytic lactic acid bacteria naturally present on the plant surface, i.e. ecotypes that can still grow also in more or less heavily wilted materials. Acidification in wilted silage, therefore, generally proceeds at a slower rate than in direct cut silage and is slower the more heavily the material has been wilted. It therefore often takes a rather long time for the pH value finally to reach the critical level for eliminating the undesirable acid-sensitive bacteria. In the meantime, these harmful microbes can multiply to a certain extent and significantly impair the fermentation quality.

For a long time, this risk of malfermentation was not noticed because grass almost always was fertilised with nitrogen and therefore always contains some nitrate when was used for ensiling experiments in the past. If the plant material contains nitrate, it is at least partly reduced to nitrite in the silo and nitrite is a very effective Clostridia inhibitor. This nitrite protects the wilted silage from butyric acid fermentation during the first days or weeks with slow acidification as long as the critical pH is not yet achieved. Butyric acid is therefore not formed in such silages (WEISSBACH & HONIG, 1996).

In the course of extensification of the grassland use during the 1990s, less nitrogen fertiliser was applied and, surprisingly, butyric acid was often found in spite of high DM contents of the silages. An extremely low nitrate content of the grass proved to be the cause (KAISER & WEISS, 1997). In the meantime, it was established that a certain minimum nitrate content in the plant material is a precondition for success in making wilted silage without a silage additive. It was then recognised that an extremely low nitrate content in the grass quite frequently can also occurs – depending on the location, weather and vegetation stage – in conventional grassland farming, i.e. also without extensification. Some butyric acid rather often occurs, therefore, in that silages but butyric acid’s smell is less noticeable in heavily wilted silage.

From the knowledge of the cause of these problems with fermentation quality of silage the possibilities for avoiding them can be deduced . One possibility is the addition of a nitrite containing chemical silage additive to replace the nitrate missing in the plant material, which proves to operate very reliably. A second possibility is to speed up the acidification by adding efficient osmotolerant lactic acid bacteria as an inoculant. That these lactic acid bacteria must be osmotolerant, i.e. capable of growing even in rather dry grass, should be self-evident.

The dry preparations, still often are preferred in practice because of its particular ease of handling (dry cultures bound in a granulated carrier medium). But dry preparations have several disadvantages. Firstly, in principle it is quite impossible to achieve a really homogeneous distribution of the bacteria in the ensiled material by using granules. Because the lactic acid bacteria are immobile, they can only affect the area in which they have arrived. Moreover, initially slow water absorption by the bacteria in a rather dry silage must be taken into account. Finally, when the bacteria have absorbed sufficient water to awake out of their “drought sleep”, a longer phase (lag phase) follows during which they first adapt to the milieu but still do not multiply.

These disadvantages can be partlially avoided by preparations that are suspended in water before application and then applied as a liquid. Homogeneous distribution is here much better possible, especially if the application is made at the chopper during harvest. Moreover, the bacteria immediately come into contact with the water necessary for their existence. But it is even much better to apply the bacteria as a fresh culture, i.e. as a suspension of metabolically active young cells ready to divide. In this case, an additional time saving can be taken into account because of the reduced lag phase and the greatest possible acceleration of dropping down the pH value.

Table 5 shows experimental results that demostrate this effect in an exemplary manner. The treatment named here “Dry application” concerns not a granulated but powdery preparation by means of which the inoculant could be distributed more homogeneously in the plant material than in a granular form. Nevertheless, there was a clear advantage from using the wet application in comparison with dry application. However, the very best effect was obtained with the fresh culture composed of metabolically active cells. For instance, a pH value of 4.5 was achieved one day or, in case of the fresh culture, even two days earlier than with the dry application. The application of fresh cultures obviously enables the best possible effect on speeding up the acidification.

Table 5. Influence of the different forms of application of a lactic acid bacteria inoculation culture on the rate of acidification in wilted grass silage

Days	Control	Dry application	Wet application	Fresh culture
Lactic acid content in % of DM:				
2	0.5	0.8	1.8	3.1
3	0.7	2.4	3.7	4.3
4	1.1	3.3	4.8	5.7
5	1.2	5.3	5.3	6.2
pH value:				
2	6.4	6.1	5.4	4.9
3	6.2	5.1	4.7	4.5
4	6.2	4.7	4.5	4.3
5	6.1	4.5	4.4	4.3

Data source: Pahlow u. Weissbach, 1995

It should be noted in general that the effect of inoculation cultures on the acidification rate, even when relatively osmotolerant bacteria are concerned, is significantly reduced when the silage DM content is very high. Therefore, only DM contents of up to 400 g/kg should be aimed to apply and DM contents in excess of 450 g/kg should generally be avoided.

This is also appropriate, because silage made from heavily wilted grass tends to warm up during feeding out, particularly when homofermentative lactic acid bacteria have been added during its preparation. The tendency to warm up is caused by extremely low acetic acid contents in that silages. This enables yeasts to proliferate explosively following the contact of silage with air, connected with intensive aerobic metabolism. Recently, to avoid this problem, bacteria cultures are recommended, which form acetic acid as well as lactic acid. However, experience as yet with such heterofermentative lactic acid bacteria (or mixtures of homofermentative and heterofermentative bacteria) in grass and legume silages is still limited and the effect up to now is not always certain.

2.3 Process strategy

From the relationships shown, it can be deduced that a combination of a short and – if the weather allows nothing else – low level of wilting with the regular use of a suitable silage additive represents the best strategy for ensuring good fermentation quality of grass and legume silages. In doing so, one should proceed from the following principles:

- Observance of the optimum cutting time, particularly with the first growth of grass, has a high priority and hardly permits any compromise in case of less than optimum weather conditions. DM contents somewhat under the otherwise desired wilting degree level are acceptable rather than a late cut.
- In order to keep nutrient losses after the mowing as low as possible and to achieve the desired wilting degree in a short time, mechanical treatments for accelerating the rate of water evaporation should be applied. Wherever possible, mower-conditioners should be used.
- Regardless of the DM content achieved, wilting should be restricted to one or two days. The mown green fodder may only once lie outside overnight.
- In good weather, wilting should be limited by the precisely adapted temporal advance of the mowing before the harvesting. In very dry weather conditions, wilting has to be interrupted by timely harvesting. Inappropriat weather occasionally produces overly wet silage material; overly dry silage material is always caused by errors in management.
- Assured fermentation quality can only be achieved through the use of silage additives as an integral part of the conservation process. The type and dosage of silage additive must be selected according to the current DM content and ensiling conditions.
- Plant material of different quality and of different treatment should be ensiled separately in order to use the silages later on according to their different feeding value.
- Even when the composition and quality of the plant material is rather uniform, the filling time of big silos should be limited to a maximum of two to three days.

As we have seen, silage additives can compensate for low DM contents within certain limits. The effectiveness of a silage additive can be described product-specifically by its equivalent of efficacy (WEISSBACH et al., 1989), expressed as difference of dry matter content which can be replaced by it (DM_w). For good silage additives, the equivalent of efficacy can be estimated as follows:

Chemical additives **DM_w 100 g DM/kg**

Bacterial inoculants **DM_w 50 g DM/kg**

When using silage additives, the DM content necessary to prevent malfermentation can be by this amount lower than the normally required DM minimum (DM_{min}). The given data clearly indicate that good chemical additives are double as effective as even the best bacterial preparations. This has been proven in comprehensive comparative experimental studies. There is evidence that the effect of bacterial inoculants in many cases is not strong enough to prevent butyric acid fermentation (OPITZ von BOBERFELD et al., 2001). Therefore, good chemical silage additives offer substantially more security to solve the silage quality problem under changing practical conditions than bacterial inoculants can do.

Table 6 shows the ranges of tolerance for the silage DM content permissible to minimise the risk of malfermentation as much as possible. DM_{min} is the corresponding minimum DM content as calculated from the range of Z/PK quotient and the equations given above for both the types of grass and for lucerne, with and without application of the respective kind of silage additive. DM_{max} is the recommended maximum DM content, which should be observed in the interests of the compressibility of the plant material and the aerobic stability of the resulting silage.

Table 6. Permissible DM content tolerance during ensiling (data in g/kg)

	DM_{min} ... DM_{max}	Tolerance
Lolium dominated swards		
Without additive	300 ... 450	150
With bacterial inoculant	250 ... 450	200
With chemical additive	200 ... 450	250
Other grass swards		
Without additive	350 ... 450	100
With bacterial inoculant	300 ... 450	150
With chemical additive	250 ... 450	200
Lucerne		
Without additive	400 ... 450	50
With bacterial inoculant	350 ... 450	100
With chemical additive	300 ... 450	150

The DM content is subjected to unavoidable fluctuations while a silo is being filled. Both limit values given in Table 6 apply to the individual truckloads. The DM content of the wettest load should be not less than DM_{min} and the driest load should not exceed DM_{max}. The average value for the material in the whole silo, depending on the conditions, should then be between 300 and 400g DM/kg or a little lower. In practice, green fodder is still often too heavily wilted for ensiling. The priority, however, should not be to have a certain DM content that absolutely must be achieved, but instead, constantly to ensure a good silage quality by observing the optimum cutting time, short wilting and application of efficient silage additives.

3. Final conclusions

It remains to be established that there are still many unused possibilities to improve the quality of grass and legume silages. The scientific knowledge and the agents available today enable to ensure a substantial higher level of silage quality than previously. Silage additives are no longer just something for emergency situations but should now form a regular part of the conservation procedure. In order to ensure the highest possible milk yields through best silages, we should make greater use of these than we have done in the past.

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SILAGE IN THE NUTRITION OF HIGH-PERFORMING DAIRY COWS

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In the recent years a considerable increase could be observed in the efficiency of dairy cows. The average production of about 10,000 kg milk in the herd per dairy cow and year as well as the individual production of more than 20,000 kg milk indicate at the limits of the physiological abilities of the animals which are conditional on the following:

- intake of energy and nutrients in the organism conditioned by keeping to the structure of the feed-stuff,
- capacity of digestion and absorption; the destructive and synthetic capacity of microorganisms in the forestomachs,
- mobilizing capacity of nutrients in the organism (in the course of the first 8 weeks of lactation the cow is able to produce about 7 kg milk per day from its physiological reserves)
- the capacity of synthesis (e.g. glucose) in the metabolism (mainly liver and mammary gland)
- stability of the skeleton
- health condition (immune system)
- reproduction including functioning of the endocrine system.

From the abovementioned it follows that intake of feed and thus also the inevitable amount of energy and the other nutrients appears to be a decisive criterion to ensure good health and production of the dairy cows. Regulation of food intake controls the metabolism with regard to production. In animals food intake and thus also the degree of saturation is principally regulated by *physiological and physical factors* (Fig. 1). Physical – mechanical factors prevail if ruminants are fed roughage. There is a close relation to the filling capacity of the rumen. The sooner the rumen is emptied between feedings, the greater is the consumption of roughage by the dairy cows. The speed of food passage depends to a great extent on the intensity of microbial processes in the rumen, which depends on the motility of the forestomachs and production of saliva with regard mainly to the physical structure of feeds and their digestibility.

In general it can be said that high-performing dairy cows must have - in relation to their live weight and milk production - a daily intake of up to 24 kg dry matter of feeds (out of these an average of 12 kg and more roughage dry matter). The intake of dry matter is influenced by the following factors:

- the animal itself (live weight, size of rumen, stage of lactation, reproduction processes)
- feed-stuffs
- feeding technique

It is generally well known that food intake markedly increases with increased milk production which is mainly caused by increased grain rations, but high-performing dairy cows have an increased roughage intake as well.

The feed intake of animals is mostly affected by the quality of feeds. Good quality is characterized by high digestibility that is related to the vegetation stage of plants and the way of conservation. Silages have proved to very positively affect the intake of roughage dry matter; this is due to the structural effect that causes a decrease of the volume of ingested feeds. The content of *silage dry matter* is of decisive importance. With each percent of increased dry matter contents in silages the DM intake increases to as much as 0.5 kg and 0.1 kg with maize and grass silage, respectively. This however is valid just up to a certain content of dry matter in the silage. On the contrary, with a very high DM content the DM intake of dairy cows decreases. One of the other important effects is the length of the cuts.

Table 1. Recommended length of silage cuts in combined feeding rations (KALAYCI, U. 1998)

Fraction	Silage		Combined feeding ration
	Maize	Grass	
Coarse (19 > mm)	10 – 15 %	15 – 25 %	6 – 10 % and more
Medium (8 – 19 mm)	40 – 50 %	30 – 40 %	30 – 50 %
Fine (< 8 mm)	up to 50 %	up to 50 %	up to 60 %

In order to provide suitable conditions for the fermentation processes in the rumen, 15-20% of the roughage (silage) cuts should have a length of more than 2 cm. With the theoretic length of cuts surpassing 1 cm and a sufficient amount of roughage in the feeding ration the structure of the latter can be expected to be suitable. When grass silage is cut to 1.2 – 2.0 cm there is a sufficient amount of more than 4 cm long cuts. On the other hand maize silage is much more fine-cut (theoretical length of cuts 0.4 – 0.8 cm) therefore feeding rations with a prevailing share of maize silage must be supplemented either with hay or with grass silage.

Since rumen fermentation processes are decisive from the viewpoint of milk production, the number of lactations (longevity of dairy cows), the fat content of the milk as well as the health state (condition) of high-performing dairy cows, the following equations have been reported by STEINWIDDER and WURM (2003) to calculate the structural values (SV) of silage:

Grass silage = SV = – 0.20 + 0.0125 . XF (crude fibre)
Hay = SV = (– 0.20 + 0.0125 . XF) . 1.06
Maize silage = SV = – 0.10 + 0.0090 . XF

Length of cuts 6 mm (at shorter or longer cuts ± 2% of the SV per each mm).

In dairy cows fed GPS silage of different length (A = 6.8 cm &B = 2.8 cm) the latter became manifest - in addition to the abovementioned factors - also in an increased intake of shorter cuts, increased efficiency as well as a higher fat and protein content of the milk.

Table 2. Effect of cut length in GPS silages on feed intake and milk production of dairy cows (GUTH et al. 1998).

Parameter		A	B
DM intake from feed volume	kg/d	16,1	16,7
Total intake of DM	kg/d	17,3	18,2
Milk FCM	kg/d	15,1	16,6
Fat content of milk	%	4,41	4,44
Protein content of milk	%	3,34	3,45

The abovementioned structural value of silage positively affects chewing and rumination of the dairy cows lasting in maize silage and grass silage-fed animals 40-70 minutes and 100 – 120 minutes/kg DM, respectively. This ensures the condition for a daily secretion of as much as 300 l saliva which to a great extent contributes to stabilization of the fermentation processes in the rumen.

An important factor to ensure the needs of energy and the other nutrients for efficient/high milk production through rumen fermentation is presented by the degradation of silage nutrients in the rumen; e.g. with grass silage the latter depends on the time of harvest and wilting but also on the way of conservation. The effect of these factors is very different- For this reason the individual ways of treatment must always be chosen in accordance with the situation at the very moment.

Table 3. Effect of different wilting times and ensilaged grassland crops treatment on nutrient digestibility and energy content (MANZKE et al., 1998)

Way of treatment	Coefficient of digestibility (%)			Energy level (MJ NEL)		
	OH	XF	XX	absolute	relative[1)]	
Wilting time: 24 h						
Control	70,1	73,2	69,6	5,99	(100)	/100/
LAB	72,3	75,1	71,0	6,16	(103)	/100/
HP	71,1	73,9	70,5	5,96	(99)	/100/
Wilting time: 48 h						
Control	64,5 a	70,2 a	60,9 a	5,32 a	(100)	/89/
LAB	69,8 b	74,6 b	66,8 b	5,84 b	(110)	/95/
CHP	69,2 b	74,2 a	67,9 b	5,77 b	(108)	/97/
Wilting time: 96 h						
Control	63,4	69,7	57,9 a	5,18	(100)	/86/
LAB	62,8	68,3	58,1	5,14	(99)	/83/
CHP	64,2	69,3	60,1 b	5,28	(102)	/89/

Control – untreated matter, LAB – treatment with lactic acid bacteria
CHP – treatment with chemical preparation
[1)] ( ) = Relative comparison between treatments, / / = Relative comparison between wiltings

Table 4. Effect of harvest time and variety on the digestibility of organic matter and fibre in maize silage (PEX et al., 1996)

Time of harvest	Variety		
	C	F	M
Dry matter contents 23 – 26 %			
Degradation (%)			
- organic matter	74.0 ± 0.9	71.2 ± 4.0	71.3 ± 1.3
- fibre	63.5 ± 2.4	61.5 ± 1.2	58.7 ± 3.3
Dry matter contents 27 – 32 %			
Degradation (%)			
- organic matter	72.8 ± 2.7	74.7 ± 1.1	76.6 ± 1.1
- fibre	61.0 ±1.7	59.9 ± 2.4	61.3 ± 2.2
Dry matter contents 34 – 41 %			
Degradation (%)			
- organic matter	74.6 ± 1.6	74.9 ± 1.6	76.6 ± 1.5

With maize silage there is also a dependence on the variety and the time of harvest. It follows from a number of experiments that there is a relation between the time of harvest, the content of fibrous material in the plant and starch levels in the grain. With the increasing degree of maturation effective degradability of organic matter of maize silage in the rumen of dairy cows becomes markedly decreased. Maize grain silage increases effective starch degradability by about 6%. However, differences of 70 to 84% (SCHWARZ and ETTLE, 2000) can be observed between different varieties. From the viewpoint of digestibility of organic matter (Table 4) and effective starch degradation dry matter contents of 30-40% in maize silage seem to be the most favourable.

With high milk production (40-50 kg/animal and day) and also systematic decrease of the costs necessary for the production of mainly feeds, all the year round feeding of silage is being started in high-performing herds. This means also new requirements for production, losses and quality of silage in the course of the year.

The question of necessity or effective treatment of silage maize presents a frequent matter of discussion. Supporting the fermentation process by means of bacterial preparations seems to have positive effects on the parameters and quality of maize silage. Intake of the latter by the animals is improved, thus efficiency of the animals increased.

Table 5. Feed intake and live weight gains in bulls fed maize silage (MANZKE et al., 1998)

	Control group (untreated silage)		Experimental group (treated silage)	
DM intake (in kg / animal . day^{-1})	6,3	(100)	6,6	(105)
- of this silage	4,5	(100)	4,8	(107)
Energy intake (MJ ME/ $anim.day^{-1}$)	68,7	(100)	72,4	(105)
Daily live weight gain (g/ $anim.day^{-1}$)	1164	(100)	124,8	(107)

However, aerobic instability of silages with increased dry matter contents and nutrient levels (maize silage, CCM, GPS a. o.) presents a rather frequent problem. Such silages negatively influence the intake and digestibility of nutrients (BOLSEN et al., 2001) - Table 6.

Table 6. Effects of aerobically treated maize silage on the intake and digestibility of nutrients

FEEDING RATION WITH EXPERIMENTAL VARIANTS (BOLSEN et al., 2001)				
	A	B	C	D
Daily intake of DM	0 % bad silage	25 % bad silage	50 % bad silage	75 % bad silage
$kg.day^{-1}$	7.95	7.34	6.94	6.66
Digestibility of organic nutrients %				
Organic matter	75.6	70.6	69.0	67.8
Crude protein	74.6	70.5	68.0	62.8
NDF	63.2	56.0	52.5	52.3
ADF	56.1	46.2	41.3	40.5

Feeding such silage to animals results in defaunation of the rumen or decrease of the volume of ruminal fauna (change of the number of rumen micro-organisms) and may affect also milk quality.

The endeavour to improve the course of the fermentation process simultaneously with the stability of the silage produced has in the recent years become evident by the increasing offer of silage preparations containing the individual strains but also combinations of homo- and heterofermentative bacteria.

Comparison of the effects of several combinations of homofermentative as well as heterofermentative bacteria of milk fermentation with propionic acid bacteria was used to study silage maize conservation (Table 7). When compared to untreated controls, application of all combinations of preparations was observed to result in decreased pH levels. Except of one case decreased lactic acid levels, increased acetic acid levels and improved stability of the silage produced were observed with all combinations. It followed from these findings that stability of the silage produced could be markedly affected by the application of combinations of bacteria. However, this improvement is dependent on the technological level, composition and the mutual ratio of bacteria but also on their other properties as growth speed, competitiveness a. o.

Table 7. Some fermentation indices (in $g.kg^{-1}$ dry matter) of maize silages treated by different preparations (GALLO 2001)

Treatment	pH	Lactic acid	Acetic acid	Propionic acid	Acetic acid total
Untreated	3.95	52.18	8.03	8.71	16.73
HoLAB 2 strains	3.79	54.53	7.44	11.41	18.85
HoLAB + PB	3.82	48.89	9.09	9.44	18.53
HoLAB 4 strains + HeLAB	3.82	45.20	13.89	19.64	33.53
HoLAB + PB + HeLAB	3.91	40.99	12.19	5.93	18.12
HoLAB 3 strains + HeLAB 2 strains	3.80	52.50	14.65	13.96	28.61

HoLAB - homofermentative lactic acid bacteria, HeLAB – heterofermentative lactic acid bacteria, PB – propionic bacteria

The use of ensilaging preparations in maize silage production is often substantiated a necessity. According to the concrete conditions silage producers have to chose the preparations improving aerobic stability or improving both the fermentation process and aerobic stability of silage. It is not possible or necessary to recommend general and preventive application of silage preparations. Each application and choice of preparations must be well considered and targeted.

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FORAGE PRODUCTION

EVALUATION OF GRASSLAND QUALITY WITH HIGHER PORTION OF WEED AND TOXIC SPECIES

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INTRODUCTION

Vegetation because of its content of above-ground phytomass encroaches most part of our environment and creates the most important sustainable source for herbivores in the ecosystem. There are about 90 millions hectares of grassland under the complicated geo-ecological conditions of Europe (excluding Ukraine and Russia), and about 3 milliard in the world (Voigtländer-Jacob, 1987). The pastures and meadows in mountains and foothills, which are used by agriculture are mostly multicomponental grass-herbage coenosis, consisting of plants in different combinations. The assumption that everything green is good for forage is wrong. There are species with different forage value on the grasslands and meadows. It is highly necessary to know about this natural treasure, to use it efficiently and rationally, and at the same time to preserve it for future generations (Novák, 2000).

The general tendency of laboratory methods is to overestimate the real quality of most plants as well as the above-ground biomass of grasslands. Moreover, chemical analyses are very expensive. Chemical analyses are oftentimes useless, mainly in case of higher content of inferior species on the grassland. The simplest evaluation of grassland from a floristic point of view is needed for practice, to set the quality and forage value. The most inexpensive method is a method of estimation based on botanical composition, which enables us to set the quality of forage accurately, without demanding chemical analyses. The most objective method seems to be a combination of chemical analyses and evaluation of the quality, on the base of floristic composition and forage values of individual plant species in the evaluated grassland. (Opitz von Boberfeld, 1994; Novák, 2000).

There are also well known scales for forage values of individual plant species and grassland classification. Albrecht von Thaer (1810) was the first author who published the list of grassland plants, later other authors continued: De Vries et al. (1942), Ellenberg (1952), Klapp-Boeker-König-Stählin (1953), Regal (1958), Stählin (1971), Šoštarič-Pisačič-Kovačevič (1974) and Jurko (1990).

MATERIAL AND METHODS

In 1992-2000, 1200 analysed pastures sites in the West Carpathians were studied. Examined areas (altitude ranging from 370 to 1150 m with various acclivity up to 25°) are mainly flysch sediments and weathered layers of cristalline rock (granite, paragneiss and others). The soils are mainly acid, up to strongly acid, alkaline only in case of application of lime soil substrates, mainly from medially heavy to heavy, here and there lighter, mostly clay loam, on some places with gravely structure. The predominant types of soil are Cambisols, Podzols, eventually Planosols or Gleyosols, on some places in the Orava region Histosols. The soils mostly content sufficient amounts of potassium, but insufficient amount of phosphorus.

For the evaluation of grassland quality it is necessary at first to find out the percentage of coverage (D - dominance) for different plant species in floristic groups. If the ground cover is homogenous, floristic analysis corresponds with one type of cover and area approximately up to 25 m^2. The estimation of coverage is given in percentage. The species, above-ground biomass of which does not reach 1 % are marked by a symbol +. The sum of coverage of individual components together with empty places gives 100 %. There is subsistent forage value from the 13 point scale (from –4 to 8) for every plant species. 8 is given to the highly valuable species and –4 to the toxic ones. For the computation of the total quality of the ground cover the following equation is used:

$$E_{GQ} = \frac{\sum (D \times FV)}{8}$$

where E_{GQ} - evaluation of grassland quality, D [%] - predominance of species and FV - forage value of species.

RESULTS AND DISCUSSION

The predominating associations in the grasslands were *Lolio-Cynosuretum***,** more rarely *Festuco-Cynosuretum, Agrosti-Festucetum*, here and there also *Anthoxantho-Agrostietum*, pertinently *Trisetetum* and *Nardetum.* The floristic group of grasses was in average 38.30 % (optimal value 50-70 %) and leguminoses 13.20 % (optimal value 15-25 %). Other herbs formed the rest. E_{GQ} reached from the 100-point scale values of 59.80. The sites were mainly very sparse (15.80 % of barren places).

Worthless, pertinently deleterious species (FV from 2 to 0) in case of their higher share radically lower the forage value, adulterate forage and create the weed component of the grassland. Into this group there can be also included the plants with low leaf rosette (FV from 1 to 2), appearing on the sites which are heavily trampled, and so they are reachable neither by the grazing animals, nor by the mowing machines, e.g. *Bellis perennis, Plantago major, Potentilla anserina* and others. There are the weeds, which present warning danger even in case of low amounts, with high reproductive coefficient (international code +++), e.g. *Anthriscus sylvestris, Arctium spec., Cirsium arvense, Chenopodium bonus-henricus, Rumex spec., Urtica dioica* and others. The plants which cause mechanical damage to the digestive organs of animals (FV = 0), e.g. *Carduus spec., Calluna vulgaris, Carlina acaulis, Cirsium arvense, Genista spec., Ononis spinosa, Vaccinium myrtillus, Vaccinium vitis–idaea* and others are also included into this group.

Special attention should be paid to toxic species (FV from –1 to –4). In the agreement with the authors Kalač-Míka (1988), Frantová-Ofúkaný (1990) and Míka et al. (2001), we consider the toxic species to be dangerous, requiring special attention when evaluating the grassland. The number of poisonings and toxicoses of domestic animals caused by toxic plants , which has recently dramatically grown, supports this idea. The danger of long-term toxicoses should not be underestimated, even though their forms are various and thus the identification of their sources is very difficult. In case of their considerable share in the forage they cause direct and non-direct losses; they cause the harm to the animal organism, influence neural system, induce the inflammation of digesting system, colics, irritation and damage of kidneys, they disturb acido-basic conditions, induce acidosis, toxicosis, even seldom death loss. Their impact on the final products - milk and meat, that can be toxic or at least not convenient for people is not neglectable either. Economic consequences of damages caused to animals and people by chronic toxicosis are at present bigger that those of contagious diseases.

Toxic species most common in the grass cover (*Cardamine pratensis, Colchicum autumnale, Euphrasia rostkoviana, Equisetum palustre, Odontites vulgaris, Ranunculus acris, Rhinanthus minor, Senecio jacobaea, Tithymalus cyparissias*) appeared on the analysed sites on average in share of tenths or hundredths per cent and just locally in higher share. They contain toxic alkaloids, influence digestibility of organic biomass, that results in the fact, that they are less grazed on the pastures, or are not grazed at all, and therefore are left on the pasture ungrazed. They destruct acidobase environment, influence neural system and cause acidosis, toxicosis and rarely death loss. Their categorization into the weeds depends on their numerousness, growth phase and condition during feeding. Special attention should be paid to semiparasitic plants, e.g. *Euphrasia rostkoviana, Odontites vulgaris, Rhinanthus minor* and others, parasitic plants, e.g. *Cuscuta epithymum, Orobanche spec.* and others. As the adult animals can distinguish the toxic species, they leave them on the pasture as the residual herbage, therefore they are rarely poisoned directly on the pasture. However, in the form of fresh mown forage, silage or hay they can be barely distinguished.

CONCLUSION

Evaluation of grassland quality was verified over ten years in 1 200 floristic analyses of grassland in the Western Carpathians. The quality of grassland can be understood on the base of floristic analysis. The floristic group of grasses was in average 38.30 % (optimal value 50-70 %) and leguminoses 13.20 %(optimal value 15-25 %). Evaluation of Grassland quality (E_{GQ}) oscillates within the range from minus values (toxic), through deleterious, worthless, low values, lower values, valuable, high values to top values of grassland with maximum value of 100. The sites were mainly very sparse (15.80 % of barren places). E_{GQ} reached from the 100-point scale values of 59.80. Worthless, pertinently deleterious species in case of their higher share radically lower the forage value. Toxic species cause the harm to the animal organism, influence neural and digesting system, induce colics, damage of kidneys, they disturb acido-basic conditions, induce acidosis, toxicosis, even seldom death loss. The evaluation of grassland can give a clue for the general or partial reconstruction, eventually revitalisation by additional seeding to increase forage value.

Keywords: grassland, floristic analysis, forage value, evaluation of quality

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QUALITY OF SIMPLE CLOVER-GRASS MIXTURES UNDER DIFFERENT SOWING PORTIONS

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INTRODUCTION

Clover-grass mixtures have got significant position in forage production of upland and mountain regions. In comparison with monocultures of clovers they are more advantageous from productive, qualitative and non-productive point of view (Klimeš and Kobes, 1999; Jargiello et al., 1990).

Opinions on the proportion of components in short-term clover-grass mixtures are different. Dančík (1973) gained the best results with the proportion of 75% of red clover in sowing, Halva et al. (1979) with its proportion of 60%. Klimeš and Kobes (1999) recommend the proportion of 80% of red clover into two-years clover-grass mixtures. Only in the mixtures with more slowly developing species such as *Festuca arundinacea* SCHREB. or *Festulolium* (festucoid type) for two-years growing they recommend 70-80%. On the contrary Turek et. al. (1993) considers the proportion of 55% of tetraploid red clover in mixtures with intergeneric grass hybrids in sowing as sufficient. With its higher proportion the increased expenses on red clover seeds were not covered by the higher yield of dry matter.

MATERIALS AND METHODS

The field small-plots experiment was carried out at submountain region of Slovakia (Liptovský Mikuláš) during the period of 1997-1998. The long-term annual precipitation is 689 mm, the long-term average annual air temperature is 6.7 °C. The soil type of the experimental stand is fluvizem typical of clay-sand character with ph 5.9, with the content of 165 mg of P, 112 mg of K and 32.7 mg of humus in 1 kg of soil.

Four two-components mixtures of tetraploid red clover (cv. Sigord) with grasses were used: M1 - with *Dactylis glomerata* cv. Dana; M2 - with *Lolium perenne* cv. Mustang (4n); M3 - with *Festulolium* Hykor; M4 - with *Festulolium* Felina.

Two proportions of red clover and grasses in sowing were used in the experiment (80:20 and 50:50). Before the initiation of the experiment and in the spring of the next year the PK fertilisation was used in the dose of 30 kg.ha^{-1} of P and 60 kg.ha^{-1} of K. In the year of sowing two cuts were realised (20.VII. and 15.IX); three cuts were realised in the second year of growing (30.V., 24.VII. and 3.X.). In the contribution we are evaluating the quality of mixtures according to the content of crude protein, crude fibre, insoluble phenols (CPFI), PDI and NEL values.

RESULTS AND DISCUSSION

In the year of sowing at the seeding rate of 80:20 red clover dominated in mixtures (tab. 1). In the mixtures with *Dactylis glomerata* (M1) and *Lolium perenne* (M2) was its portion in yield lower than in the sowing (60% and 66% respectively), on the contrary in the mixtures with intergeneric grass hybrids (*Festulolium*) the portion of red clover was higher (89% - M3; 90% - M4). At seeding rate 50:50 the grasses were already dominating in the year of sowing. In the second year of growing grasses began to dominate in mixtures even within the seeding rate of 80:20, most of them competitively strong *Dactylis glomerata*. The gained results of the botanical composition of clover-grass mixtures correspond with the results published by Klimeš and Kobes (1999) and support the results of Rataj et al. (1997) about the weaker competitive ability of intergeneric grass hybrids in comparison with tetraploid red clover, which they did not suppress in the mixture.

In the year of sowing the yields of mixtures varied from 8.10 to 10.81 t.ha^{-1} of dry matter. At the sowing portion of 80:20 the mixture with *Dactylis glomerata* (M1) was the most productive (10.81 t.ha^{-1}), at the portion of 50:50 the mixture with *Lolium perenne* (M2) provided the highest yield of dry matter (10.72 t.ha^{-1}). In the second year of growing at sowing rate of 80:20 the mixtures with *Festulolium* (M3 and M4) were more productive then the mixtures M1 and M2. At sowing rate 50:50 the mixture with *Lolium perenne* (M2) was the most productive as well as in the year of sowing (17.57 t.ha^{-1}). The differences between the mixtures and between the sowing portions were not statistically significant.

It came into evidence that even with the lower portion of more expensive tetraploid red clover in sowing is not significant reduction of the yield of mixtures. In the mixture with tetraploid cv. of *Lolium perenne* the yield was in favour of the sowing rate of 50:50 in both years, what identically published Turek et al.(1993).

The average content of crude protein varied in range of 152.77-210.51 g.kg^{-1} of dry matter and corresponded with the portion of red clover in the yield - it was higher at the portion of 80:20 and in the year of sowing. The contents of PDI (94.08-133.56 g.kg^{-1} of dry matter) and NEL (6.09-6.98 MJ.kg^{-1} of dry matter) were also usually higher at the sowing portion of 80:20 and in the first year of growing. The contrary tendency was apparent at crude fibre. The lowest content of crude protein and PDI within mixtures had mixture M1 (with *Dactylis glomerata*), which had also the highest content of crude fibre and CPFI. The high portion of *Dactylis glomerata* in the mixture and species disposition caused the highest content of CPFI in this mixture. Slamka (1998) found out very strong negative relation between the amount of CPFI and the digestibility of the organic matter. From the facts mentioned above it is possible to presume the highest digestibility of biomass in the mixture with tetraploid cv. of *Lolium perenne* - M2 (the lowest value of CPFI) and the worse digestibility in mixture with *Dactylis glomerata* (M1).

Table 1. Dry matter yields and quality of clover-grass mixtures

Mixture	Seeding rate	Year	Portion of red clover in mixtures %	Dry matter yields $t.ha^{-1}$	Crude protein $g.kg^{-1}$ of d.m.	Crude fibre $g.kg^{-1}$ of d.m.	PDI $g.kg^{-1}$ of d.m.	NEL $MJ.kg^{-1}$ of d.m.	CPFI $g.kg^{-1}$ of d.m.
M1	80:20	1997	60.0	10.81	185.88	243.37	125.11	6.19	
		1998	31.0	15.96	158.78	292.81	102.24	6.10	10.25
	average		45.5	13.39	169.72	272.85	111.47	6.14	
	50:50	1997	37.0	9.86	182.03	256.29	117.22	6.15	
		1998	23.0	16.07	156.89	297.91	103.32	6.09	
	average		30.0	12.97	166.45	282.08	108.61	6.11	
M2	80:20	1997	66.0	9.94	200.07	239.92	128.83	6.22	
		1998	62.0	16.78	179.10	259.99	115.76	6.11	7.39
	average		64.0	13.36	186.90	252.52	120.62	6.15	
	50:50	1997	36.0	10.72	181.16	247.67	116.65	6.82	
		1998	42.0	17.57	162.68	272.11	94.08	6.09	
	average		39.0	14.15	169.68	262.85	102.63	6.36	
M3	80:20	1997	89.0	8.44	207.41	215.71	133.56	6.23	
		1998	61.0	17.65	167.69	256.15	107.98	6.11	7.89
	average		75.0	13.05	180.54	243.07	116.26	6.15	
	50:50	1997	56.0	9.76	196.57	230.87	126.57	6.19	
		1998	36.0	16.37	163.87	301.01	105.52	6.10	
	average		46.0	13.07	176.08	274.81	113.38	6.13	
M4	80:20	1997	90.0	8.10	210.51	205.88	130.10	6.98	
		1998	60.0	17.32	165.62	297.91	106.65	6.09	7.81
	average		75.0	12.71	179.92	268.58	114.12	6.37	
	50:50	1997	45.0	8.43	205.94	222.58	132.61	6.11	
		1998	39.0	16.39	152.77	272.47	98.37	6.10	
	average		42.0	12.41	170.83	262.07	109.99	6.10	

CONCLUSIONS

The productive ability and quality of four simple mixtures of *Trifolium pratense* (Sigord 4n) with *Dactylis glomerata* (Dana) - M1, *Lolium perenne* (Mustang 4n) - M2, *Festulolium* (Hykor) - M3 and *Festulolium* (Felina) - M4 respectively were studied in the field experiments at submontain region (Liptovský Mikuláš) during the period of 1997-1998. Two sowing rates of components (80:20 and 50:50) were used in the trial. In a total of two years the mixture of *Trifolium pratense* with *Lolium perenne* produced the highest yield. The contents of crude protein, PDI and NEL corresponded with a portion of red clover in mixtures. The smallest content of crude protein, PDI and NEL and the highest content of crude fibre and CPFI were determined in the mixture of *Trifolium pratense* with *Dactylis glomerata*.

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POSSIBILITIES OF USING A SWARD WITH ADDITIONAL SOWING OF *FESTUCA ARUNDINACEA* AND HYBRID FELINA FOR ENSILAGE

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SUMMARY

A semi-cultivated grass stand with dominant *Festuca rubra*, *Agropyron repens*, *Dactylis glomerata*, *Poa* ssp., *Phleum pratense*, *Festuca pratensis*, *Lolium perenne*, *Ranunculus repens*, *Cirsium arvense* was subjected to plough-free additional strip sowing with *Festuca arundinacea* and intergeneric hybrid Felina (*Festuca arundinacea* x *Lolium multiflorum*). The sward is used extensively and a possibility was investigated of its use for extended autumn or winter grazing. Growing season forage from the so called preparatory cuts is meant for conservation by ensilaging or for drying. First cut quality was evaluated in summer and quality of the second cut was measured at its harvest after 30 or 60 days. Characteristics studied were as follows: NEL content, WSC, contents of N-substances and ash in forage DM assessed by the NIRS method. It follows from the research results that the first cut from the beginning of June can be used for conservation by ensilaging.

INTRODUCTION

With the period of grazing being extended to autumn or winter months, animals are given forage from the summer growth (so called forage on stalk) but additional feeding with conserved fodder is needed, too. According to Opitz von Boberfeld (2002), energy requirements of cows without market production of milk and of the growing meat cattle are not so high as those of dairy cows. Sufficient basis is a proper utilisation of medium-quality straw and hay from extensive grass stands. Herbage that is cut and immediately conserved will reach energy contents and contents of N-substances comparable with the parameters of straw (Opitz von Boberfeld, 1996). Furthermore, the hay from extensive grasslands shows a better acceptation in comparison with straw (Jilg and Briemle, 1992).

As compared with hay making, ensilaging has a lower risk of weather impact, which favourably reflects in working costs and low conservation losses. Commercially successful all year pasture management of cows without market production of milk heads towards the extensive management of swards in larger areas (Opitz von Boberfeld, 2002). In these grass stands N-fertilisation makes the ration more expensive which can be prevented by restrictive N-fertilization. On the other hand, the restriction of N-doses in connexion with an extremely overmature sward may result in faulty butyric acid fermentation due to the extremely low content of nitrates in the to-be-ensilaged herbage (Opitz von Boberfeld and Sterzenbach, 1999). Nitrite developing from nitrates kills *Clostridia* which are responsible for undesired butyric acid fermentation. Provided that the ensilaged material is not contaminated (*Clostridia* are soil bacteria) from extensive grasslands, the ensilage is sufficiently rammed and air forced out, the process of ensilaging need not necessarily result in poor fermentation (Opitz von Boberfeld, 1997). Requirements of conserved feeds during winter grazing are hard to predict as they depend on the general course of weather (Opitz von Boberfeld, 2002). According to Opitz von Boberfeld (1994), material suitable for conservation is the growth of perennial swards.

MATERIAL AND METHODS

Herbage quality from a semi-cultivated sward with additional sowing of *Festuca arundinacea* and intergeneric hybrid Felina (*Festuca arundinacea* x *Lolium multiflorum*) was assessed in a small-plot trial established at an altitude of 553masl in the Bohemian-Moravian Upland. Species dominant in the original sward prior to the additional sowing were *Festuca rubra*, *Agropyron repens*, *Dactylis glomerata*, *Poa* ssp., *Phleum pratense*, *Festuca pratensis*, *Lolium perenne*, *Ranunculus repens*, and *Cirsium arvense*. Sward quality was evaluated in winter (preconditions for a so called winter grazing) and summer months (use for hay or ensilage) with the sward being used for grazing in June and then in July (off-set 30 days between the 1st and 2nd cut) or in June and then in August (off-set 60 days between the 1st and 2nd cut). Spring fertilisation of the sward was 50kg N, 30kg P and 60kg K.ha^{-1}. Herbage samples were dried at 60°C and analysed by NIRS method. Characteristics measured were: net energy of lactation (NEL), water-soluble carbohydrates (WSC), N-substances and ash. Results are for two years of study 2000-2002.

RESULTS AND DISCUSSION

As it follows from Tab. 1, the content of N-substances ranged from 112.7 g.kg^{-1} to 201.5 g.kg^{-1} in dependence on the cut and on the added species. Average content of N-substances in the 1st cut (June) was 121.7 g.kg^{-1}; the 2nd cut (July) had a significantly higher content of N-substances (196.8 g.kg^{-1}) as well as the delayed 2nd cut (August) – 120.3 g.kg^{-1}. As compared with the control, the additional sowing had no significant effect on the increase of N-substances. The content of water-soluble carbohydrates was higher in older herbage, its values in the 1st cut ranging from 40.4-41.9 g.kg^{-1}, from 28.0-39.5 g.kg^{-1} 30 days after the first cut, and from 34.8-42.8 g.kg^{-1} 60 days after the first cut. NEL was lowest in the 1st cut at the beginning of June, its values amounting to 5.3 MJ.kg^{-1} both in the stand with- and without additional sowing. Values for the 2nd cut at the beginning of July were 5.6-5.8 MJ.kg^{-1} and 5.4-5.6 MJ.kg^{-1} for the 2nd cut at the beginning of August. Tab. 2 indicates that the time of cut had a highly significant effect ($\alpha < 0.01$) on the contents of N-substances, WSC and NEL while the additionally sown species exhibited a significant effect ($\alpha < 0.05$) only in the WSC-content. Similarly, the content of ash was significantly highly affected ($\alpha < 0.01$) by the time of cut and significantly affected ($\alpha < 0.05$) by the additionally sown species. Nevertheless, the content of ash was lowest in the 1st

cut at the beginning of June, when it reached –depending on the added species- values from 78 g.kg^{-1} to 86 g.kg^{-1} and highest in the 2nd cut at the beginning of August (102 g.kg^{-1} – 117 g.kg^{-1}).

Average production in June, July (30 days after 1st cut) and August was 17.0 t.ha^{-1} fresh weight of average DM at 23%, 6.0 t.ha^{-1} fresh weight of av. DM at 21%, and 8.5 t.ha^{-1} fresh weight of av. DM at 27%, respectively. According to Opitz von Boberfeld (2002), hay originating from swards rich in species should contain 92.0 g.kg^{-1} N-substances and 5.1 MJ.kg^{-1} NEL at harvest towards the end of June, and 80 g.kg^{-1} N-substances and 4.4 MJ.kg^{-1} NEM at harvest in August. Ensilage made of swards rich in species should contain 108 g.kg^{-1} N-substances and 6.5 MJ.kg^{-1} NEL. According to Haigh (1995), a successful process of ensilaging requires an amount of 37 g.kg^{-1} WSC at least. The criterion was reached in the June variants both with- and without the additional sowing. The lower content of WSC (especially in July) in connexion with the low production impair the possible use of second cuts for conservation by ensilaging.

Table 1. Average, minimum and maximum values of N-substances, WSC and NEL in the sward in dependence on cut and additionally sown species

Month	Added species	N-subst. (g.kg DM^{-1})			WSC (g.kg DM^{-1})			NEL (MJ.kg DM^{-1})		
		min	x	max	min	x	max	min	x	max
June (1st cut)	No addition	79,9	112,7	138,2	33,5	41,7	52,9	4,9	5,3	5,6
	F.a.	93,9	122,6	150,3	30,0	40,4	52,1	4,7	5,3	5,6
	Felina	111,6	129,9	163,4	30,3	41,9	59,8	4,9	5,3	5,7
July (30 days after 1st cut)	No addition	143,2	200,5	263,9	6,3	28,0	56,6	4,4	5,6	6,3
	F.a.	152,3	188,4	243,1	21.0	39,5	52,3	5,4	5,8	6,2
	Felina	156,7	201,5	274,9	17,1	34.0	47,8	5,2	5,7	6,3
August (60 days after 1st cut)	No addition	126,7	172,3	254,1	18,6	34,8	55,3	4,6	5,4	6,3
	F.a.	123,6	169,8	288,8	23,7	42,8	60,0	5,0	5,5	6,2
	Felina	105,8	171,9	253,3	23,3	41,7	68,5	4,9	5,6	6,4

Table 2. Significance of the effect of studied factors on the contents of nutrients

	N-substances	WSC	NEL	Ash
Month	0,000	0,006	0,000	0,000
Added species	0,640	0,025	0,259	0,038
Month x ad. species	0,753	0,226	0,817	0,006

CONCLUSION

The sufficient amount of conserved fodder for extended autumn or winter grazing may be ensured by using the forage from so called preparatory cuts in the growing season. The first cut is suitable for ensilaging both with respect to production and with respect to the content of water-soluble sugars and other nutrients. The additional sowing of *Festuca arundinacea* or intergeneric hybrid Felina has a pronounced effect only on the increased WSC content in the second cuts. If the sward is used -before the resting stage which is to ensure production in autumn and winter months- as late as in July, i.e. 30 days after the 1st cut, it appears less fitted for ensilaging. The same applies in the case when an off-set of 60 days is left between the 1st and 2nd cut.

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HERBAGE DRY MATTER CHEMICAL COMPOSITION OF PERMANENT GRASSLAND AFTER CESSATION OF FERTILIZATION

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After the cessation of eight-year mineral fertilisation of semi-natural grassland, changes in the chemical composition of grass biomass were investigated in the period 1994-2002. The most distinct decrease was detected in nitrogen (by 46%), sodium (by 33%). A slight decrease was found in magnesium levels (by 2%) and potassium content (by 9%), while phosphorus and calcium concentrations increased (by 10 and 5 %, respectively).

INTRODUCTION

Intensive fertilisation and exploitation of semi-natural grassland changes the chemical composition of grass matter. Dry matter nutrient concentration always reflects the changes in botanical composition and the actual effect of applied fertilisers (Velich 1986, Holúbek 1991).

However, at present the problems of structural changes in semi-natural grassland chemical composition after the reduction or complete absence of inorganic fertilisation seem to be topic. Botanical diversity of these grasslands has been changing over the years, with dicotyledonous plants tending to acquire a dominant position (Jančovič 1996), which can adversely affect the quality of above-ground biomass and its fitness for conservation (Nősberger and Kessler 1997).

The aim of this contribution is to describe the changes in chemical composition of semi-natural grassland grass matter after the cessation of inorganic fertilisation.

MATERIAL AND METHODS

The changes in grass matter chemical composition, which took place after the cessation of 8-year fertilisation, were investigated on semi-natural grassland (*Lolio-Cynosuretum typicum* R. Tx. 1937) on the site of Chvojnica (altitude 600 m above sea level) in Strážov Hills (mountains in central Slovakia).

The experiment was established in four replicates and the area of one experimental harvest plot was 10 m^2. In the period 1986-1989 harvest was carried out on all treatments at stage of pasture maturity four times a year. In a subsequent period (1990-1993) harvest was carried out differently, according to the amount of fertilisers applied at a hay-cut maturity growth stage three times a year. Botanical analysis using the reduced projective dominance method was performed before each cut to determine the botanical composition changes in individual treatments.

The following treatments of fertilisation were used:

Treatment 1: unfertilised control,

Treatment 2: 35 kg/ha P + 70 kg/ha K, applied in spring,

Treatment 3: PK-fertilisation as in treatment 2, plus 60 kg/ha N which was subdivided into 2 applications: 30 kg in spring and 30 kg after the second harvest during the period 1986 – 1989, and was given as a single application in spring during 1990-1993.

Treatment 4: PK-fertilisation as in treatment 2, plus 120 kg/ha N which was subdivided into 4 applications during 1986-1989: 30 kg in spring and 30 kg after the 1st, 2nd and 3rd harvest, and into 2 applications during 1990-1993: 80 kg in spring and 40 kg after the first harvest.

Treatment 5: PK-fertilisation as in treatment 2, plus 240 kg/ha N which was subdivided into 4 applications during 1986-1989: 60 kg in spring and 60 kg after the 1st, 2nd and 3rd harvest , and into 2 applications during 1990-1993: 100 kg in spring, 80 kg after the first harvest and 60 kg after the second one.

Within the period 1994-2002 the grasslands were not fertilised and were utilised only by one cut at a maximum above-ground biomass formation growth stage at the end of June, according to the method of Rychnovská et al. (1987).

It was found out that in the nine years of cessation fertilisation (2002) and in the last year (1993) of eight–year periodical fertilisation the average values of mineral nutrient concentrations (N, P, K, Ca, Mg, Na) corresponded with the values specified by the Slovak technical standard (STN 467007).

RESULTS AND DISCUSSION

In the last year of nitrogen fertilisation (1993) higher concentrations of nitrogen in the grassland dry matter were found out in the treatments with N fertilisation (22.03-26.89 g/kg) than in the unfertilised control (15.12 g/kg) and treatment with PK fertilisation (17.24 g/kg).

In contrast, phosphorus concentration decreased with increasing nitrogen dose. However, the lowest phosphorus concentration was revealed in the unfertilised control treatment (1.31 g/kg). It is known from a number of works that as a consequence of increasing nitrogen dose after long-term fertilisation, the potassium concentration in dry matter decreases (Lichner 1973, Velich 1986, Holúbek et al. 1990). This was also confirmed by our experiment. After the application of 240 kg/ha N (treatment 5), the potassium dry matter concentration (14.06 g/kg) decreased below the level of the unfertilized control treatment (16.19 g/kg). A similar tendency was also found in the calcium concentration having an enormously low value in the treatment fertilized with 240 kg/ha N (2.63 g/kg). The reason for this was the entire reduction of legumes and the subsequent propagation of dicotyledoneous herb and grass species generally characterized by a low calcium concentration in dry matter (*Plantago media* L*., Plantago lanceolata* L*., Cynosurus cristatus* L*., Anthoxanthum odoratum* L*.)*.

Magnesium concentration was nearly the same in all treatments, only in treatments 2 and 3 decreased below 3 g/kg Mg DM. Interestingly, in all treatments natrium concentration was kept at the same level, 0.31 g/kg Na DM on average.

Nine years after the cessation of fertilising (2002), the DM nitrogen concentration in all treatments decreased. A rapid reduction in nitrogen concentration from 9.95 to 14.39 g/kg N DM was found out mainly in treatments 3, 4 and 5.

Phosphorus concentration in all treatments increased from 0.07 to 0.69 g/kg P besides treatment 3 (60 kg/ha N).

Changes in DM phosphorus concentration connected to the changes in botanical composition of grassland phytocenosis (plant species with higher P content – *Plantago lanceolata* L., *Alchemilla vulgaris* Opitz., *Leontodon autumnalis* L., *Taraxacum officinale* auct non Weber).

Potassium concentration decreased minimally in treatments 2, 3, 4 and treatments 1 and 5 potassium concentration increased from 0.35 to 2.62 g/kg K DM , which is also related to the changes in botanical composition of grassland.

Calcium levels decreased in treatments 1, 2 and 3, while increasing by 0.09 to 6.40 g/kg in treatments 4 and 5 (120 and 240 kg/ha N). Magnesium concentration decreased only slightly, whereas sodium concentration in DM decreased markedly (by 0.13 g/kg on the average). The relative concentration reduction was the most pronounced with nitrogen (by 46%) and sodium (by 33%). A slight decrease was found in magnesium levels (by 2%) and potassium content (by 9%), while phosphorus and calcium concentration increased (by 5 and 10%), respectively.

The changes in chemical composition of grass biomass, taking place in the period without inorganic fertilising, reflect the structural and functional changes in grassland. The nine–years period following the cessation of inorganic fertilisation significantly influenced the botanical composition of grasslands. At the same time it should be emphasized that before this absence the grasslands were utilised only by one cut, the first cut represented 46-70% of total yield (average from eight years), and under such conditions there was a long period without utilisation when the species resistant to lower trophic levels could propagate, thus influencing the concentration of mineral elements in the dry matter of grasslands. Jančovič (1996) and Gáborčík et al. (1997) claim that another factor which can influence the mineral element content in grass biomass is the gradual accumulation of root matter, particularly in the second year after absence of inorganic fertilising. Supposedly, the more intensive accumulation of root matter also causes the retention of some nutrients (K, Na) in the roots, which may be adversely reflected in their concentration in the above-ground biomass. In the case of nitrogen this was unambiguously caused by its exclusion from fertilisation. Verification of the effects of cessation inorganic fertilisation on semi-natural grasslands will require further studies of the chemical composition changes in all plant species, first of all in the dominant ones which determine the new botanical composition of the grass phytocenosis.

CONCLUSIONS AND RECOMMENDATIONS

From the results obtained with cessation of inorganic fertilising can be drawn the following conclusions a recommendations:

- the concentration of nitrogen and sodium was decreased sharply (by 46 and 33%) in comparison with last year fertilisation.
- a slight decrease was found out in magnesium levels (by 2%) and potassium content (by 9%), while phosphorus and calcium concentration increased (by 5 and 10%), respectively.
- verification of the effect of absence mineral fertilisation on semi-natural grassland will require further studies fo the chemical composition changes in all plant species, first of all in the dominant ones which determine the new botanical composition of the grass phytocenosis.

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MINERAL SUBSTANCIES FOR YOUNG CATTLE NOURISHMENT

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INTRODUCTION

The important fodder quality index is the capacity of the mineral substances. Between mineral substance capacity in plants and animals' claims are differences resulting out of the different pretensions for mineral nourishment. Therefore, except individual elements' concentration, it's important to watch their reciprocal rate, especially Ca : P, Na : K and (Ca + Mg) : K.

This discrepancy in the claims is been able to be reconciled to a certain extent by the fertilisation and grass vesture nourishment and botanical structure (Klapp 1971, Lichner et al. 1983, Holúbek 1991).

In accordance by Kováč et al. (1998), the fodder rations compounded of the volume fodder have a high K excess and low Na capacity and owing to this fact arise a high Na : K disproportion.

Holúbek (1991) in his experiments by the rations raising registered falling tendency P concentration in dry-mass, but hereby he found out that annual fertilisation raises the P capacity in dry-mass.

With regards to Ca, raising N rations causes its falling capacity. There varies Ca : P rate, which is more important than their absolute values (Krajčovič 1992).

Mg concentration increases with raising N fertilisation intensity (Toman 1980), but systematic intensive fertilisation causes soil complex impoverishment of this element and following fall of its capacity in dry-mass (Lichner 1997).

Holúbek and Holúbek (1999) ascertained that differences in fodder quality from variedly worked grass vestures in their mineral structure aspect aren't essential, additional sowing and radical renovation doesn't solve the situation, just makes it a bit better.

MATERIAL AND METHODS

The realisation of these experiments took place in long-range meadow experiment, established by the Department of Grass Ecosystems and Fodder Crops SPU at Nitra in 1986, in relation to a research task "Elimination of long-range antropozoogene ballast to a grass ecosystem".

The stand is situated in altitude of 600 m in the locality Chvojnica in Strážov Hills. Climatic it belongs to the mild warm area, semi-dry subregion with mostly cold winters. According to a many years standing measurements, an average temperature reaches 7,5 °C, for vegetation period it's 11,1 °C. Long-range all-year precipitation total average is 848 mm, for vegetation 431 mm. Soil-producing substrate is created by crystal minerals with granite, para-gneiss preponderance and important crystal slates presence, where had been created brown, acid, sand-clayey soil (kambisol).

The original vesture in phytocenological standpoint represents the union Cynosurion R. Tx. 1937, association *Lolio-Cynosuretum typicum* R. Tx. 1937. From botanical groups standpoint before these experiments have been established there had dominated grasses in the cover (73%). The leguminous created 2%, and other meadow herbs 25% portion.

The experiment was originally established by the block method in four reiterations with experimental plot area 10 m² and protective 0,5m wide zone.

We have watched 2 series of variants: A – gradated nourishment intensity (var.1 – non-fertilised control, var. 2 – PK, var. 3 – PK + 60 kg N/ha, var. 4 - PK + 120 kg N/ha, var. 5 – PK + 240 kg N/ha) and B – alternating nourishment intensity (in the first year only PK fertilisation was applied, next year various nitrogen rations: var. 6 – PK + 60 kg N/ha, var. 7 – PK + 120 kg N/ha, var. 8 – PK + 240 kg N/ha, on var. 9 in the second year fertilisation was left out, on var. 10 was applied raising nitrogen ration in following years – 1styear PK + 60 kg N/ha, 2nd year PK + 120 kg N/ha, 3rd year PK + 240 kg N/ha).

Stating the prime production was based on green mass materiality determination from collection lot, dry-mass settling concentration in grass material and following adjustment of dry-mass crop on hectare. We stated following mineral elements' concentration in grasscover dry-mass from taken samples:

- phosphorus after wet way mineralization by photo-metrical phosphomolybden method
- potassium and sodium by flame photometry after wet way mineralisation
- calcium and magnesia complex-metrically by titration

The influence of different nourishment ways for grass vesture to a concentration mineral substances' changes in dry-mass we judged from normative nourishment need standpoint for young cattle (SOMMER a kol. 1994). Provided that heifer at usefulness shown above needs to receive 6,41 kg dry-mass daily (SOMMER a kol. 1994), we calculated the mineral substances' offer in daily nourishment ration by the relation: the mineral substances offer = mineral substances concentration x daily dry-mass receipt

RESULTS AND DISCUSSION

According to more authors (Klapp 1971, Lichner et al. 1983, Holúbek 1991) there is a difference between the mineral substances' capacity in plants and animals' requirements, following out of different claims to a mineral nourishment, whereby this discrepancy is been able to be reconciled by fertilisation of grass vestures and by forming a botanical structure.

Table 1. The mineral substances offer for young heifers in daily nourishment ration (5,98 kg/ks)/g/(3 years average)

Mineral substances	Opt.	C	Treatments									
			1	2	3	4	5	6	7	8	9	10
P	18 g	1	9,91	13,93	11,84	11,73	16,09	12,82	12,80	12,44	12,48	11,71
		2	10,92	14,76	11,60	11,88	14,83	13,70	13,80	13,42	12,52	11,64
		3	11,30	12,46	10,92	9,44	11,97	11,97	11,90	11,11	12,73	9,91
K	22 g	1	107,11	147,64	154,27	151,72	130,19	154,29	144,44	150,38	132,62	155,87
		2	116,34	153,75	150,34	147,52	123,26	145,42	150,96	152,60	141,15	149,31
		3	105,91	129,18	118,78	102,56	89,16	114,10	126,79	116,43	111,68	116,09
Ca	22 g	1	52,82	48,01	43,57	39,91	41,22	48,05	48,84	44,61	49,70	45,55
		2	66,81	63,42	51,73	52,09	43,65	56,94	59,93	57,45	62,90	52,97
		3	82,80	66,71	64,21	62,97	51,11	67,33	70,68	68,25	68,44	57,11
Mg	6 g	1	18,46	21,11	23,25	23,31	23,87	27,99	22,76	23,61	24,19	25,47
		2	19,55	23,63	25,81	28,05	30,53	27,24	26,39	26,99	28,67	26,13
		3	28,10	22,65	26,71	24,66	28,20	25,58	25,08	25,28	26,07	25,30
Na	7 g	1	1,54	1,30	1,39	1,37	1,24	1,37	1,30	1,39	1,32	1,28
		2	1,41	1,47	1,39	1,43	1,39	1,58	1,67	1,75	1,67	1,69
		3	2,12	1,75	1,73	2,01	1,75	1,69	1,97	1,86	1,77	1,99

C – cut Opt. – optimum

The potassium offer exceeded the animals' need 4 – 7 times. But if we make allowance for compromise between physiological claims of animals and plants, 20 –22 grams to kg of dry-mass (Kováč et al. 1990), we can state just a small surplus, almost optimum in mineral substances concentration. Even of the plants' claims standpoint was the year 1999 deficient.

Entirely we registered insufficient phosphorus cover necessities. Its shortage was even more expressed by high calcium excess (1,8 – 3,8 times), what was expressed in unfavourable Ca : P rate, which should have reached value 1,2 (SOMMER et al. 1994).

To secure the 300 kg heifers claims, at introduced increase (0,6 kg a day) it highly crossed their claims for magnesia (3 – 5 times).

The Na capacity in dry-mass didn't exceed 0,39 gNa/kg for dry-mass, what confirmed the information about its low concentration in grass cover phytomass mentioned in the literature (LICHNER et al. 1983).

CONCLUSION

From mineral substances capacity comparison in fodder dry-mass and standard claims of meat type heifers' results that concentration and reciprocal mineral substances rates in fodder ration in monodiet feeding aren't optimal. It shows high surplus of potassium, calcium and magnesia. Insufficient is phosphorus and sodium secure. Over-limited Ca amount causes unbalance in Ca : P rate. Tetanic index values dropped during watched period from 2 – 3 multiple closes above the demanded standard level.

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MOUNTAIN BROME (*BROMUS MARGINATUS* NEES EX STEUD.) - HIGHLY PRODUCTIVE SILAGE GRASS SUITABLE FOR DRY REGIONS

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SUMMARY

In the year1998 the first mountain brome variety ´Tacit´was in the Czech Republic registered. It is mainly used as silage grass with a high dry matter production potential, with forage of better-than-average nutritive value, which is kept till the stage of early flowering. It grows well in a wide variety of soils, esp. moderately moist, well-developed, deep, medium textured soils, in pure stand or in a simple mixture, e.g. with alfalfa or red clover (at least 70 % mountain brome and at most 30 % legumes). The tolerance against drought is also of great advantage.
Key words: grasses; mountain brome; grass mixtures; persistence; cutting height; seeding rate

INTRODUCTION

Mountain brome (*Bromus marginatus* Nees ex Steud.) is native range grass in Northern America. The collection which was introduced to the Czech Republic in the period between the world wars allowed breeding of a material which was registered as a cultivar ´Tacit´ in 1998. It is a grass with a high yield potential and tolerant against drought.

MATERIAL AND METHODS

In the year 1999 the identical field trials with 5 legume-grass mixtures at 2 sites (Červený Dvůr near Tábor and Jevíčko were established (Table 1) and kept at cutting regime (3 cuts per year) 3 subsequent years (Figure 1).

RESULTS AND DISCUSSION

The yield of legume grass mixtures (No. 2, 3, 4, 5) did not exceeded significantly that of pure stand of mountain brome (Figure 1) but the herbage quality was better (Table 1). The seeding rate of 2 mil viable seeds of mountain brome cv. ´Tacit´ (28.1 $kg.ha^{-1}$) is sufficient to establish productive stand. The seeding amount can be decreased in the mixture with legumes. The growing in pure stand or in a simple mixture, e.g. with alfalfa, is appropriate, because of its low competitiveness. Mixtures with red clover were slightly worse, and mixtures with white clovers, resp. other grasses less suitable. The optimal cutting height of mountain brome is 5 – 8 cm with regard to forage yield and persistence. Although this grass does not have special demands on site, it does not tolerate long-term dampness and floods. It is mainly used as silage grass with high dry matter production potential, with forage of better-than-average nutritive value, which is kept till the stage of early flowering.

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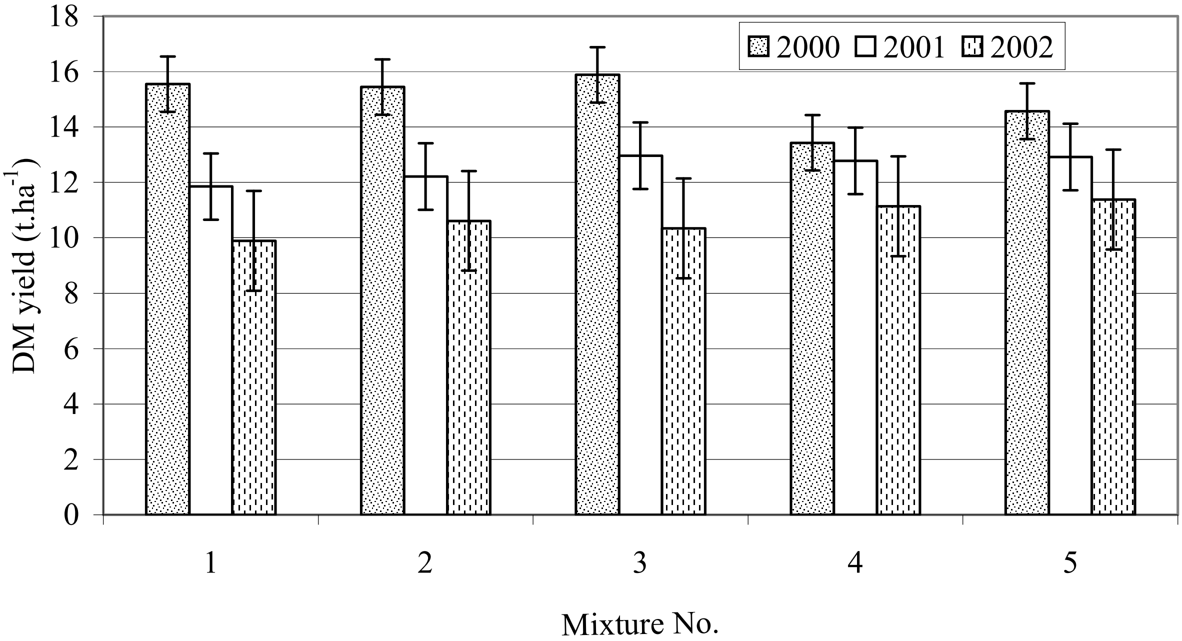
Table 1. Forage quality parameters in 1st cut (means of 2 sites and 3 harvest years)

Seeding mixture		Forage quality parameters			
No.	Seeding rate ($kg.ha^{-1}$)	CP $g.kg^{-1}$ DM	NEL $MJ.kg^{-1}$ DM	OMD %	WSC $g.kg^{-1}$ DM
1	48 kg mountain brome cv. ´Tacit´ (MB)	133.6	5.8	74.9	57.8
2	42 kg MB + 6 kg red clover cv. ´Tábor´	139.4	5.9	75.2	57.5
3	36 kg MB + 12 kg red clover cv. ´Tábor´	148.1	5.9	76.0	56.5
4	29 kg MB + 10 kg creeping red fescue cv. ´Tagera´ + 5 kg Kentucky blue grass cv. ´Slezanka´ + 5 kg white clover cv. ´Nivel´	146.8	5.9	76.7	52.4
5	42 kg MB + 6 kg alfalfa cv. ´Magda´	142.4	5.9	75.5	55.9
$L.S.D._{0.95}$		11.2	0.3	2.7	6.4
$L.S.D._{0.99}$		14.8	0.5	3.6	8.5

Figure 1. Dry matter (DM) yield in 1st, 2nd, and 3rd harvest year (in $t.ha^{-1}$).
Mean of 2 sites, error bars represent L.S.D.$_{0.95}$.



ECONOMY OF PRODUCTION OF PRESERVED FODDER FROM GRASSLANDS

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INTRODUCTION

In Slovakia, the conditions of production and cultivation of forage crops and fodder have changed since 1989. Nowadays, the attention is paid to quantity and quality of forage crops in accordance with the economy and ecology of production of grasslands (Murgaš 1998). This economy requires the usage of new approaches to the fodder cultivation in different production conditions with emphasis on the alternative usage of sources and effective production (Holúbek 2002). The new information about the above mentioned problems presented at the international conferences points at the need of grassland evaluation in the wider context. We should take into account the production potential as well as non-production potential that is connected with the country's ecology and landscape ecological planning (Krajčovič 1995). Nowadays, low input farming systems and extensive forms of grassland cultivation are preferred. (Krajčovič 1995, Jančovič 2000).

The aim of the paper is to evaluate three technologies of grassland cultivation with emphasis on:

- the yield of dry matter and its structure in different conditions of grassland nutrition and fertilization
- the fodder value of dry matter of perennial grassland, grassland with additional sowing and renewed grassland
- the production milk potential of the grasslands
- the economy of fodder production in intensive and extensive conditions of agrotechnology

MATERIALS AND METHODS

The article deals with the results of seven-year research aimed at the fertilization, quality and usage of grasslands in nutrition of ruminants. The soil and climatic conditions, the phytocenologic characteristics of the observed stand, the management of the research, the characteristics of the experimental work, the chemical analysis and costs on forage crops and fodder in the systems of grassland cultivation are discussed in Holúbek, I. (2002).

RESULTS AND DISCUSSION

Problems of management, economy of cultivation, harvest, forage conservation and usage of grasslands in nutrition of animals are complex and detailed. The long-lasting research of grasslands shows the following results:

A. Production and quality of grasslands

The high production and nutrition potential are typical for anthropogenically influenced grasslands. The observed indicators in production of dry matter, N-substances, NEL and PMP_{NEL} have an increasing tendency either as a result of fertilization by artificial fertilizer in the following order: variant 1 – variant 2 – variant 3 – variant 4, or as a result of additional sowing in the following direction: perennial grassland grassland with additional sowing and renewed grassland.

The absolute values of production of non-fertilized grasslands are as follows:

- 4.03-5.50 $t.ha^{-1}$ of dry matter
- 0.649-0.974 $t.ha^{-1}$ of N- substances
- 22, 843-30, 735 MJ NEL . ha^{-1}
- 3,780-4,989 litres of milk per 1 ha (PMP_{NEL}).

Grasslands fertilized by 30 kg P. ha^{-1} + 60 kg K. ha^{-1}:

- 5.01-5.83 $t.ha^{-1}$ of dry matter
- 0.832-1.070 $t.ha^{-1}$ of N- substances
- 28,903-32,090 MJ NEL . ha^{-1}
- 4,382-4,979 litres of milk per 1 ha (PMP_{NEL}).

Grasslands fertilized by 90 kg N.ha^{-1} + PK dose:

- 6.64-8.04 $t.ha^{-1}$ of dry matter
- 1.079-1.259 $t.ha^{-1}$ of N- substances
- 37,103-45,169 MJ NEL . ha^{-1}
- 5,898-7,467 litres of milk per 1 ha (PMP_{NEL}).

Grasslands fertilized by 180 kg N.ha^{-1} + PK dose:

- 7.57-9.30 $t.ha^{-1}$of dry matter
- 1.353-1.596 $t.ha^{-1}$ of N- substances
- 43,079-52,163 MJ NEL . ha^{-1}
- 6,962-8,701 litres of milk per 1 ha (PMP_{NEL}).

B. Economic indicators

The results of the economic analysis of three systems of grassland cultivation are as follows:

With regard to inputs of fossil energy, the artificial fertilizer together with agricultural machinery have a crucial position.

Costs per1 ha of grassland have an increasing tendency (variant 1 □ variant 2 □ variant 3 □ variant 4). Highest costs were obtained in variants fertilized by highest doses of mineral fertilizer: 11, 923 $Sk.ha^{-1}$ in the perennial grassland, 13, 124 $Sk.ha^{-1}$ in the grassland with additional sowing and 13, 476 $Sk.ha^{-1}$ in the renewed grassland.

The lowest costs per1 ha of grassland were obtained in non-fertilized controls: 4,381 $Sk.ha^{-1}$ in the perennial grassland, 5,582 $Sk.ha^{-1}$ in the grassland with additional sowing and 5,934 in the renewed grassland.

We do not recommend to use the preferred phosphoric and potassic fertilization in conditions of grasslands with low proportion of papilionaceous plants (below 10 % in the grassland structure). Higher costs of artificial fertilizer are not adequate to the yield of dry matter and its quality. In comparison with costs of non - fertilized controls, the costs of fertilized controls (PK fertilizer) are higher: perennial grassland 184%, grassland with additional sowing 166% and renewed grassland 162%.

On the one hand the lowest production costs per 1 ton of dry matter were obtained on non-fertilized grasslands (1,015 Sk in the grass stand with additional sowing and 1,124 Sk in the renewed grass stand), but on the other hand the highest costs were obtained in renewed and intensively cultivated grasslands (1, 400-1,600 Sk). According to the results of economic evaluation of inputs and outputs of grasslands, the highest average profit was obtained on variants with highest intensity of N fertilization and in the non-fertilized variants which were renewed by additional sowing and tillage.

When we increase doses of N-fertilizer from 90 kg to 180 kg $N.ha^{-1}$, the production costs per 1 ton of N-substances are lower: from 9,993Sk to 9,468 Sk in the perennial grassland, from 8,918 Sk to 8,396 Sk in the grassland with additional sowing and from 9,468 Sk to 8,443 Sk in the renewed grassland.

The lowest production costs of individual forage crops per 1 kg of dry matter are in grasslands – pastures and in the non-fertilized grasslands which are used by cutting.

The economy of breeding of ruminants in regions with the high proportion of grasslands is influenced by forage and its quality. In conditions of basic production, it is necessary to decrease the proportion of human work in systems of growing forage crops and production of fodder plant. A special attention should be paid to the forage value presented by proteinaceous and energy values, tastiness, feeding of animals and digestibility of organic matter.

CONCLUSION

The fodder and its quality can influence the economy of ruminant breeding in marginal areas of Slovakia. It is inevitable to pay attention to required value of fodder represented by proteinaceous value and energy value, fodder tastiness and digestibility of nutrients. Therefore, it is required to lower prime costs for one unit of area and one unit of production.

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POSSIBILITIES AND NEEDS FOR CONSERVING FODDER FROM GRASSLANDS IN POLISH PART OF THE SUDETEN

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INTRODUCTION

The needs for conserving bulk fodder in a region depend on farm animals, on the structure and size of a herd an on the way of its feeding. Cattle and sheep are almost exclusively bred in the Sudeten. Low profitability of animal production decimated the herds. The stock per 100 ha equalled 76 ind. in 1975 and regularly dropped to 51 in 1989 and to 21 in 1994. Sheep stock decreased in a similar way. Therefore, the demand for bulk fodder must not refer to the present animal stock but should rather be predictive basing on available fodder base. In mountainous regions most bulk fodder is obtained from permanent grasslands – from pastures in summer and from meadows in winter.

The paper presents the estimated target area of grasslands. Basing on this, potential production of bulk fodder was predicted. Natural and organisational factors and available technology were considered when discussing the methods of preservation fodder from grasslands.

MATERIAL AND METHODS

The Sudeten are situated in south-western part of Poland and occupy 4800 km^2. Forests cover c. 40% of that surface and croplands – c. 50%. Grasslands dominate among the latter – meadows and pastures occupy up to 90% of croplands in some communes.

The paper contains data on verified (with our own method acc. to natural criteria) grassland areas in the Sudeten. Yielding capacity of grasslands was taken from classification of their quality, data from the statistical yearbook of Dolnośląskie Voivodship and recent literature.

Possibilities of fodder preservation are presented based upon own studies and literature references.

RESULTS

Amount and quality of crops

Grassland area in the Sudeten was estimated as an output from the regulation of field-forest and field-turf borders (Fatyga and Górecki, 2001) and verified in view of rationalising fodder production. Grasslands of low efficiency were excluded from agricultural use and intended for afforestation; inefficient part of arable lands – for the turf cover. So verified area of grasslands will cover 121 thousand ha.

The Sudeten are the forest and fodder region. Fodder base for farm animals depends largely on grasslands. In the years 1965-1970 grasslands in Poland, including those on mountainous grounds, were classified into three complexes: very good, medium and poor. Very good grasslands comprised only a fraction of percent of the Sudeten area. Dominating complex of medium grasslands occupied 74 thousand ha and poor grasslands covered c. 29 thousand ha. Yielding was estimated for each complex of grasslands. The yielding, adequate for conditions of the years 1965-1970 was very lowered. According to recent studies on fertilisation, yields from very good grasslands may vary from 8 to 12 t/ha, those from medium grasslands – from 4 to 8 t/ha. Poor grasslands were eliminated after verification. The area of very good grasslands increased to approximately 1 000 ha and the remaining 120 thousand ha are the medium grasslands. Basing on areas of particular grassland classes and on yielding, potential size of the fodder base was calculated. Taking average yield from very good grasslands as 10 t dry wt./ha and their area of 1000 ha one may expect 10 thousand dry wt. of crops from these grasslands. Taking respectively 6 t dry wt./ha and 120 thousand ha of medium class grasslands we obtain the crop of 72 thousand tons. In total, yields from grasslands in the Sudeten may thus reach 82 thousand tons.

The quality of fodder from grasslands depends on species composition of meadow vegetation, on fertilisation, terms and methods of harvesting and on preservation. Appropriate composition of high quality grasses and legumes allows to obtain high yields of good quality. Botanical composition of most grasslands in the Sudeten is of moderate quality. It is usually composed of *Agrostis vulgaris* community with *Festuca rubra*, which occupies 36.4% area. Valuable meadow community is *Arrhenatheretum elatioris* composed of *Arrhenatherum elatius*, *Trifolium pratense*, *Dactylis glomerata*, *Alopecurus pratensis* and *Bromus inermis*. This community covers 31% area. Less valuable community *Holcus mollis* and highly degraded community *Anthoxanthum odoratum* occupy 19% area. Additionally, there is 6% of *Lolio-Cynosuretum* and 7.5% of wetland plants. In the recent years grasslands in the Sudeten become more and more overgrown by weeds and the real plaque are *Deschampsia caespitosa, Rumex crispus* and *Rumex obtusifolius*. Appropriate fertilisation, especially with nitrogen, may improve botanical composition through increasing contribution of valuable species. It may also level habitat differentiation and the rate of regrowth. On small slopes (up to 7^o) restoration is possible with a method of complete cultivation or through sowing grasses and legumes. Good components of mixtures at all elevations appeared to be *Phleum pratense* and *Dactylis glomerata* and from legumes - *Trifolium pratense*. This method is seldom used since it is expensive and requires great labour inputs. Important factor affecting fodder quality is the term of harvesting. Meadows should be mowed in the phase of earing in grasses and formation of flower buds in clover and other dicotyledons. In the Sudeten the term of harvesting depends on elevation a.s.l. and lasts from the beginning of June to the beginning of July. This is mostly too late, hence higher content of fibre and thus lower quality of fodder and difficulties in ensilage. Farmers intend the first cut for preservation, next regrowths are usually grazed.

Possibilities and ways of fodder preservation

Fodder from grasslands is preserved in a form of hay, ensilage and hay ensilage. High quality green raw material is prerequisite to any of these methods. As mentioned earlier, the principles of green forage production are well known. The problem is in harvesting, which relies on mechanization and natural conditions. Mechanization depends in turn on climate (associated with the elevation) and inclination. The efficiency of machines is affected by relative heights and quality of roads, the distance from farm and shapes and sizes of grasslands. Important is also the soil grain structure – decisive for its weight (Banasiak, 1991, Fatyga, 1991). Elevation above sea level is of greatest importance since climate and chiefly precipitation is closely related to it (every 100 m increment in elevation means additional 75 mm of annual precipitation in the Sudeten). Precipitation (rain, snow, fog) heightens difficulties caused by other factors like slope and the quality of substratum. This means difficulties in driving uphill, skids, decreased velocity, increased soil resistance etc.

According to meteorologists (Bac, 1991) winter in the Sudeten (Nov-Mar) is extremely dry, spring (Apr-Jun) is very wet, summer (Jul-Aug) – particularly wet, cloudy and cold and autumn (Sep-Nov) is dry, warm and long. These are the long term averaged data and not always pertain to weather in recent years. Studies on agricultural mechanization showed that the idex of utilisation of the labour time of machines in the summer is lower by 3 to 8% and in the autumn – by 21%. Average index of labour days in the Sudeten varies from 0.75 – 0.90 that for lowlands. More detailed calculations for particular harvesters of green forage were made by Banasiak (1991). According to the author the possibilities vary from 0.93 to 0.78. The least difficult was the exploitation of tedder rakes and ridgers of a working width of 3 – 6 m (index 0.93). The index for rotary mower (2.4 – 2.6 m wide) was 0.90, for devices compacting and forming ensilage prisms – 0.92, for collecting trailers (3-5 t carrying capacity) – 0.89 and for field hay cutters – 0.83. The lowest index of utilisation (0.78) was calculated for hay baler. Standard machines and agricultural tools are most often used up to now in the Sudeten. They may operate at an inclination not exceeding 7^{o}. Low level of the exploitation efficiency is a result of a lack of improved versions of the machines adopted to mountainous conditions.

Natural way of drying, used by 90% of farmers in the Sudeten (Mikołajczak, 1998) consists in repeated tedding of green forage on the ground. This make some losses and is very laborious. Artificial drying to 40% moisture on a meadow using cold or warm air or through ventilation under the roof to 15-20% moisture is applied by only 5% of farmers. Recently, more common becomes a method of collecting pressed hay. Ensilage is produced in open silos or in prisms. The next harvests are intended for grazing. The most modern method is to ensile in foil wrapped bales. Partly dried green fodder is formed into bales with hay baler and then wrapped in foil using special folding machines. Ensilage of green fodder is less common. Only 30% of farmers ensile green fodder usually in prisms. Folding with foil is applied by less than 10% of farmers due to high costs of foil.

CONCLUSIONS

1. A decrease of ruminant stock in the Sudeten in the recent 10 years has diminished grassland utilisation to c. 30%. Potential production of fodder from these grasslands has been estimated at 82 thousand tons dry weight.
2. Possibilities of fodder preservation are limited by the conditions of harvesting: by natural and organisational factors like mechanization.
3. Most common way of preserving fodder from grasslands, used by 90% of farmers, is drying hay on the ground. Ensilage is applied by 30% of farmers and ensilage in the foil wrapped bales – by 5%.
4. Maintaining agriculture in the Sudeten depends on restoration of breeding ruminants.

SUMMARY

The Sudeten is the region of green fodder. Due to lacking market for animal products, the ruminant stock dropped to c. 25% in the last decade. Now the problem in the Sudeten is to restore breeding of ruminants: cattle and sheep and additionally goats. Potential production of fodder from grasslands in the region is estimated at 82 thousand tons dry weight. The sward may be used for grazing and be preserved for winter. Preservation is limited by harvesting conditions: natural factors like elevation above sea level, and associated climate, inclination and compactness of grounds, and organisational factors like dispersed and irregular plots, distance and the quality of roads etc. Separate problem lies in mechanization of processes i.e. machines and tools not adapted to mountainous conditions. Now, 90% of farmers preserve fodder by drying it on the ground to produce hay. Ensilage in prisms is used by c. 30% of farmers and in bales wrapped in foil – by only 5%.

HERBAGE QUALITY OF THE 1st CUTS OF PASTURE SWARDS USED FOR CONSERVATION

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ABSTRACT

Herbage quality of pasture swards used for alternate grazing was assessed in dependence on fertilization and pastoral system of management. Mineral fertilization (3 x 30kg N, 30kg P and 90kg K.ha^{-1}) showed in an increased representation of grasses (61.1% vs. 50.4%), significantly higher crude fibre content (204.8 vs. 190.8g.kg^{-1}DM), significantly reduced energy concentration (5.56 vs. 5.82 MJ NEL), and in an insignificantly higher content of crude protein (195.8 vs. 191.8g.kg^{-1}DM). The changes in herbage quality were given mainly by the change in the botanical composition of swards. Absence of mineral fertilization and continuous grazing showed in a higher share of white clover in the swards and in a higher quality of herbage.

INTRODUCTION

Productivity of animals standing in the focus of attention, herbage needs to be harvested at a very early stage of growth when the concentration of energy and other nutrients in dry matter near the values of concentrates. With the gradual development of swards of perennial forage crops the contents of crude protein, fat and ash decrease, the concentration of energy (NEL) falls, and the fibre content increases. The decrease in the herbage content of digestible nutrients is slower in the period before blooming while the herbage yield shows relatively a faster growth (Míka et al., 1997). In order to achieve an optimum yield of digestible nutrients and hence an optimum productivity of animals, a compromise needs to be made between the lower yield of highly digestible herbage and the high yield of strawy forage of low digestibility (Frame, 1994). According to Krajčovič (1968), the reduced production of dry forage at early harvest on the pastures is compensated by the increased concentration of nutrients so that the animal production per unit area can equal or even surmount the production from the cut swards.

Herbage quality can be markedly affected also by fertilization. Fertilization of swards shows in herbage quality both directly – by changing the chemical composition of plants, and indirectly – by changing the botanical composition of grass stands. Higher levels of N-fertilization will increase also the content of crude protein in herbage, impair the ensiling capacity, increase the representation of grasses, and they will also force out legumes from the stand.

MATERIAL AND METHODS

The experiment was established as a system of two blocks with a random layout of trial plots on the site in Rapotín at an altitude of 400masl. Measurements were made in 4 sward variants (permanent, additionally sown and 2 variants newly established) and two levels of fertilization: **H0** – no mineral fertilization, only excrements of grazing animals, and **H1** – 3 x 30kg N (prior to 1st, 2nd and 3rd cut) + 30kg P and 90kg K per hectare (prior to 1st cut in spring) in addition to animal excrements.

The swards were used in alternate system of management, i.e. the first herbage growth was cut for conservation and other 3 growths were grazed. Grazing of swards was provided by meat breeds of beef cattle. and their cross-breds with pasture load ranging from 1.8 – 2.2 cattle units per hectare. The two blocks with different grazing systems were singled out within the framework of all variants as follows:

A. Rotational grazing – the first growth was cut and the sward was grazed in the following three grazing cycles by using the system of rotational grazing;
B. Continuous grazing – after the first growth was cut, the sward was continuously grazed until mid-November.

Herbage samples for quality assessment were dried in a drier at a temperature of 60°C, dry forage was homogenized in the laboratory grinder and contents of dry matter, fibre and crude protein were determined by the physical method on NIRS-6500 instrument (Míka, 1997b) along with the concentration of energy and other quality parameters that were not assessed. A more detailed description of the locality and composition of individual swards can be found in the following publications (Hejduk, 2000a; Hejduk, 2000b). Results were processed by using the Statgraphics statistic programme, version 7.0 and the multifactorial analysis of variance. Harvest times in the respective years were as follows: 29 May 1996, 4 June 1997, 20 May 1998 and 17 May 1999.

RESULTS AND DISCUSSION

Qualitative parameters measured in the herbage were as follows: crude fibre content, crude protein and energy concentration expressed as net energy of lactation (NEL). Tab. 1 indicates that all studied qualitative parameters with an exception of N-substances were significantly affected by the used mineral fertilization. Gradual improvement of the qualitative parameters in the respective years resulted from earlier harvest.

Content of crude proteins was significantly affected by the year, significantly increased at continuous grazing (by 9.2g.kg^{-1}) but remained unaffected by fertilization and sward type. The trend, that gradating doses of N fertilization significantly increase the herbage content of crude protein was not demonstrated. The insignificant effect of fertilization on the content of N-substances is given by the higher representation of white clover in the unfertilized variants (34.5 resp. 24.0, i.e. more by 10.5%) The highest content of crude protein was recorded in 1997 when the occurrence of white clover in the swards culminated (in the 1st cut in the av. of all variants at 47.9% dry forage yield).

Content of crude fibre was significantly affected by the year of harvest, significantly increased by fertilization (by

14.0g.kg^{-1}) and a significantly higher fibre content was found at rotational grazing (by 8.9g.kg^{-1}). The fertilization showed in the increased CF content due to the increased share of grasses in the yield (50.4 resp. 61.1%) to the detriment of legumes and herbs.

Table 1. DM content of crude protein in 1st cuts in the respective years

Management system	Fertilization	1996	1997	1998	1999	Average
Rotational grazing	H0	163.7	189.8	189.8	196.8	185.0
	H1	159.3	213.0	203.6	196.7	193.1
Continuous grazing	H0	172.1	215.0	198.5	209.0	198.6
	H1	163.4	221.1	207.7	199.7	198.0

Table 2. DM content of crude fibre (g.kg^{-1}) in 1st cuts in the respective years

Management system	Fertilization	1996	1997	1998	1999	Average
Rotational grazing	H0	227.6	217.5	180.5	162.9	197.1
	H1	255.6	191.9	196.9	185.2	207.4
Continuous grazing	H0	215.4	188.7	182.2	151.9	184.5
	H1	257.1	184.7	195.9	171.4	202.2

In grasses and legumes, the energy concentration in herbage closely correlates with the (NEL) concentration of energy (Pozdíšek, 1997). The value of NEL was reduced by 0.16 MJ at rotational grazing and fertilization reduced the energy concentration by 0.26 MJ NEL. The increased NEL values on unfertilized swards and at continuous grazing are given by the higher representation of white clover which exhibits up to 6.62 resp. 7.0 MJ.kg^{-1}NEL (Zeman, 1995; Thöni et Schupbach, 1988).

Table 3. Herbage concentration of NEL energy (MJ per kg DM) in 1st cuts in the respective years

Management system	Fertilization	1996	1997	1998	1999	Average
Rotational grazing	H0	5.37	5.15	5.90	6.41	5.71
	H1	4.98	5.33	5.68	6.06	5.51
Continuous grazing	H0	5.56	5.65	5.99	6.51	5.93
	H1	4.92	5.55	5.73	6.22	5.60

Table 4. Effect of fertilization on herbage quality of 1st cuts (Rapotín 1996-1999)

Variant of fertilization	Parameter of quality		
	Fibre	Crude protein	NEL
	g per kg DM	g per kg DM	MJ per kg DM
no fertilization (H0)	190.8	191.8	5.82
fertilized (H1)	204.8	195.8	5.56
difference H0-H1	14.0**	4.0	-0.26**
DT0.05	7.7	8.2	0.11
rel. H1/H0 (%)	107.3	102.1	95.5

CONCLUSION

It follows from the above experimental results that good herbage quality can be achieved even with using the extensive method of sward management by grazing. Better parameters of herbage quality at continuous grazing (as compared with rotational grazing) and from unfertilized swards are given by the higher share of white clover. The used fertilization manifested in the increased representation of grasses, which resulted in the increased content of crude fibre, decreased energy concentration but the content of crude protein did not change. Timely harvest of herbage from pasture stands with their alternate grazing will show both in the high quality of conserved herbage and it will also ensure a uniform and high herbage quality during the grazing period.

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EVALUATION OF THE EFFECT OF HORSE GRAZING ON THE YIELD AND QUALITY OF GRASS COVER IN THE NATURE RESERVE PASTVISKO

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INTRODUCTION

In 1999, the protected landscape areas covered the area of 350 000 hectares of a total agricultural land in the Czech Republic, of which the area of 170-200 000 hectares was grassland. However, only 3 % of the grassland area were strictly protected (1st zone). Another 16 % of this area were utilized with some restrictions and the remaining ca. 80 % of the grassland were maintained by using common agricultural procedures and methods of grassland management.

MATERIALS AND METHODS

The main goal of this study was to determine the optimum utilization of grassland in the nature reserve Pastvisko u Lednice. The total of 6 representative patches of grassland (A1, A2, A3, B1, B2, B3) were selected for sample collection. The samples of grass cover collected from both open and fenced areas were analysed for the nutritional value and the yield. In the case of open areas, the samples of grass cover were collected from the sample patch of 3x1 m^2 in 14-day intervals. 5 samples of grass were collected from the fenced area (2x2 m) in the period between 27 April 1999 and 12 October 1999 when the pasture reached grazing maturity. The samples collected were analysed for the weight, dry matter content, the content of nitrogeneous substances, and ash.

RESULTS AND DISCUSSION

Knowledge of both yield and nutritional value of grass is of primary importance as it enables the assessment of the optimum utilization of a particular pasture. There were two allotments (A and B) in the nature reserve Pastvisko which could be potentially utilized for grazing. Three different patches of grassland located within each allotment were compared (sample patches 1, 2, and 3). Furthermore, the parameters of the two sites A and B were also compared. It follows from Table 1 that the yield and the nutritional values of grass in both sites were comparable.

Table 1. The content of dry matter, N-substances, and ash in grass and the yield of grass during the grazing period - Pastvisko 1999 – fenced area A/B.

Variables[1)]	Unit	Site[2)]					
		A1	A2	A3	B1	B2	B3
Dry matter	%	22.53_a[3)]	20.40_a	22.23_a	21.51_a	18.84_a	21.76_a
N-substances	%	13.25_a	13.35_a	14.47_{ab}	15.68_{ab}	18.49_b	15.25_{ab}
Ash	%	13.53_a	20.81_b	13.60_a	15.46_a	12.98_a	13.85_a
Yield of fresh grass	t/hectare	4.22_a	4.68_{ab}	5.41_{ab}	4.08_a	8.10_{bc}	5.55_{ac}
Dry matter yield	t/hectare	0.86_a	0.91_a	1.16_a	0.92_a	1.56_a	1.18_a

1) The average value over the whole grazing period
2) A, B - open pasture
3) The average values of the same range marked with different letters differ significantly (P > 0,05)

The main aim of the present study was to evaluate the effect of grazing on the perennial grassland in the nature reserve Pastvisko. Since Allotment A was only mown in 1999, it was not included in the evaluation concerning the condition of both fenced and open (grazed) areas. It follows from Table 2 that the parameters of open and fenced areas of B such as the nutritional value and the yield were comparable and that the nutritional value of grass was influenced by phenophase rather than by the particular conditions at the site.

Table 2. The content of dry matter, N-substances, and ash in grass and the yield of grass during the grazing period Pastvisko 1999 - open/fenced area B.

Variable[1)]	Unit	Site[2)]					
		B1	(B1)	B2	(B2)	B3	(B3)
Dry matter	%	26.42_{ad}[3)]	21.51_{ac}	24.56_{acd}	18.84_{bc}	29.54_d	21.76_{ac}
N-substances	%	12.55_{ac}	15.68_{ab}	16.18_{bd}	18.49_{bd}	11.38_c	15.25_{ad}
Ash	%	10.59_a	15.46_{bc}	11.45_{ab}	12.98_{ab}	11.13_a	13.85_{ab}
Yield of fresh grass	t/ha	4.12_a	4.08_a	5.58_{ab}	8.09_b	5.44_{ab}	5.55_{ab}
Dry matter yield	t/ha	1.17_a	0.92_a	1.31_a	1.56_a	1.60_a	1.18_a

1) The average value over the whole grazing period
2) B - open pasture, (B) - enclosure
3) The average values of the same range marked with different letters differ significantly (P > 0.05)

Evaluation of the optimum utilization of Pastvisko was based on the real situation in 1999 when Area A was mown. Since hay plays an important role in horse feeding, it is assumed that the production of hay will continue at this site in the future. The evaluation of the potential utilization of this site was therefore based on the findings (e.g. dry matter content) for Allotment B. The production efficiency was determined on the basis of analysis of the samples collected on 27 April, 25 May, 7 July, 19 August, and 12 October 1999. Moreover, it was assumed that the growth of grass cover during the vegetation period was linear. The consumption of dry matter per horse (at a medium exertion) per day was 9 kg provided that the live weight of the horse was 500 kg (Table 3). The utilization of Pasture B was quantified for two levels of ungrazed herbage - 30 and 50 %.

Table 3. Production potential and the expected utilization of Allotment B

Sample collection	Area	Yield of dry matter per area[1)]	No. of vegetation days	Daily production of dry matter	Expected utilization [2)]
27 April 1999	B1 - 3 hectares	549	8	69	31-43[3)]
	B2 - 5 hectares	1670		209	
	B3 – 1.9 hectares	2204		276	
25 May 1999	B1 - 3 hectares	3660	28	131	39-54
	B2 - 5 hectares	13530		483	
	B3 – 0.9 hectares	2329		83	
7 July 1999	B1 - 3 hectares	3309	43	77	19-27
	B2 - 5 hectares	11125		259	
	B3 – 0.5 hectares	354		8	
19 August 1999	B1 - 3 hectares	3681	43	86	18-25
	B2 - 5 hectares	9655		224	
	B3 – 0.5 hectares	560		13	
12 October 1999	B1 - 3 hectares	2580	54	48	6-8
	B2 - 5 hectares	2905		54	
	B3 – 0.5 hectares	162		3	

1) On Areas B1, B2, and B3
2) The number of horses on Allotment B with 30 and 50 % of ungrazed herbage.
3) The number of horses was as follows: 10 horses on 20 July, 17 horses on 3 August, 11 horses on 19 August, 12 horses on 31 August, and 18 horses on 15 September 1999.

On the basis of the above findings it can be concluded that at the peak of the growth curve Allotment B could provide feed for 39-54 horses. However, when the growth decreases it can feed only 6-8 horses. This trend is in good agreement with the general growth curve typical of perennial grass cover during the vegetation period. Moreover, the grass growth curve for this site was also affected by the decreasing area of the pasture (turf damage, some area was used for training). Suitable grazing management should be applied to address this problem.

CONCLUSIONS AND RECOMMENDATIONS

1) Only Area B should be grazed, Area A should only be mown or grazed in late summer and during autumn.
2) The number of horses grazed on Area B should not exceed 20 and grazing management should be adjusted accordingly. It means that a part of the pasture should be mown off in spring to make hay (in this case it is necessary to fence the respective area with an electric fence). In late summer and during autumn it is necessary to ensure additional fodder for grazing animals or to extend the pasture towards Area A.
3) During the vegetation period it is strictly necessary to perform grassland maintenance (mowing and removal of ungrazed herbage). If ungrazed herbage is not removed from the grazing area, turf under the mown grass may rot away causing severe turf damage. Fertilization of pastures should also be regularly performed.
4) It is not recommended to increase the number of horses in Area B in order to graze down an excess of grass resulting from re-sowing, fertilization, and proper grassland management. The monitoring performed in 1999 showed that it caused mechanical damage to turf in this area.
5) The conservationists should therefore decide on whether Area B will be used for grazing or as a paddock for horse training. If it is used for horse training one should take into account an increased risk of partial or total damage to turf.

SUMMARY

The main goal of this study was to find out the optimum conditions for utilization of pastures located in the nature reserve Pastvisko u Lednice. The samples of grass cover were collected in 14-day intervals during horse grazing. The maximum possible utilization of pastures was established on the basis of parameters such as the growth of grass cover, the nutritional value of grass, and the condition of grass cover. A number of specific problems connected with the commercial utilization of the nature reserve occurred during the study.

THE INFLUENCE OF GRASS-LEGUME GENOTYPE MIXTURE COMPOSITION TO TIME DIFFERENCY OF THEIR PRUDUCTIVITY

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In the years 1996-1999 it was studied the aspects of productive and nonproductive aspects of different grass-legume mixtures at different ecological conditions (Kaplice – 670 m a.s.l. and Hladké Životice – 275 m a.s.l.). There are presented the results of time differences of crop yield production of six combinations of *Trifolium pratense*, cv. Vesna, Start, Tábor, *Festulolium*, cv. Perun, Hykor and *Arrhenatherum alatius*, cv. Medián. It showes, that the highest plasticity in different ecological conditions, from the point of wiew of 3-year mean crop yields values (mean crop yield from both stands per 3 years 17,25 t hay/ha/year) and with productive stability at this period showes the combination: *Trifolium pratense*, cv. Start (80 %) + *Festulolium*, cv. Perun (10 %) and *Arrhenatherum elatius*, cv. Medián (10 %). However, this combination showes together with it lower productive stability in the course of year. A bit lower mean crop yield (for both stands 16,31 t hay/ha/year), but very good balance of production in the course of all years and in the course of individual year too, has the combination *Trifolium pratense*, cv. Tábor (80 %) + *Festulolium*, cv. Perun (10 %) a *Arrhenatherum elatius*, cv. Medián (10 %). Both presented combinations have very good presumptions to their exploitation for 3 years (at first 2 years with PK fertilisation only, at 3rd year with dose 100 (60+40) kg N/ha + PK). All verified grass-legume mixtures are able for exploitation for 3 years at lowland stand. In the highland the combination *Trifolium pratense*, cv. Tábor (80 %) + *Festulolium*, cv. Perun (10 %) and *Festulolium*, cv. Hykor (10 %) has presumptions for it´s exploitation for 2 years only. From the wiewpoint of grass-legume mixtures exploitation for 2 years (without N application) it is the most productive at both stands the combination *Trifolium pratense*, cv. Start (80 %) + *Festulolium*, cv. Perun (10 %) and *Arrhenatherum elatius*, cv. Medián (10 %), which gives the mean yield 21,80 t hay/ha/year at this period at lowland stand and 16,11 t hay/ha/year at highland stand and with good balance of production at all years and also in the course of year.

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Table 1. Ověřované jetelovinotravní směsi a jejich produkční uplatnění v jednotlivých užitkových letech na stanovišti Kaplice (S_1).

Var.subvar	*Trifolium pratense*			*Festulolium*		Arrhenatherum elatius	Užitkový rok výnos sena v t/ha			k
	Vesna	Start	Tábor	Hykor	Perun	Medián	97	98	99	
(3) 1.1	80				10	10	15,71	16,50	12,56	0,89
(1) 1.2				10	10		15,06	15,24	12,94	0,93
(6) 2.1		80			10	10	16,54	16,61	13,68	0,90
(5) 2.2				10	10		15,18	15,37	12,90	0,92
(8) 3.1			80		10	10	13,21	15,44	13,08	0,99
(7) 3.2				10	10		14,57	14,88	10,04	0,85

k-vyrovnanost produkce

Table 2. Ověřované jetelovinotravní směsi a jejich produkční uplatnění v jednotlivých užitkových letech na stanovišti Hladké Životice (S_2).

Var.subvar	*Trifolium pratense*			*Festulolium*		Arrhenatherum elatius	Užitkový rok, výnos sena v t/ha			k
	Vesna	Start	Tábor	Hykor	Perun	Medián	97	98	99	
(3) 1.1	80				10	10	24,59	19,00	17,52	0,84
(1) 1.2				10	10		22,94	18,33	17,18	0,87
(6) 2.1		80			10	10	22,68	17,73	17,27	0,87
(5) 2.2				10	10		21,68	16,61	16,06	0,86
(8) 3.1			80		10	10	22,74	16,67	16,67	0,86
(7) 3.2				10	10		22,40	16,38	15,91	0,84

Table 3. Průměrná produkce pícní biomasy za 3 užitkové roky (výnos sena v t/ha) na jednotlivých stanovištích a v celkovém průměru s vyznačením homogenních skupin na hladině $P_{0,05}$

Stanoviště S_1				Stanoviště S_2				Stanoviště S_{12}			
Subvar.	t/ha sena	Homogenní skupiny		Subvar.	t/ha sena	Homogenní skupiny		Subvar.	t/ha sena	Homogenní skupiny	
2.1	15,28	*		1.1	20,37	*		1.1	17,65	*	
1.1	14,92	*		1.2	19,48	*		2.1	17,25	*	
2.2	14,48	*	*	2.1	19,23	*	*	1.2	16,95	*	*
1.2	14,41	*	*	3.1	18,71	*	*	3.1	16,31	*	*
3.1	13,91	*	*	3.2	18,23		*	2.2	16,30		*
3.2	13,33		*	2.2	18,12		*	3.2	15,78		*
X	14,39				19,02				16,71		

Table 4. Podíly sečí na celkové produkci píce na stanovišti S_1 v letech 1997 – 1999 (průměrné hodnoty podílů na produkci v %).

Var.Subvar	Podíl sečí na produkci v % (X_{97-99})		
	1. Seč	2. Seč	3. Seč
(3) 1.1	40,32	30,53	29,14
(1) 1.2	38,79	30,36	30,84
(6) 2.1	41,76	33,07	25,18
(5) 2.2	41,89	30,45	27,67
(8) 3.1	41,37	30,79	27,83
(7) 3.2	39,56	30,87	29,57

THE INFLUENCE OF SOWING TECHNOLOGY ON THE PROPORTION OF STRIP-SOWN *FESTUCA ARUNDINACEA* CV. KORA IN THE GRASSLAND IN THE HARVEST YEARS 1997 - 2002

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SUMMARY

The contribution evaluates a long-term trial with strip-sowing at the site at Jevíčko and studies persistence of strip-sown *Festuca arundinacea* (FA), cv. Kora, from sowings in 1996 and 1997, in yield years 1997 - 2002 in four dates of strip-sowing (spring, after 1st harvest, after 2nd harvest, September). Undersowing was carried out with (1) a slot sowing machine SE-2-024, (2) a prototype of a machine for strip sowing in four levels of width and depth of sward tilling; renovation of the grassland was done by rotary tillage. Strip sowing (proportion of FA 28 %) has statistically much higher dry matter production of strip-sown species in comparison to the slot sowing by the SE-2-024 (proportion of FA 14 %). Dry matter production of *Festuca arundinacea*, cv. Kora, strip sown, significantly increases with depth and mainly width of sward tillage. High persistence and productivity of *Festuca arundinacea* and festucoid intergenus hybrids bred from it are significant biological precondition for long-term effect of strip sowing, which is also reflected in strip sowing economy.

INTRODUCTION

Strip sowing into the grassland serves for introduction of legumes, grasses and, on the basis of special requirements, even herbs into meadows and pastures. The level of sophistication and technological backup created an independent branch of grassland management from strip sowing with specific technological procedures. The aim of strip sowing is to create more productive grassland of higher quality at the given site with long-term effect.

MATERIALS AND METHODS

Grassland management trials were established at the site at Jevíčko with (1) a slot sowing machine SE-2-024 and (2) a prototype of strip sowing machine in four depths (50, 100, 150 and 200 mm) and four widhts (50, 100, 150 and 200 mm) of rotary milled sward (Kohoutek *et al.*, 2002). Renovation of grassland was done by rotary tillage, sowing of renovation alternation was done similarly as other alternations at the span width of the strip sowing, that is 450 mm. Strip sowing was done into temporary grassland with majority of *Dactylis glomerata* (60 %), *Poa pratensis* (5 %), *Alopecurus pratensis* (20 %), *Arrhenatherum elatius* (15 %). *Festuca arundinacea* Schreb., cv. Kora, was strip sown at the rate of 400 viable seeds per 1 m^2. It was done in four time groups (in spring, after the 1st harvest, after the 2nd harvest, and in September) in 1996 and 1997, in four replications. The vegetation was harvested three times a year in yield years. In the year of strip sowing the trials were fertilized after the cut with nitrogen at the rate of 60 $kg.ha^{-1}$ N; in the next yield years with phosphorus and potassium (in spring) at the rate of 35 $kg.ha^{-1}$ P and 100 $kg.ha^{-1}$ K and nitrogen at the rate of 180 $kg.ha^{-1}$ N andfor a year fertilized with 60 $kg.ha^{-1}$ N in the spring, after the 1st and 2nd cuts. In the yield years (1997-2002) we evaluated dry matter production of strip sown grassland, the proportion of strip sown variety as % of projective dominance and corrected dry matter production of strip sown variety calculated on the basis of projective dominance and total dry matter production from the trial plot. The forage quality was evaluated using NIRSystems – 6500 instrument. The concentrations of crude protein (CP), crude fibre (CF), net energy of lactation (NEL) and protein really digested in small intestine (PDIE) in DM were assessed. The results from particular observations were evaluated with the variance analysis, model of double classification with more observations in subclass, resp. with two-factor and three-factor variance analyses. Testing the significance of differences was done with the Tuckey test.

RESULTS AND DISCUSSIONS

Strip sowing of tall fescue (Table 1 and Figure 1) was successful in all dates of strip sowing. The proportion of strip sown variety evaluated with corrected DM production was in the average of trials 2.78 $t.ha^{-1}$ DM from total DM production of the grassland 10.64 $t.ha^{-1}$. Increasing width (50 – 200 mm) of strips in the average of sowing years (1996 and 1997) increases corrected DM production from 1.61 $t.ha^{-1}$ DM to 3.99 $t.ha^{-1}$ DM (statistically highly significantly), that is from 16 % to 38 % (control slot sowing 14 %, tillage 49 %), increasing depth (50 – 200 mm) of strip milling increased DM production from 2.31 $t.ha^{-1}$ to 3.32 $t.ha^{-1}$ DM (also statistically highly significantly), that is from 22 % to 32 %. Tall fescue develops slowly in the year of sowing and the 1st yield year, however its proportion increases in the next years (till 4th or 5th year), and its a variety with high persistence (10 to 15 years). The CP concentration was low, in the average of yield years 1270 $g.kg^{-1}$ DM, crude fibre concentration higher (280.8 $g.kg^{-1}$ DM), PDIE 79.9 $g.kg^{-1}$ DM, NEL concentration 5.31 $MJ.kg^{-1}$ DM, which means forage of average quality. When tall fescue is strip sown, it is necessary to do the 1st harvest early, since it is one of the earliest fodder grasses.

CONCLUSION

Strip sowing in the grassland can be executed during the whole vegetation period till mid September. Presently, seeder SPP – 8 with operating range 3.6 m is used in the Czech Republic, SPP – 6 with operating range 3 m is used in Slovakia (PD Smrečany). Technology of strip sowing was used on the area of 500 ha in the past four years. Introduction of tall fescue into legume-grass mixtures for strip sowing has a great significance in practice, because after red clover disappears, persistent grass takes over in the strip sown grassland.

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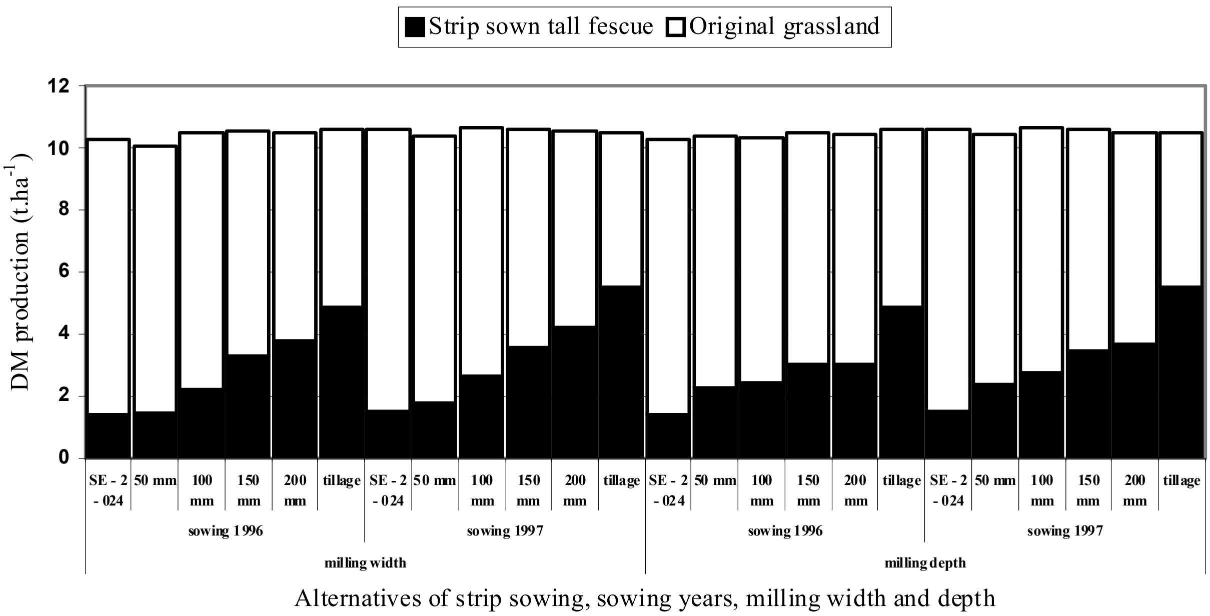
Table 1. Parameters of herage quality from grassland strip sown with tall fescue

Parameter	Harvest year						
	1997	1998	1999	2000	2001	2002	mean
CP ($g.kg^{-1}$ DM)	112.8	124.0	119.7	126.3	136.2	142.8	127.0
CF ($g.kg^{-1}$ DM)	300.9	269.4	278.3	285.7	280.9	269.8	280.8
PDIE ($g.kg^{-1}$ DM)	75.5	78.8	79.5	79.5	82.0	83.9	79.9
NEL ($MJ.kg^{-1}$ DM)	5.08	5.49	5.10	5.25	5.27	5.69	5.31

Figure 1. The influence of width and depth of milling on corrected DM production of strip sown tall fescue Kora in the average of dates of sowing and yield years at the site at Jevíčko in 1996 – 2002



CHANGES OF PLANT DIVERSITY ON MEADOW UNDER DIFFERENT MANAGEMENT REGIMES

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INTRODUCTION

Grasslands are many species communities. Species diversity of swards depends on stand conditions especially on water and nutrient regimes and on the way of utilization. Botanical composition is a result of long term influence of whole complex of stand conditions (Velich, 1996). The highest species diversity of perrenial grasslands occurs in the middle of soil fertility and of gradient of disturbance intensity (Grime in Lepš, 1999). High intensity of grassland utilization quickly leads to a reduction of species number because on stand stay only those species, which accept changed conditions (Královec, 1995). Also abandoned swards change their botanical composition. Fiala and Gaisler (1999) mentioned, that in these grasslands decrease species richness and consequently ecological stability, increases proportion of weeds and tall grasses. At the same time degradable phase is taking up, which is liable to tree succession. Relations between plants in community are based on mutual contact (direct or indirect) both in underground and aboveground parts (Rychnovská et al., 1985). Competition ability of species considers morphological and physiological constitution (Laštůvka, 1986; Klimeš, 1997).

Grasslands have significant roles in agriculture and as a part of nature. They produce forage for stock and carry out non-productive ecological functions. Extensive grasslands are important element in ecological stability of landscape (Lipský, 1998). But only grasslands with proper management can carry out their functions (Velich, 1996; Klimeš, 1997; Penk, 2001). Natural treatment of grassland management is grazing and mowing, when all forage is used in animal production. At present there is a lack of forage from grasslands in Czech Republic because of low stock number. Many meadows and pastures stay as fallow. Spare solution of grassland management non-used for forage production seems to be a modified pratotechnology by mulching (Fiala and Gaisler, 1999; Zelený et al., 2001; Duffková, 2002). The main difference between mowing with biomass removal and mulching is in spreading of mown and slashed plant biomass on soil surface as a result of mulching. This fresh material directly and indirectly affects soil and growing conditions (Zelený et al., 2001). Mowing reduce the amount of litter; increase spring temperatures and supports seedlings. In abandoned or mulched swards, when on the stand stays big amount of biomass, increases the importance of light competition (Lepš, 1999). Dominancy of individual species depends on sward type. Kvítek et al. (1998) recorded in the second year of mulching increased proportion of *Dactylis glomerata* L., which reached in the third year 67 % of dominancy from 35, resp. 8 % of dominancy. Mulching of wet meadows with dominancy of *Phalaroides arundinacea* supported weeds as *Urtica dioica* L., *Cirsium palustre* (L.) Scop. (Duffková, 2002). The way of grassland utilization must always correspond to sward type and stand ecological conditions.

MATERIAL AND METHODS

Long-term experiment was established in order to study the effect of low intensity grassland management in 2001. The experiment is located on valley meadow with domination of *Alopecurus pratensis* L. (growth type *Alopecuretum*) in Černíkovice, Benešov disctrict, Czech Republic. The altitude is of 363 m above sea level, the average annual temperature is 7,8°C and precipitation is 617 mm. Stand belongs to grain production area. Water regime of the stand is mesohygrophytic (H_4) with fluctuating underground water level. Nutrient regime is mesotrophic (N_3). The soil type gleic, soil variety (0-0.2 m) loam; pH (KCl) – 5.0; %C_{ox} = 2.90; % N_t = 0.41; Ct / N_t = 7.07. The experimental stand was divided into 24 plots (5 x 4,5 m). Six treatments are observed in four replications. Variants of grassland management were chosen: mown once (1C) and twice a year with biomass removal – fertilized $N_{100}P_{40}K_{100}$ (2C+N) and unfertilized (2C), mulched twice (2M) and once a year (1M) and non-used plots (0). Botanical analyses were carried out by the method of reduced projective domination (D in %) in spring before the first cut.

RESULTS AND DISCUSSION

The technology of mulching is known particularly from market gardening and gardening. It is used for ability of mulch to suppress seedling and growing of weeds and increasing of soil moisture through limited surface evaporation. In the same way works mulch on treated stands. In the third year of differential treatment of meadow sward we observed decline of grass dominancy on mulched plots by 17 % in comparison to mown plots. On abandoned (non-used) plots is the declination of grass proportion more significant (to 41 %) and they are replaced by forbs. When compare twice and once mulched plots, 2M have 70 % proportion of grasses whereas 1M 56 % of grasses (Table 1).

Table 1. Dominancy of agrobotanical groups (in %) depending on meadow treatment

Treatment/ agrobotanical group	2C+N	2C	2M	1C	1M	0
grasses	87	84	70	53	56	41
legumes	2	1	2	3	1	1
non-legume forbs	5	14	23	37	36	52
empty places	6	2	5	7	7	6

However not all forbs are welcome in swards. To undesirable species belong those, which by their robust growth overshadow or in other way constrain valuable species. In our experiment it is *Heracleum sphondylium* L., *Aegopodium podagraria* L., *Angelica silvestris* L. *Anthriscus silvestris* (L.) Hoffm., *Chaerophyllum aromaticum* L. and leafy docks (*Rumex* sp.). Further it can be forbs, which are not accepted by animals or those, which debase the forage quality. To this group belongs species like *Cirsium arvense* (L.) Scop., *Equisetum palustre* L., and from monocotyledonous *Holcus lanatus* L. and *Carex* sp.. The coverage of all those undesirable species reached on abandoned plots (0) to 27 %, on twice mulched (2M) 21 %, whereas on mown plots (2C) only 3 %. Plenty of robust species have also lignified stems, which on once a year treated plots significantly make harvest worst both mowing and mulching. Wrong worked mulch matter is subsequently slowly decomposed.

CONCLUSIONS AND RECOMMENDATIONS

- mowing and mulching once a year at the end of vegetation is not recommended on meadows with natural fertility with regard to botanical composition
- forage is over mature, contains big amount of lignified stems, which make harvest worst
- once a year treated plots have rough-and-thumble aspect for most of the year, it makes the stand unattractive
- we recommend to manage those swards twice a year
- entirely mulching decreases the dominancy of grasses and allows undesirable forbs growing. Mulching is only substitutional temporary solution of grassland management. To moderate negative effect of mulch on botanical composition is possible by combination of mowing and mulching within the year or to alternate them year by year
- all these procedures is farther necessary to test and study, because the influence of mulch is not only on botanical composition, but also on soil conditions, microbial activity of soil and soil water chemical composition. Different treatments are also suitable for different ecological stand conditions and sward types.

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ABSTRACT

The effect of modified pratotechnology on botanical composition of meadow sward was tested since 2001. The trial was established on valley meadow (dominant species Alopecurus pratensis L.) in Černíkovice at the altitude of 363 m, average annual temperature 7.8°C and precipitation 617 mm. Tested ways of meadow maintenance were: mown twice a year unfertilized and fertilized with N_{100}PK, mown once a year (control), mulched twice and once a year and non-used plots, all unfertilized. The botanical composition is observed every spring before first cut or mulching. The data shows that reduction or cessation of sward utilizing leads to enhancement of species total number. It is propably only temporal tendency as can be conclude from literature. Significant differences between plots are in agrobotanical groups dominancy. On twice a year used swards became dominant grasses (70 - 87 %), with the reduction of using decreases their dominancy (53 - 56 %) and increases dominancy of other non-legume forbs.

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THE YIELD AND FORAGE QUALITY OF THE FOXTAIL MEADOW (*ALOPECURETUM*)

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INTRODUCTION

The *Alopecuretum* growth type is very important, productive and quality. It has the optimum conditions for distribution on alluvial and flood-plain soils. Klečka et al. (1938) suggest that nutrient supply (N) and moisture are dominance and vitality of *Alopecurus pratensis* main deciding factors. Based on Veselá and Mrkvička (1997) these factors affect the yield, quality and competition ability of predominant species. This growth type is represented in 10 % of cenoses of total permanent grassland area. It is distributed in all production areas on mesophytic stands (H_3) with abundant available nutrient storage (N_4) in particular N and P (Regal and Veselá, 1975). Botanical composition, yield and forage quality of meadow swards result from the interactions of conservative and progressive ecological factors (Klimeš, 2000). The yield capability is highly diverse (Krajčovič et al., 1968; Regal and Veselá, 1975; Mrkvička and Veselá, 1999). At optimal moisture conditions and good nutrient supply in soil yield of 10 t and more of hay per hectare can be reached.

Forage quality as a factor of production intensity and efficiency becomes important with the economical climate changes and get a more concrete concept. Nutrient content in grassland herbage dry mass is a valuable indicator regarding cattle nutritional demands. The forage quality is affected by many factors (species, phenological period, ecological conditions and other). The grassland species diversity leads to considerable chemical composition variety (Rychnovská et al., 1985). The fertilization of perennial and permanent grasslands influences the herbage chemical composition indirectly through the botanical composition changes and directly through the nutritional changes of present species. At the long-term fertilization the botanical composition is gradually stabilized and the rate of direct effect of fertilizing on herbage quality increases (Velich, 1985; Mrkvička and Veselá, 2002).

MATERIAL AND METHODS

The experiment concerning the study of botanical composition of stands and yielding abilities was founded in Černíkovice, district of Benešov in 1966 on a valley meadow of mesophyte to mezohygrophyte character. The locality lays in 363 meters above sea level, of annual precipitation 617 mm and mean annual temperature 7.8 °C. The underground water level ranges from 0.1 to 0.7 m under the soil surface. The soil type gleic, soil variety (0-0.2 m) loam; pH (KCl) – 5.0; $\%C_{ox} = 2.90$; $\% N_t = 0.41$; $Ct / N_t = 7.07$. The experiment was established in randomised blocks with 4 replications. The plot area: 30 m^2 (5m . 6m). The variants of fertilization for the evaluation: 0 - $P_{40} K_{100}$ - $N_{100} P_{40} K_{100}$ - $N_{200} P_{40} K_{100}$. The basic type of fertilization was ammonium nitrate with calcite (LAV 27.5 %) applied in separate doses 3:1 in spring and after the first cutting. Phosphorus (40 kg/ha) was applied in superphosphate in autumn and potassium (100 kg/ha) in potassium salt in autumn and from 1985 after the first cutting. Floristic composition of phytocenosis was evaluated before the harvest of the first cutting in all cases, by means of the estimation of reduced projective leaf area (dominance D) when the stand aspects enabled a precise differentiation of individual species. For limiting the estimates, the method of gradual partition of total dominance on morphologically different agrobotanical groups and individual species was used.

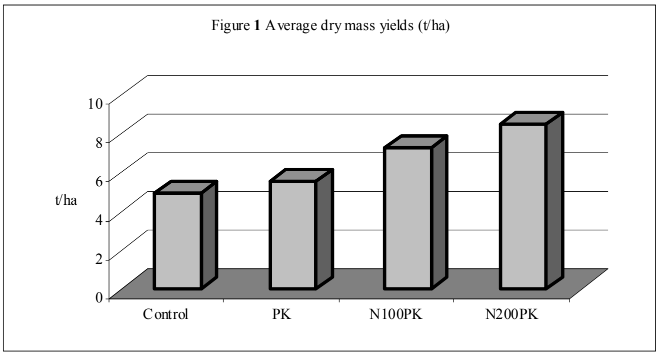
RESULTS AND DISCUSSION

From the Table 1 is evident, that the highest total dominance is in variant fertilized with high doses of nitrogen. The long-term fertilization with 100 and 200 kg N/ha (+PK) leads to expansion of rhizomatous grasses in comparison with the plots fertilized only with $P_{40}K_{100}$ by about 22 and 30 % of dominance. Here was a reduction of freely bunch-type grasses from 12 % (var. PK) to 3 and 1 % D (N-fertilized variants) in process at the same time.

Table 1. The average dominance of agrobotanical groups (in %) in *Alopecuretum* growth type (1966 – 2000)

% of dominance							
Treatment	Total	Grasses				Legumes	Other herbs
		rhizomatous		freely bunch-type			
		Meadow foxtail	other	cultured	uncultured		
$N_0 P_0 K_0$	88.4	25.0	11.2	9.0	17.0	5.6	20.6
$P_{40} K_{100}$	86.5	22.0	7.4	8.9	16.0	15.1	17.1
$N_{100} P_{40} K_{100}$	91.0	67.6	6.7	3.3	3.1	0.3	10.0
$N_{200} P_{40} K_{100}$	96.0	70.0	19.5	1.5	1.0	+	4.0

In long-term fertilization study in 1966 – 2000 was found out an average yield of 4.97 t/ha of hay in the control variant (Figure 1).The lowest yield was in 1976 (2.35 t/ha of hay) and the highest in 1967 (10.82 t/ha). In $P_{40}K_{100}$ variant the average hay yield was of 5.53 t/ha with extreme yield values of 2.53 t/ha (in 1976) and 11.23 t/ha (in 1966). In variant of the nitrogen fertilization with 100 kg/ha (+PK), the long-term average yields of hay were 7.29 t/ha with boundary values of 3.90 t/ha (1989) and 14.25 t/ha (1966) and with 200 kg N/ha (+PK) were yields of 8.53 t/ha with boundary values of 4.25 t/ha (1989) and 15.98 t/ha (1967). The highest yields of hay in studied variants were reached in the first three years of observations (1966 – 1968). The stability of sward yield potential varies depending on climate



conditions course and nutrient dotation (Jančovič et al., 2000). It was confirmed also in our observations, for instance in 1976, 1989, and 1998, especially in variants without nitrogen fertilization. Regal and Veselá (1975) mention, that production capability of *Alopecuretum* is the most variable (2.2 – 8.5 t/ha) between all observed growth types. The dosage of 100 kg N/ha increased yield by 47 % compared to control. Similar data were noticed at the same fertilization variant in a 35-year average. From Table 2 is evident, that total nitrogen (N_t) in forage was increased with dotation of N, and it corresponds to previously cited data of Velich (1985). The content of presented mineral matters in forage dry mass generally correspond to literature data. Quotient K:(Ca+Mg), so-called tetanal ratio, exceeded the value 2.2 in all variants.

Table 2. Weighted averages of total nitrogen (N_{tot} in % dry matter) and minerals content in forage (in g/kg) at different fertilization levels in total yields (1966 – 2000)

Variants	N_{tot}	Minerals content (in g/kg)				K: (Ca+Mg)
		P	K	Ca	Mg	
0	20.0	2.6	18.0	5.6	1.7	2.47
P_{40} K_{100}	20.6	3.1	19.5	6.1	1.6	2.53
N_{100} P_{40} K_{100}	21.3	2.9	20.2	4.2	1.5	3.54
N_{200} P_{40} K_{100}	24.4	2.8	19.4	4.9	1.5	3.03

CONCLUSIONS AND RECOMMENDATIONS

- agrobotanical groups and species dominance changes in *Alopecuretum* depend mainly on pratotechnique and conservative ecological factors course
- with regard to botanical composition, mineral fertilizers dotation is utilized well in conventional agriculture on foxtail meadows, and it is specially marked in years with higher precipitation
- at favorable ecological conditions is necessary to cut these meadows three-times a year and hay yield attain about 5 t/ha without fertilizing
- there is no risk of dicotyledonous weeds spreading with right mowing and fertilizing management with regard to high competition ability of *Alopecurus pratensis*
- foxtail meadows have excellent dietetic quality of forage. The forage quality is affected by cutting terms organization. Is important to pay attention mainly to the first cut, which begins after second May decade.

This research was supported by Research Project MSM of Czech Republic No. 41200003.

ABSTRACT

Alopecuretum represent cenose with specific dominant species. It is situated in all production areas on mesophytic to mesohygrophytic soils with good nutrient supply. In period 1966 – 2000 sward botanical composition changes, yield and average contents of important elements in forage were observed. The experiment was established in randomized blocks with four replications. The plot area was 30 m^2 (5 m x 6 m). The variants of fertilization for the evaluation: 0 – $P_{40}K_{100}$ – $N_{100}P_{400}K_{100}$ – $N_{100}P_{40}K_{100}$. From the morphological and histological formation perspective, consequently also nutritious value, species presented in mixed meadow sward are not homogenous system. The considerable variability in nutritious value exists between species and agrobotanical groups. The quality of meadow herbage is also affected by growing phase of plants at cutting term and ecological conservative and progressive factors.

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THE COMPARISON OF FORAGE YIELD AND QUALITY OF SOME RED CLOVER VARIETIES

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ABSTRACT

The aim of the work was to evaluate the yield and the nutritive values of some Czech and Slovak red clover varieties. The following quality parameters were determined in samples of red clover: CP, digestibility of CP, fibre, fat, ash, PDIN, PDIE, NEL, NEV, BE, ME. From among the diploid varieties Viglana gave the highest yield and the better quality; from the tetraploid varieties Margot and Beskyd were the most productive ones with high nutritive values, the variety Javorina showed excellent results in more quality parameters.

INTRODUCTION

Red clover is the second most common clover crop in Slovakia. Apart from being grown as monoculture, it is used as co-component in mixed forages for fresh fodder, hay and ensilage, making an important contribution in restoring soil fertility (Jamriška, 1998). Red clover as forage has a high biomass increase, recovers well after cuts and provides high quality fodder. High contents of protein and ash, high digestibility and slower decrease of its quality after the overrun of optimum forage ripening (Taylor, Quesenberry, 1996) use to result in good ingestion by livestock what means its fundamental advantage. Though at present a wider assortment of tetraploid varieties is available, however, diploid varieties are still more commonly spread in farming practice. Chlumecký is the most frequently grown variety despite of its having been outdone by more recently listed varieties showing better parameters that have been included in foreign catalogues, too.

MATERIAL AND METHODS

The yield and quality of eight Slovak and Czech diploid and tetraploid varieties coming from a red clover trial, established at the experimental base of the RIPP in Piešťany in 2000, have been evaluated in the presented paper. In 2001 and 2002 one-kilo samples were taken in three replicates from three cuts. Quality parameters of the taken samples were determined. After the determination of leaf/stem ratio, the plant material was dried, then homogenised and analysed at Research Station of Grassland Ecosystems in Jevíčko, NIRS method was applied to determine crude protein (CP), the digestibility of CP, fat, fibre and ash as well as PDIN, PDIE, NEL, NEV, BE and ME values.

RESULTS AND DISCUSSION

The highest yields (in average per years and per cuts) were achieved (Table 1) with Beskyd and Margot varieties. Viglana, Sigord and Amos varieties gave standard yields. The leaf/stem ratio shows an important influence on forage yields. The most of the tested varieties showed above-average values, diploid varieties were significantly surpassed by tetraploid as a result of the morphology of these latter ones. Higher leaf/stem ratio reflected in the contents of CP, digestibility of CP and ash, these quality parameters were the best by Javorina variety with highest proportion of leaves.

Nutritive value of plants is indicated by two PDI values - PDIE and PDIN. In the case of PDIN higher variability (110,5 g/kg and 116,3 g/kg by Dolina and Amos respectively) was found. Differences between the varieties (Figure. 1) were smaller in the case of PDIE; PDIE values were higher by the diploid varieties as compared with tetraploid ones. The energetic aspect of livestock nutrition is expressed by energy parameters as the general influence of feed within their organisms (Sommer et al., 1985). Energy values as BE, ME, NEL and NEV did not show high variability; differences between the varieties were negligible. Higher values of all energy parameters were achieved by the diploid varieties.

Most significant differences between the varieties were found in CP, digestibility of CP, fat, fibre and ash content values. From the diploid varieties Viglana showed the best nutritive value, from the tetraploid varieties Javorina, Margot, Amos and Beskyd showed above-average values of more parameters. Growing of Margot and Beskyd varieties for fodder have also been recommended by Valihora (2003).

CONCLUSION

On the basis of the achieved results a conclusion may have been drawn that the highest yield and the best quality of fodder were given by diploid Viglana variety. Margot and Beskyd were the most productive tetraploid varieties. These two varieties showed high nutritive values, while Javorina gave excellent results in more quality parameters.

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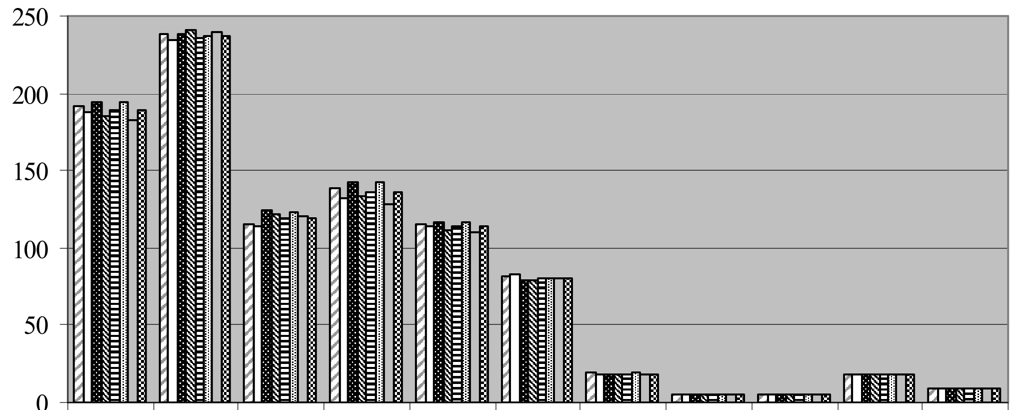
Table 1. The comparison of the yield of green matter (GM) and leaf/stem ratio of red clover varieties

Variety	Ploidy	State	Yield of GM t/ha	Leaf/stem ratio %
Viglana	2n	SVK	10.2	60
Manuela	2n	SVK	9.6	58
Javorina	4n	SVK	9.2	70
Sigord	4n	SVK	10.0	64
Margot	4n	SVK	11.3	68
Amos	4n	CZE	10.0	68
Dolina	4n	CZE	8.6	69
Beskyd	4n	CZE	11.5	69
Average			10.1	66

Figure 1. The nutritive value of the evaluated red clover varieties



	CP g/kg	Fibre g/kg	Ash g/kg	Digest. of CP g/kg	PDIN g/kg	PDIE g/kg	Fat g/kg	NEL MJ/kg	NEV MJ/kg	BE MJ/kg	ME MJ/kg
Viglana	191,9	238,8	115,3	138,4	115,0	81,5	19,1	5,62	5,43	18,01	9,25
Manuela	187,5	234,5	114,0	132,7	113,5	82,5	18,5	5,77	5,60	18,07	9,46
Javorina	194,3	238,4	124,2	143,1	116,2	79,6	18,7	5,33	5,08	17,85	8,82
Sigord	185,5	240,9	121,4	132,9	111,4	79,4	18,3	5,39	5,16	17,89	8,90
Margot	189,1	236,4	119,4	136,2	114,3	80,5	18,4	5,52	5,31	18,01	9,09
Amos	193,9	237,5	123,5	142,9	116,3	79,7	18,9	5,36	5,12	17,93	8,86
Dolina	182,1	240,1	120,4	128,1	110,5	79,7	18,2	5,45	5,23	17,92	8,99
Beskyd	189,8	236,6	118,6	136,1	114,6	80,7	18,7	5,52	5,31	18,00	9,10

THE INFLUENCE OF HARROWING ON THE YIELD OF ALFALFA (Medicago sativa L.)

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ABSTRACT
A polyfactorial field experiment with alfalfa *(Medicago sativa L.)* cv. Palava (standard), Jarka and Vlasta (higher tolerance to crown and root diseases) was established in Červený Újezd (405 m a. s. l., clay loam orthic luvisol) in the year 1998. The stands were cut 3 times per year, a control variant was left without a treatment, the others were cultivated by a spike or vibration harrow before the beginning of vegetation period and after the 1st cut in the course of 1999-2001. The cultivation of the stands resulted in significantly lower amount of plants per m^2 in the end of the fourth year by 8-28%, and in a lower average number of stems per m^2. The dry mass yield was statistically influenced only at cv. Jarka (by 9,8 – 10,97 under harrowing by vibration harrow once per year or by spike harrow). These ways of alfalfa stands cultivation cannot be recommend for wide use without a knowledge of the variety properties.
Key words: *Medicago sativa L.*, cultivars, harrowing, stand density, yield capacity

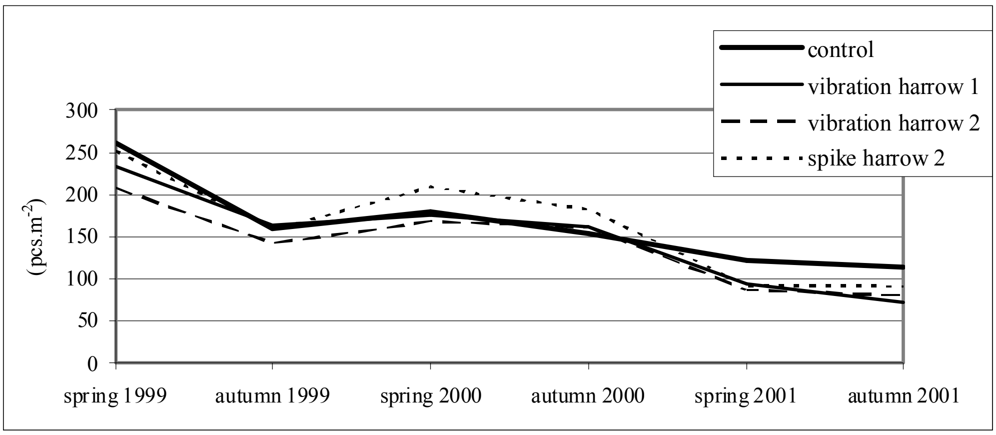
INTRODUCTION
The need of an effective soil surface cultivation of alfalfa fields for improving of the conditions for overgrowing from underground buds was improved in various experiments especially in older stands, where the soil is usually more compacted (Velich, 1971, Šantrůček, 1989). A better cultivation effect of a vibration harrow in comparison with a spike harrow described Šantrůček, Svobodová, Vrzal, Fogl (2001), but it was found, that these treatments do not result in significantly higher dry mass yields, plants and stems density. The reason can be also the plants damaging by the machines crossing and spreading of root and crown diseases. Because of the diseases infestation risk the cultivars with a higher tolerance are bred. It is possible to expect, that the reaction of Jarka and Vlasta cultivars with a higher disease tolerance (registered in 1995) on stands cultivation can be different than the one of the older cultivars.

MATERIAL AND METHODS
A polyfactorial field experiment with three Czech cultivars of alfalfa *(Medicago sativa L.)* with different tolerance to root and head diseases (Palava, Jarka, Vlasta) was carried out in the Research Station of the Czech University of Agriculture in Prague in Červený Újezd (405 m a. s. l., average temperature 7.6 ˚C, average annual precipitation 493 mm, clay loam orthic luvisol) in the years 1999-2001. The alfalfa was sown in the spring 1998 with a companion crop (spring wheat, sowing rate 50 kg.ha^{-1}) to rows of a space 125 mm, sowing rate 16 kg.ha^{-1} germination seeds. The experiment had four replications and it was cut three times per year. A part of the field was left without a treatment, the rest area was cultivated by a spike or vibration harrow to the depth 70 mm before the beginning of vegetation period and after the first cut, or by vibration harrow only in the beginning of vegetation.

Number of plants and stems per m^2 on randomly chosen areas (8 times 0,125 m^2) and dry mass yields (10 m^2 in each plot) were measured.

RESULTS AND DISCUSSION
All the ways of cultivation caused a significant decrease of plants number of all the cultivars in comparison with the control variant by 8-28% in the fourth year of vegetation (figure 1).

Figure 1. Number of plants (pcs.m^{-2})



The number of stems per m^2 (table 1) was not significantly higher on the cultivated plots at particular cultivars in the years 1999-2001. On the contrary the total stems number in the three years was significantly decreased by double cultivating by vibration harrow at all the cultivars by 11-15%. Cultivation by spike harrow had the weakest influence on the number of stems. Vlasta cultivar was characterised by a significantly higher number of stems (756 per m^2) by 6,8 % than Palava.

Table 1. Average stems number ($pcs.m^{-2}$)

Treatment/cultivar	Palava	Jarka	Vlasta	average
control	753	730	792	758
vibration harrow 1	701	704	739	715
vibration harrow 2	638	650	703	664
spike harrow 2	740	717	792	750
D_{min} α 0,05	63	63	63	36

An increase of dry mass yield by cultivation manifested more considerably rather in the second and third cuts (table 2). The total dry mass yield of Palava in three years (1999-2001) was not significantly influenced by cultivation (lower in comparison with non treated control maximally by 5,1%). The total yield of the recent cultivar Jarka was significantly higher under one cultivation by vibration harrow by 10% and under double cultivation by spike harrow by 11%. This cultivar was more yielding in average by 6% than Palava or Vlasta. The highest average yields (by 6% more in comparison with the control - table 5) were on the plots two times per year cultivated by spike harrow.

Table 2. Total dry mass yield ($t.ha^{-1}$, relatively - % of the control) in the years 1999-2001

	t/ha			%		
	Palava	Jarka	Vlasta	Palava	Jarka	Vlasta
control	38,1	37,4	37,4	100,0	100,0	100,0
vibration harrow 1	36,1	41,1	35,4	94,9	109,8	94,7
vibration harrow 2	38,0	39,2	38,5	99,7	104,8	103,0
spike harrow 2	38,5	41,5	39,7	101,0	111,0	106,1
D_{min} α 0,05	2,7	2,7	2,7			

It is possible in some cases to reach a higher number of stems per plant by harrowing or by other ways of alfalfa stands cultivation, but the total number of stems per m^2 depends also on the number of plants. The weight of one stem manifests in the dry mass yield.

CONCLUSIONS

Reaching of high forage yields of alfalfa is a condition of the economy effectiveness of its growing. Only dense and complete swards can fulfil as well their ecological functions consisting in soil quality improvement. The increase of the yield by cultivation represented 2-4 t alfalfa hay per hectare in this experiment in three years by altogether 3-6 cultivation at only one of the used cultivars. It was proved, that the reaction on cultivation of different alfalfa varieties, especially bred for higher diseases tolerance, can vary. It is necessary to know such their properties for a decision about the best stand management and to consider the economical efficiency of the treatments on account of the actual prices and required yields. Without a detailed information about the cultivar requirements no cultivation of dense and complete alfalfa stands with the minimisation of the field crossing is the best way of their maintenance.

The results were obtained with the support of the research project MSM 41210-0003.

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INFLUENCE OF SACCHARIDES CONCENTRATION IN ALFALFA ROOTS BEFORE OVERWINTERING ON YIELD AND FORAGE QUALITY

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ABSTRACT

The influence of reserve substances content (saccharose, fructose, starch) in alfalfa roots before overwintering on the yield and forage quality in the following year was researched. Content of NL, PDI, fibre, ADF, NDF and NE in the dry aboveground mass was analysed. The different concentration of reserve substances was achieved by three various terms of the last cutting (September, October, November). The highest content of reserve saccharides (starch 101 $g.kg^{-1}$) was found on the variant with the last cutting in November, the highest DM yield (16,74 $t.ha^{-1}$) was reached on the plots cut in October. The forage quality was influenced only by the sequence of cutting in the evaluated year, no by the content of sugars in roots before overwintering.

INTRODUCTION

Alfalfa (*Medicago sativa* L.) is one of the most important legumes growing on the arable land in the Czech republic. The alfalfa yield, quality, digestibility and sappiness are influenced by the serie of factors, e.g. frequency of cutting, age of stands, variety and nutrition (TÓTH, 2001). The root diseases as well as pests and weather conditions have an effect on the forage yield and quality. The object of this work is to define the influence of saccharides concentration in alfalfa roots before overwintering on the yield and forage quality.

MATERIAL AND METHODS

The field experiment (split plot arrangement) was established in the field of the Research station of Faculty of Agronomy Czech University of Agriculture in Červený Újezd (sugar beet production area, of sugar beet-cereal type, wheat subtype; 405 m a. s. l.) in 2001. Prevailing soil type in the experimental area is clay loam orthic luvisol. The soil reaction is neutral or slightly alkaline. According to the agrometeorological characteristics the places belongs from moderate to warm and mostly dry climatic area. The vegetation period is from 150 to 160 days. The mean annual temperature is 7.7 °C throughout 30 year normal and during the warm half-year 13.8 °C. The long-term annual sum of precipitations is 493 mm and during the warm half-year 333 mm. The mean year temperature in the agrometeorological year 2001/2002 was 8.7 °C, during vegetation 14.2 °C. The annual sum of precipitations was 667 mm and in vegetation season 479 mm.

The stand of the French variety Europe was cut three times per year. The first and second cut were done in the same date. The last cut was carried out in three various terms (September, October, November) for achieving of a different regrowth and a root saccharides concentration. The sampling for saccharides quantification (saccharose, fructose, starch) were taken at the end of November 2001. The content of NL, PDI, NE, fiber, ADF, NDF was evaluated in each cut in the year 2002.

RESULTS AND DISCUSSION

A different length of stems in winter was reached by three various terms of the last cutting (September 35 mm, October 30 mm, November 18 mm), which corresponds with the rule that the stand should have only short stems before overwintering (ŠANTRŮČEK et al., 2001). The highest content of reserve saccharides in the roots (starch 101 $g.kg^{-1}$) was found on variant with the last cutting in November (table 1.), the highest DM yield (16,74 $t.ha^{-1}$) was reached on the plots with the last cutting in October (fig. 1.). The lowest differences were observed in the fibre content, PDI and NE, the highest in NL and NDF (table 2.). The relationship among the observed parameters were evaluated and a decrease of NL and PDI due to NDF increase (MÍKA, 1997) was confirmed.

Table 1. Content of reserve saccharides ($g.kg^{-1}$) in alfalfa roots

cultivar	last cutting	autmn 2001			spring 2002			difference		
		starch	fructose	sucrose	starch	fructose	sucrose	starch	fructose	sucrose
Europe	September	56.30	7.49	167.00	18.20	7.35	72.40	38.10	0.14	94.60
	October	62.50	9.34	185.00	18.20	5.82	80.70	44.30	3.52	104.30
	November	101.00	7.78	173.00	18.30	6.14	90.10	82.70	1.64	82.90

CONCLUSION

The yield of alfalfa after overwintering is influenced especially by the stand development in autumn, not by the concentration of reserve saccharides in roots. The best term of the last cut is seemed to be a half of October. The influence of the root saccharides content on forage quality is not statistically significant. The hay quality is influenced mainly by the sequence of cut and stage of development. The forage conservation quality is most convenient in the first cut because of the highest content of energy.

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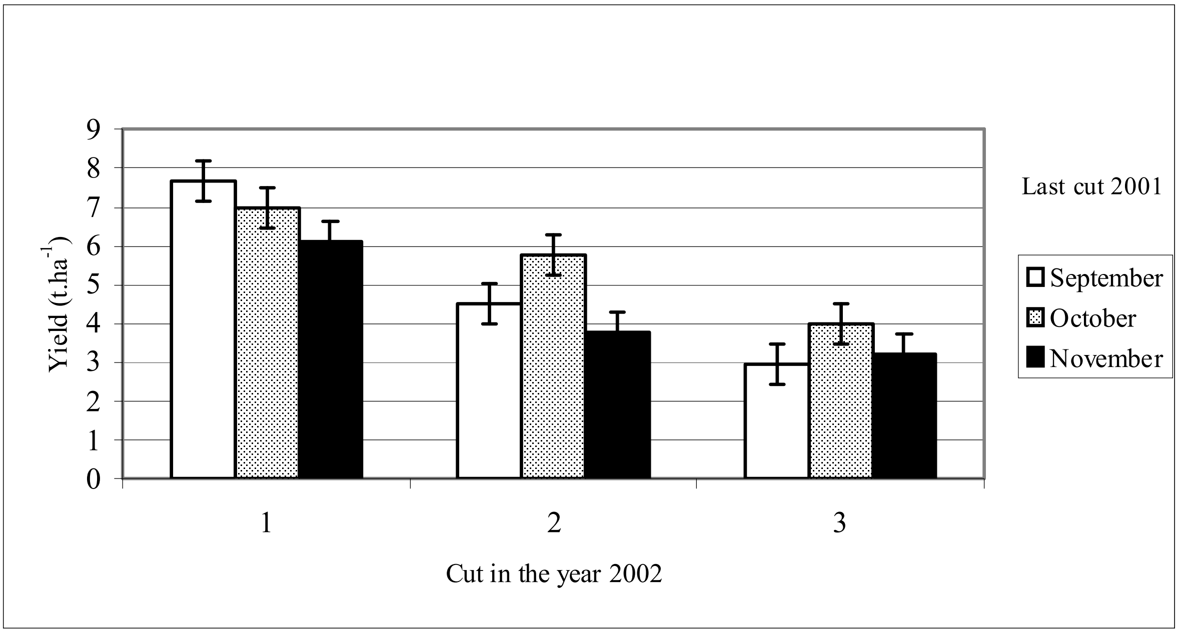
Table 2. Forage quality of alfalfa (content in g.kg^{-1} DM, NEL and NEV in MJ.kg^{-1}) in the second vegetation year (2002)

last cutting 2001	cutting 2002	nitrogenous matter	asch	fibre	ADF	NDF	PDIA	PDIN	PDIE	NEL	NEV
September	1	169.6	87.9	286.1	396.4	494.6	38.12	106.52	86.86	5.41	5.17
	2	173.7	84.6	263.8	355.6	494.9	39.04	109.11	88.00	5.46	5.22
	3	213.6	85.5	236.0	331.1	442.4	46.24	133.79	93.31	5.35	5.06
	mean	**185.6**	**86.0**	**262.0**	**361.0**	**477.3**	**41.1**	**116.5**	**89.4**	**5.4**	**5.2**
October	1	178.4	95.3	273.2	344.7	449.0	40.09	112.03	90.15	5.63	5.45
	2	181.3	88.9	262.3	378.7	512.6	40.75	113.89	89.24	5.44	5.20
	3	187.9	78.0	259.4	381.9	500.7	40.68	117.68	88.05	5.28	4.99
	mean	**182.5**	**87.4**	**265.0**	**368.4**	**487.4**	**40.5**	**114.5**	**89.1**	**5.5**	**5.2**
November	1	174.4	94.7	272.9	390.4	469.2	39.21	109.56	89.40	5.63	5.45
	2	161.1	77.5	274.1	398.3	512.1	36.22	101.23	85.72	5.47	5.23
	3	144.9	90.7	290.1	404.7	549.6	51.37	90.75	77.77	5.04	4.73
	mean	**160.1**	**87.6**	**279.0**	**397.8**	**510.3**	**42.3**	**100.5**	**84.3**	**5.4**	**5.1**

Figure 1. Dry mass yield (t.ha^{-1}) in the year 2002 - the influence of the last term of cutting before overwintering



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FORAGE QUALITY OF NEW CZECH STRAINS OF HYBRID ALFALFA

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ABSTRACT

Forage quality of new Czech strains of Medicago media R. (ŽE XLI, ŽE XLII, ŽE XLV) was compared with cultivar Jarka (Medicago sativa L.) at three-times cut stands with different treatment (no cultivation, harrowing, rolling after each cut). The content of NL, ash, PDI, fibre, ADF, NDF and NE was evaluated. There were no significant differences among cultivar Jarka and new strains forage quality. The forage from the first cut had statistically significant higher contents of NEL, NEV (P<0,01) and PDIE (P<0,01). The content of PDI and NL was significantly lower in the third cut (P<0,05), and the concentration of fibre was higher (P<0,01) than in the second cut. The sequence of cuts as well as the development stage of stands are more important factors for forage quality than cultivars or a treatment. The relationships among observed parameters were evaluated by a simple regression. There were a negative relation among NDF concentration and the content of PDI and NE (e.g. NEL=6,39365 – 0,002301NDF, (P<0,01), R = 0,553918). The fibre and ADF contents had a negative relation to NE concentration but not to NL and PDI concentration.
Keywords: alfalfa; *Medicago sativa* L., *Medicago falcata* R., quality of forage, strains

INTRODUCTION

The alfalfa (*Medicago sativa L.*) is one of the most important legumes with a high quality of protein forage (Dukić, Erić, 1997), which in optimal maturity stage contents over 20% NL, in PDI about 10% (Míka et al, 1997). The sick alfalfa (Medicago falcata L.) is a wild species with a low forage quality but with a range of important attributes (winterhardiness, modesty, creep root, etc.) for alfalfa breeding. It is important to evaluate a forage quality at these hybrid forms (*M. sativa* x *M. falcata*) because a higher ratio of *M. falcata* in genotype can set a lower quality of forage.

MATERIAL AND METHODS

The plot trial was established in the field of the Research station of Faculty of Agronomy Czech University of Agriculture in Červený Újezd in 2001. The experimental plots were established as split plot in sugar beet production area, of sugar beet-cereal type, wheat subtype; 405 m a. s. l. Prevailing soil type is a clay loam orthic luvisol. The soil reaction is neutral or slightly alkaline. According to the agrometeorological characteristics the places belongs from moderate to warm and mostly dry climatic area. The mean annual temperature is 7.7 °C throughout 30 year normal and during the warm half-year 13.8 °C. The long-term annual sum of precipitations is 493 mm and during the warm half-year 333 mm. The stands of three new strains of hybrid alfalfa (ŽE XLI, ŽE XLII, ŽE XLV) and registered variety Jarka were cut three-times per year and treated by different ways (harrowing, rolling after each cut or without a treatment). The samplings were taken from each cut. The protein value of forage (NL, PDIA, PDIE, PDIN), content of structure saccharides (fibre, ADF, NDF) and energy value (NEL, NEV) were evaluated. The results from the second year of vegetation were evaluated by a multifactor analysis of variance and a simple regression.

RESULTS AND DISCUSSION

The acquired values of evaluated parameters correspond with values of alfalfa published by Míka et al. (1997) for concrete maturity stage and sequence of cuts. There were no significant differences in the forage quality of the observed strains and the cultivar Jarka neither in dependence on the stand treatment. The lower differences among strains were in fibre and ADF content, the highest (no significant) in content of NDF and NL. Forage quality of the evaluated varieties is on the same level and it is not affected by the treatment after cutting (table 1).

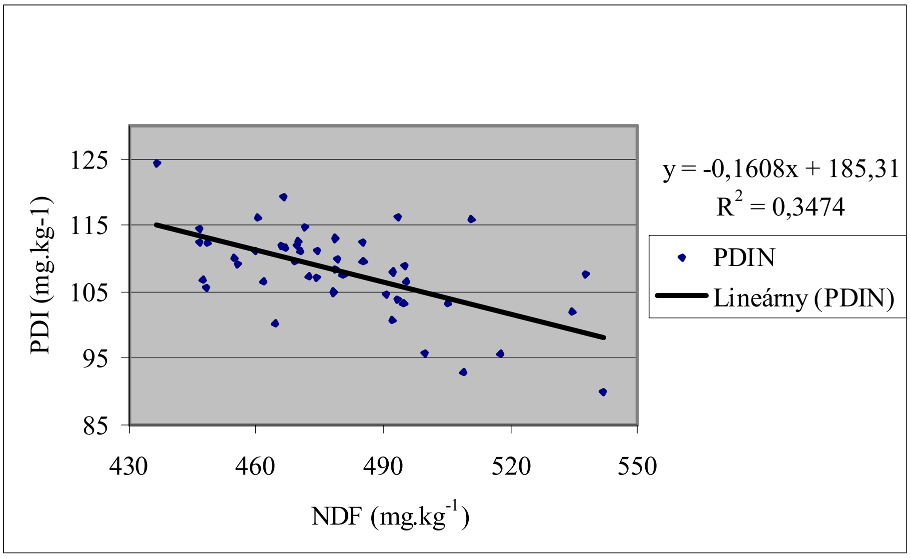
The influence of the cut sequence on forage quality is statistically significant. It can be explained by a different maturity stage and various stand development to another cut (Keftasa D, Tuvesson M., 1993). The first cut provided a forage with a significantly higher concentration of NE and PDIE (P<0,01), the content of ADF and fibre was significantly lower (P<0,05). The content of NL and PDI in the first cut was comparable with second cut which in comparison with the third cut has a higher concentration of fibre, PDI and NL (P<0,05). The sequences of cut and the development stage are more important factors for forage quality than a variety or a treatment.

The relationship among observed parameters was evaluated. The negative relation between content of NE and fibre concentration was confirmed (Vorlíček, Z. et al, 2001 etc). The fibre concentration is in positive correlation with NDF value (P<0,05). The dependence of NDF content on the PDIN concentration is presented in the figure 1. The equation is significant (P<0,01), correlation coefficient = – 0,585925. A similar relation of NDF was achieved with PDIE, PDIA, NL as well as NEL (y=6,39365 – 0,002301x, P<0,01, correlation coefficient = 0,553918). There are total negative relations among NDF concentration and contents of NL, PDI and NE. ADF and fibre concentration are in negative correlation with NE concentration but no with the content of NL and PDI.

Table 1. The forage quality of new strains and cultivar Jarka (year 2002, average of three cuts, contents in $g.kg^{-1}$ DM, NEL and NEV in $MJ.kg^{-1}$ DM)

strain/cultivar	treatment	CP	ash	fibre	ADF	NDF	PDIA	PDIN	PDIE	NEL	NEV
ŽE XLI	harrowing	160,4	93,1	294,7	412,7	492,1	36,0	100,7	83,7	5,27	5,00
	rolling	171,0	90,6	284,1	396,4	472,5	38,4	107,4	86,9	5,40	5,16
	no treatment	185,0	92,9	290,9	403,4	460,5	41,6	116,2	88,8	5,33	5,03
ŽE XLII	harrowing	175,3	100,7	282,5	385,0	455,0	39,4	110,1	86,5	5,27	5,01
	rolling	167,1	96,5	291,2	403,7	478,2	37,6	105,0	84,9	5,26	5,00
	no treatment	173,5	86,4	298,4	423,2	495,1	39,0	109,0	86,8	5,32	5,05
ŽE XLV	harrowing	178,7	93,6	295,3	410,2	474,6	39,0	111,3	86,0	5,24	4,96
	rolling	175,1	95,6	287,0	402,0	479,3	39,4	110,0	86,7	5,28	5,02
	no treatment	169,7	91,9	304,6	417,8	495,5	38,1	106,6	85,2	5,23	4,96
JARKA	harrowing	174,4	94,2	292,0	404,6	469,2	39,2	109,6	86,7	5,30	5,04
	rolling	165,4	89,4	298,7	407,5	493,3	37,2	103,9	84,9	5,29	5,02
	no treatment	171,9	90,1	300,7	429,2	492,4	38,7	108,0	86,1	5,28	5,01

Figure 1. The dependence of NDF content on the PDIN concentration



CONCLUSION

The forage quality of alfalfa was affected mainly by a stage of development and a sequence of cut, the influence of a variety and a treatment after cutting was not significant. The first cut had a higher content of NE with the same level of NL and PDI content, it can be utilize by forage conservation.

The experiment will be continued but the results already showed that forage quality of evaluated strains and variety Jarka is comparable. If the new strains are better in specific parameters, they will be listed as varieties in the Czech republic.

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WEED INFESTATION INFLUENCE ON CHEMICAL COMPOSITION OF SILAGE MAIZE (*ZEA MAYS* L.)

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ABSTRACT

The influence of various ways of regulation in weed infestation of silage maize stands was studied in 1998 - 2000. Four variants of stands were compared: 1. without weed eradication (check), 2. mechanically weeded from the phase of 5th maize leaf till the end of vegetation, 3. mechanically weeded from the beginning of vegetation till the phase of 5th maize leaf and later on without protection, 4. chemical weeding. The percentage of ears, husks, stalks and leaves was evaluated from total weight of maize plant in dependence weed infestation. The qualitative parameters of silage maize biomass were evaluated. There was proved, that weed infestation negatively influences the total plant weight of maize, but there is no influence on percentage share of individual plant parts. Qualitative parameters of harvested biomass are worsening by presence of weeds. Energy content (NEL, NEG) is decreased and content of ash and crude fibre is increased. Variant with fungicide treatment showed the highest weight of whole plants and quality of harvested biomass.

Keywords: maize; plant weight; NEL; NEG; ash content; crude fibre content

INTRODUCTION

Whole complex of fodder characteristics is important for determination of fodder value. Metabolizable energy (ME), netto energy of lactation (NEL), netto energy of gain (NEG) and utilizable protein content expressed in PDI belongs to most important qualitative indicators. Content of organic matter (crude protein, fat, crude fibre, NFE) and ash is also studied (Prokeš, 2002). Ear is the main energy holder in maize plant, in it is the 65 % of total nutrient content (Čermák et al., 2003). The percentage proportion of ear weight in total plant weight should be minimum 50 % (Padrůněk, 1997).

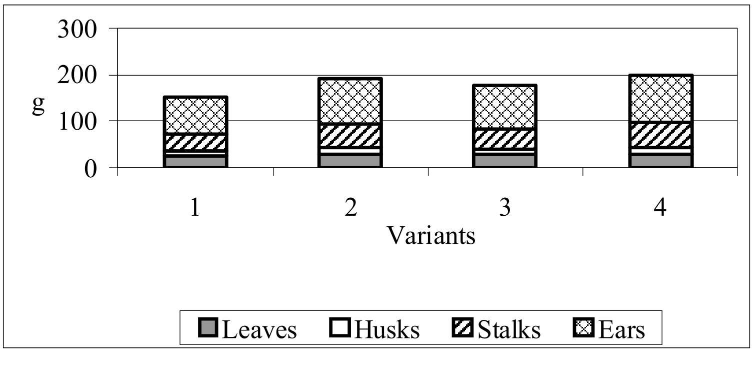
MATERIAL AND METHODS

The plot experiments with silage maize were established in 1998 - 2000 in the field of Faculty of Agronomy, Czech University of Agriculture in Prague at the Research station in Červený Újezd. The experimental plots were established in sugar beet production area, of sugar beet-cereal type, wheat subtype; 405 m above sea level. The kind of soil is medium. Clay loam orthic luvisol is the prevailing soil type in the experimental area. The soil reaction is from neutral to slightly acid. The mean annual temperature is 7.7 °C throughout 30 year normal and during the warm half-year is 13.8 °C. The long-term annual sum of precipitations is 493 mm and during the warm half-year 333 mm. The studied variants: 1. without weed eradication (check), 2. mechanically weeded from the phase of 5th maize leaf till the end of vegetation, 3. mechanically weeded from the beginning of vegetation till the phase of 5th maize leaf and later on without protection, 4. chemical weeding. The mechanical cultivation of the maize stands was accomplished in 14-days interval. The chemical weeding was made by postemergental herbicides. The experiment was situated in randomized blocks, each variant was in four replications.

RESULTS AND DISCUSSION

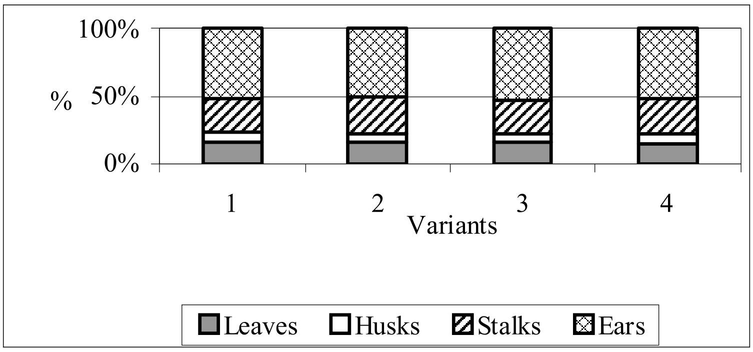
The highest total weight of dry plants was achieved on chemically treated variant. The lowest average weight of one plant was on check variant. This variant was statistically significant different from variant with chemical weeding. Among the rest of variants was no significant difference in whole plant weight. Stand of maize infested with weeds from phase of 5th leaf had more negative influence than infestation at the beginning of vegetation. The same relations were recorded in quantification of individual plant parts – ears and stalks. There were no statistically significant differences among variants in weight of leaves and husks (Figure 1).

Figure 1. Weight of individual plant parts of maize (g of DM) in 1998 - 2000



The approximately same value of percentage share of plant parts was reached in all variant without regarding the way of treatment during vegetation. Lower weight of all plant parts was caused by weed infestation, but there were no important influence on reciprocal rate of individual plant parts of maize (Figure 2). These results corresponded to outcomes of Novotný and Povolný (2000), who manifest, that contemporary hybrids are very uniform when yield indicators (total dry matter yield, ear percentage, early mature, stalk solidity, etc.) are evaluated.

Figure 2. Proportion of individual plants of maize (%) in 1998 - 2000



Average NEL content in three years ranged from 6.00 to 6.22 MJ/kg and NEG from 5.92 to 6.17 MJ/kg. The lowest energy content was achieved in variants 1 and 3, which included in their samples weed biomass. The ash content was in these variants higher. Mineral content increased by weed infestation can make ensilage of harvested biomass more difficult. Weeds accumulate in their biomass big amount of phosphorus and potassium and by this way they compete for these nutrients with culture plants (Schroth et al., 1995). There was increase of crude fibre content in consequence of weed infestation in 11 g/kg (Table 1).

Table 1. Effect of the way of stand treatment on the chemical composition of silage maize

		Variant 1	Variant 2	Variant 3	Variant 4
Dry matter	g/kg	324.57	321.33	327.57	322.90
ME	MJ/kg	10.11	10.38	10.12	10.42
NEL	MJ/kg	6.00	6.19	6.00	6.22
NEG	MJ/kg	5.93	6.11	5.92	6.17
Ash content	g/kg	52.82	38.02	51.36	36.67
Crude fibre	g/kg	217.89	204.36	216.57	207.56

CONCLUSIONS

Weed infestation negatively influences total plant weight of maize, but has no influence on percentage share of individual plant parts (stalks, leaves, ears and husks). Presence of weed plants impairs qualitative indicator of harvested biomass, decreases energy content (NEL, NEG) and increases ash and crude fibre content.

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FLORISTICAL CHANGES OF THREE TYPES OF GRASSLAND AFTER TERMINATION OF MINERAL FERTILIZING AND OF THE UTILIZATION

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INTRODUCTION

Floristical composition of grassland is a result of the influence of all ecologic elements of the whole ecosystem and of the use of the area.

The grassland ecosystems are significantly changed in the result of pratotechnical acts of the agricultural use. Use of mineral fertilizers, radical renewal or seeding may result in changes of soil character, disbalance of mineralising and immobilisating processes in the soil. This is reflected also in changes of the floristical composition of vegetation and the stability of their species as well as production stability (Jančovič 1997; Jančovič et al. 1999).

Higher level of fertilizing increases the production of the biomass, but it is also the cause of smaller diversity of the floristical composition of the grassland (Kostuch 1992).

The objective of this work is to describe changes in the floristical composition of three types of grassland after termination of mineral fertilization and of the utilization.

MATERIAL AND METHODS

The experimental monitoring was carried out in a long-term meadow test founded by the Department of Grass Ecosystems and Fodder Crops at the Slovak Agricultural University in Nitra in 1992 as a follow up of the research „Ecologisation of cultivating systems in grassland“.

The territory of the trial site is situated at an altitude of 640 m above sea level, with the latitude of 48° 53’ and longitude of 18° 34’ in the locality Chvojnica in the Strážov Hills (Central Slovakia).

The site belongs to a slightly warm region, to moderate dry subregion, with dominantly cold winter. According to long-term measurements, the average annual temperature reaches 7.4°C and 13.8°C in the growing season. The long-term average of the whole-year sum of precipitation is 805 mm, while it is 446 mm during the growing season.

Permanent grassland was identified as association of *Lolio-Cynosuretum* R. Tx 1937 in view of phytocenology.

The trial was based by the block method and it is divided in three paralel blocks: permanent grassland (PG), reseeded grassland (RG) and temporary grassland (TG). Each block has four treatments with four repetitions.

PG represents the original vegetation. In 1992 we reseeded grass-clover mixture using a ploughless sowing machine in the RG. The composition of the mixture was as follows:

Dactylis glomerata L., cv. Rela	4 kg/ha
festulolium (*Festuca arundinacea* Schreb. x *Lolium multiflorum* Lamk.), cv. Felina	12 kg/ha
Lolium perenne L., cv. Metropol	8 kg/ha
Trifolium repens L., cv. Huia	2 kg/ha
Trifolium pratense L., cv. Sigord	3 kg/ha

The third part (TG) of the original grassland was subjected to radical renovation by ploughing in autumn 1991 followed by spring sowing of grass-clover mixture with the same composition as in RG.

All three blocs were cut three times during the growing season. Original treatments of fertilization and does of nitrogen are presented in Table 1.

In 1998 all the trial areas were divided in two parts. In one part we continued in original fertilization and utilization (cutting 3 times), while the other part was unfertilized but identically used by three cuttings.

In 2002 we stopped adding mineral fertilizers within the whole trial and the vegetation was “deserted” (without utilization).

Botanical analysis was performed by the method of projective dominance before each utilization (in 2002 in time of maximum creation of phytomass) to find the changes in floristic composition of the stand in different treatments (Regal, 1956).

Table 1. Treatments of fertilization and nitrogen dose distribution

Treatments of fertilization	Utilization	Dose of pure nutrients (kg/ha)			Time of nitrogen application		
		P	K	N	in spring	after the 1st cut	after the 2nd cut
0	Three-cut system of utilization	-	-	-	-	-	-
PK		30	60	-	-	-	-
N_{90}		30	60	90	30	30	30
N_{180}		30	60	180	60	60	60

RESULTS AND DISCUSSION

In the first year of modified acts, i.e. minimalising of the utilization and absence of fertilizing, we recorded dynamic changes in the share of individual floristic groups.

The most significant changes in the floristic group of grasses were recorded in the 4th treatment (TG) after one-year absence of fertilizing. The share of grasses decreased to 35% (70.67% in 2001) and after a four-year absence of fertilizing in the same type to 29.5% (61.33% in 2001).

A more significant rise of the share of the group of grasses was observed in the first treatment of TG in which the share of grasses rose by 17.67% and in the second treatment of TG after a one-year absence of PK fertilizing the share of grasses rose by 13.76%. Floristical composition of reseeded grassland is presented in Table 2.

Out of individual species in the PG there dominated *Agrostis tenuis* Sibth. (20.5-46%). The exception was recorded in the fourth treatment with the dominance of *Poa pratensis* L. (33.5%). In TG (23.25-56.5%) and RG (20.5-65.5%) we recorded the highest presence of *Dactylis glomerata* L.

In the floristic group of leguminous we observed the increase of share in 2002 as compared with 2001 when the presence was only sporadic in the third cutting. Out of the individual species in TG (1.5-6%) and RG (1.5-12.5%) the highest share was recorded in *Vicia cracca* L., *Trifolium repens* L. (1.5-6.5%) dominated in PG.

Regeneration of leguminous after absence of fertilizing by higher dosage of nitrogen is mentioned also by Jančovič (1999) in his work.

Representation of other meadow herbs was directly influenced by the share of grasses. Decreasing share of grasses meant increasing share of herbs and vice versa. The highest presence (58.5%) was recorded in the treatment 4 PG after a four-year absence of fertilizing. The highest share after a one-year absence was found in the first treatment RG (41%).

Veronica chamaedrys L., *Achillea millefolium* L. a *Ranunculus acris* L dominated from out of individual species on PG and RG. The highest percentage of representation was recorded in *Achillea millefolium* L., *Veronica chamaedrys* L. and *Acetosa pratensis* Mill.

Changes of the share of agrobotanic groups caused by termination of mineral fertilization are stated also by Ilavská et al. (2002). We agree with the authors in the finding that the share of grass species was sinking and share of dicotyledonous species was rising in the treatments which were originally N fertilized (P+K).

The share of blank places was increased in the 3rd and 4th treatment in all three blocks after a one-year absence of fertilizing, on the contrary, in the 1st and 2nd treatment we recorded their decrease.

Table 2. Floristical composition of reseeded grassland – 2001 (the last year of fertilizing, %)

Grassland	Floristical groups	treatments			
		1	2	3	
RG	grasses	62.33	63.33	67.33	78.33
	leguminous	1.0	1.83	+	-
	other meadow herbs	28.5	26.33	27.67	17.0
	blank places	8.17	8.5	5.0	4.67
Floristical composition of reseeded grassland – 2002 (after one year absence of fertilizing, %)					
RG	grasses	56.0	41.5	59.5	67.0
	leguminous	1.5	12.0	2.0	-
	other meadow herbs	41.0	39.5	31.5	10.5
	blank places	1.5	7.0	7.0	22.5

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DYNAMICS OF GRASSLANDS PRODUCTION IN HILLY AND MOUNTAINOUS REGIONS OF SERBIA

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ABSTRACT

In our investigations we have monitored dynamics of production on natural grassland on 1000m (*Agrostietum vulgaris*) and 1600m (*Festuco-Agrostetum*) a.s.l. Grassland was fertilized with $N_{120}P_{30}K_{60}$ and $N_{80+40}P_{30}K_{60}$.

In association *Agrostietum vulgaris* (1000m) vegetation period starts between April 1st and 10th. More intensive plant growth is registered by the end of April beginning of May reaching the maximum in the second half of May, and subsequently decreases until the end of vegetation period. On 1600m vegetation in average is 15 days late in comparison to vegetation on 1000m and the curve representing daily production are similar, however with lower values.

Total production on grasslands varied from 3.85-7.25 tha^{-1} on 1000m, and 3.51-5.09 tha^{-1}on 1600m.

Key words: natural grassland, production, dynamics of production

INTRODUCTION

Grasslands in Serbia with 32% of agricultural area represent considerable resource for production of fodder. Their importance is even higher in hilly-mountainous regions where they usually represent main source of food for livestock.

Wish of each producer is to have as evenly distributed production of fodder throughout the year as possible, especially in regard to green mass that has the best quality. However, distribution of production is uneven and depends on numerous factors: type of grassland, ecological conditions (Peeters and Kopec, 1996), fertilization (Umrani et al., 1998), exploitation system (Orr et al., 1988, Lazarević, 1996), etc.

Objective of this paper was to determine dynamic changes in production during vegetation period on different heights above the sea levels in order to successfully harmonize the production and use of fodder.

MATERIAL AND METHODS

The investigations were carried out on the Mt. Kopaonik with ass. *Agrostietum vulgaris* in Preslo saddle (1000 m) and with ass. *Festuco-Agrostetum* in Rendara saddle (1600 m) over the period 1988-1990. The first cut was performed in six cutting terms: 40, 47, 54, 61, 68 and 75 days from the beginning of vegetation, and the second cut after 42-day regeneration. The amounts of fertilizers applied were as follows: before beginning of vegetation it was applied $P_{30}K_{60}$, and N_{120} was applied in two variant, all quantities with PK or N_{80} with PK, and N_{40} for top dressing for second cut ($N_{80+40}P_{30}K_{60}$). The trial was established in five replicates, the elemanry plot being 20 m^2 in size. The results for DM yield were analyzed by analyses of variance using LSD test.

RESULTS AND DISCUSSION

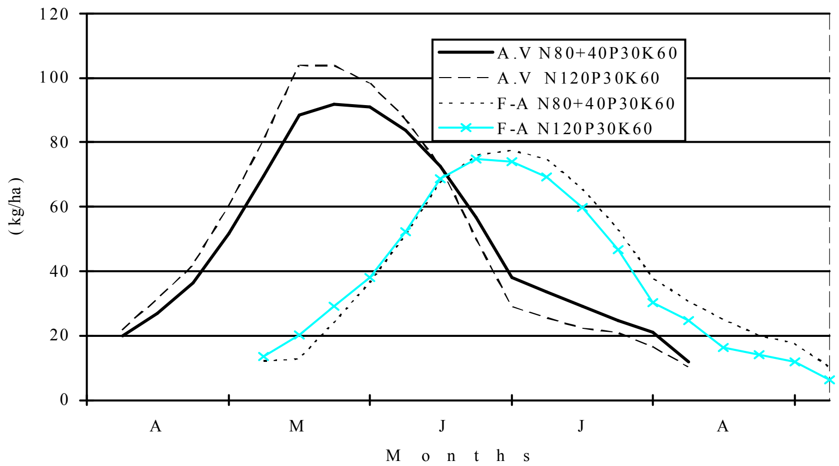
Beginning of vegetation period on location Preslo (1000 m above sea level) varied from April 1st to April 10th, whereas on location Rendara vegetation was late in average by 15 days. With each 100 m vegetation was later in average by 2-3 days. Production on grasslands according to locations, fertilization treatments and cuts is presented in Table 1.

Table 1. Influence time of cutting on DM yield of natural grassland in mountainous regions of Serbia

Time of cutting	*Agrostietum vulgaris* (1000 m)						*Festuco – Agrostetum* (1600 m)					
	$N_{120}P_{30}K_{60}$			$N_{80+40}P_{30}K_{60}$			$N_{120}P_{30}K_{60}$			$N_{80+40}P_{30}K_{60}$		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total
1	1.92	1.90	3.82	1.58	2.45	4.03	1.00	2.50	3.50	0.84	2.93	3.77
2	2.95	1.55	4.50	2.35	2.11	4.46	1.94	1.79	3.73	1.77	2.14	3.91
3	3.95	1.18	5.13	3.48	1.68	5.16	2.48	1.24	3.72	2.31	1.64	3.95
4	4.85	1.07	5.92	4.14	1.30	5.44	3.14	0.76	3.90	2.99	0.98	3.97
5	5.70	0.77	6.47	4.95	0.95	5.90	3.95	0.64	4.59	3.74	0.96	4.70
6	6.82	0.43	7.25	5.78	0.50	6.28	4.82	0.27	5.09	4.55	0.43	4.98
Lsd 5%	0.57	0.35	0.65	0.57	0.35	0.65	0.54	0.33	0.71	0.54	0.33	0.71
1%	0.70	0.42	0.79	0.70	0.42	0.79	0.67	0.40	0.88	0.67	0.40	0.88

What can be observed as regularity is that production of grasslands with delaying of cut of 40 to 75 days according to vegetation constantly, almost linearly increased in first and decreased in second cut. Production increased more intensively when entire quantity of N fertilizer was applied in spring during first cut, but treatment with fertilizers has caused increased production in second cut. However, the effect of this treatment was expressed in earlier dates for cut, whereas in later cuts, because of dry period, it is neglectable. This indicates the conclusion that treatment with fertilizer of grasslands in hilly-mountainous regions has no effect and that entire quantity of fertilizer should be applied in spring, at least when use of grasslands by cutting is considered. This is in accordance with previous results obtained in hilly-mountainous region (Lazarević, 1991). The highest production on grasslands was realized by cutting 75 days after vegetation (7.25 and 6.28 tha^{-1} on location Preslo and 5.09 and 4.98 tha^{-1} on location Rendara with $N_{120}PK$ and $N_{80+40}PK$). Production of grasslands on location Preslo was higher in comparison to location Rendara in average by 1.43 tha^{-1} with $N_{120}PK$ and 1.00 tha^{-1} with $N_{80+40}PK$.

Figure 1. Daily production (kg $DMha^{-1}$) of natural grassland in ass. *Agrostietum vulgaris* (A.v) and *Festuco-Agrostetum* (F-A) on Kopaonik mountain



Daily production (Graph 1) has relatively similar curved line. It is characterized with sudden increase of daily accumulation in spring period and same sudden decrease in second part of vegetation. Maximum daily production was registered on location Preslo (1000 m) in second half of May in amount of 103,8 kg $SMha^{-1}$ with $N_{120}PK$ and 91.86 $kgha^{-1}$ with $N_{80+40}PK$. On location Rendara (1600 m) daily production shows the same curved line, but due to later onset of vegetation maximum values are achieved in second half of June, 74.73 and 77.5 kg $SMha^{-1}$ with $N_{120}PK$ and $N_{80+40}PK$. Subsequently production decreased and depending on climatic conditions ceased by the end of August.

CONCLUSION

Yields of natural grasslands directly depend on time of first cut. Delaying of cut from 40 to 75 days increases the production in first cut, but decreases it in the second, however increase is more intensive and therefore total production higher with later cuts

Treatment with top dressing fertilizers showed no positive effects on increase of production and it cannot be recommended as measure for fertilization of natural grasslands in hilly-mountainous regions.

Daily production has explosive growth in spring period, reaches maximum value in second half of May on 1000 m above sea level (approximately 100 kg $SMha^{-1}$), and in second half of June on 1600 m above sea level (approximately 75 kg $SMha^{-1}$), and afterwards decreases suddenly until termination of vegetation period.

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PRODUCTIVITY OF *ZEA MAYS* L. AND *VICIA FABA L.* AS ASSOCIATED CROPS IN AFTER CROP SEEDING

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ABSTRACT

Corn and fodder broad beans were investigated as pure and associated crops in after crop seeding. In associated crops density for both species was reduced by ½ in comparison to pure crop seeding. Crop was raised in conditions with irrigation. Mixtures have realized higher yields than pure crops, which is consequence of higher yield of broad beans than expected. Fodder broad bean contains considerably higher quantity of crude proteins and it induced higher quantity of crude protein in mixture compared to corn. The highest gross energy value in production of milk and meat was achieved by corn (5.88 and 5.97 $MJkg^{-1}$ DM), whereas in case of mixtures, higher production per unit of surface was realized.

Keywords: corn, fodder broad beans, after crop seeding, associated crops, productivity, irrigation

INTRODUCTION

After the harvest of cereals in Serbia, 70 to 100 days remain with approximately 900^{0}C. This enables the providing of new quantities of fodder by after crop seeding especially of fodder cultures. However, most limiting factor for stabile production is insufficient precipitation. In Serbia, second half of summer is mainly dry. Therefore, irrigation of after crops is essential.

*Miskovic et al. (*1980) by investigating corn and soy bean in associated crop seeding occurring in regular seeding period, have obtained results confirming that higher presence of soy bean in used mixture increased protein content, but decreased total yield of green mass. *Andrighetto et al.* (1992) pointed out that similar yields were obtained with associated crops of corn and soybean and pure crops, but considerably higher protein content. Objective of this research was to investigate the behaviour of less investigated fodder broad beans and corn in pure crops and mixtures raised as after crops.

MATERIAL AND METHODS

Field trial was set according to plan of random block system in four repetitions. Prior to seeding fertilization was carried out with N_{45} $P_{45}K_{45}$ and subsequently seeding of corn ZP-196 (*Zea mays* L.) and fodder broad beans - Vezuvijana (*Vicia faba* L.).

Seeding was carried out as pure and associated crops. Corn in pure crop was planted in distance between rows of 40 cm and fodder broad beans on distance of 20 cm. Planed density of corn in pure crop was 100 and of fodder broad beans 800 thousand of plants per hectare. Formation of associated crops of corn and broad beans was carried out by reducing the density for both plants by ½ in relation to puree crops. Seeding was carried out in the same row or alternating rows.

RESULTS AND DISCUSSION

Mixtures have realized higher production than pure crops. Mixture seeded in the same row realized higher production. The highest yield of over-ground bio mass was established for mixture of corn and broad beans (seeding in the same row) 5874 $kgha^{-1}$. Achieved yield was by 16.1% higher than yield of corn and by 19.4% higher than yield of broad beans. Stated differences in yield were statistically highly significant. Higher yield by mixture in regard to pure crops was realized by higher yield of broad beans by 20% in relation to expected yield (Table 1).

Based on obtained data in this investigation it can be observed that fodder broad bean plants in associated crop seeding had more space and lower competitive pressure from corn plants than plants of it's own species.

In conditions of favourable water regime and poor nitrogen content in soil, which was more limiting to development of corn than to development of legumes, it can be concluded that interspecies competition was greater than intraspecies competition. Considering the LER index development, in our research it was within the limits defined by *Russell and Caldwell* (1989) for associated corn and soybean crops.

Besides this higher LER index, fodder broad beans in associated crop with corn realized higher weight participation in total mass. Participation of broad beans in silo-mass was 56.4% and 58.5%, which is upper limit in which broad beans can participate in silo-mass with corn according to results by *Dinic et al.* (1999), and that silage of satisfactory quality is obtained.

The highest net energy value in production of milk and meat was realized by corn (5.88 and 5.97 $MJkg^{-1}$). Corn has realized higher energy value in production of meat, whereas broad beans and mixtures had higher energy value in production of milk. Net energy value of mixtures was lower compared to corn. However, considering production of net energy value per unit of surface it can be observed that mixtures have realized higher production of NEM per unit of surface in relation to corn.

The highest production of NEM (Net Energy Value for meat production) per unit of surface was realized by mixture of corn and broad beans planted in the same row 32325 $MJha^{-1}$. Realized production enables 735 kg of gain which is by 6.9% higher production enabled by corn and by 27.2% more than pure crop of broad beans. Same mixture realized also the highest production of NEL (Net Energy Value for milk production) 32535 $MJha^{-1}$, which is by 9.3 % more compared to corn and by 24.9% more compared to production of pure crop of broad beans.

Table 1. Average yields and energy value of *Zea mays* and *Vicia faba* as pure stands or mixtures

Species	Zea mays	Vicia faba	Zea mays - Vicia faba	Zea mays + Vicia faba	Lsd 0.05 0.01
Yields of components kgha^{-1}			2534 / 3276	2435 / 3439	443
Total yileds kgha^{-1}	5060	4918	5810	5874	594
Relativly (%)	100.0	97.2	114.8	116.1	8.8
Relativly yields of components			0.50 / 0.67	0.48 / 0.70	11.7
LER			1.17	1.18	
NEL MJkg^{-1}DM	5.88	5.30	5.55	5.54	
NEM MJkg^{-1}DM	5.97	5.17	5.52	5.50	
DCP gkg^{-1}SM	52.3	133.5	98.0	99.6	
NEL MJha^{-1} kg milk	29762 (5580)	26044(4891)	32254 (6047)	32535 (6100)	
NEM MJha^{-1} kg meat	30219(687)	25429 (578)	32072 (729)	32325 (735)	
DCP kgha^{-1} kg milk (kg meat)	265 (3285) (482)	658 (8157) (1196)	571 (7079) (1038)	586 (7264) (1065)	

Legend: - sowing in alternative rows, + sowing in the same rows. In brackets: possible milk and meat production

Differences in regard to possible production of milk based on protein and energy in case of mixtures amount to 17.1% and 19.1%, in case of broad beans by 66.8% higher on basis of protein, whereas in case of corn by 69.9% higher on basis of energy in relation to potential production based on protein.

Differences in regard to potential meat production based on net energy and digestible crude proteins vary from 42.4% and 44.9%, in case of mixtures, broad beans 106.9% in favour of protein, whereas corn enables by 42.5% higher production of meat based on energy compared to potential production based on proteins.

From the aspect of factor contained in the minimum as limiting factor, the lowest production of milk (3285 kgha^{-1}) and meat (482 kgha^{-1}) is achieved by use of corn based on protein. Mixtures provide considerably higher production of 6047 and 6100 kgha^{-1} of milk and 729 and 735 kgha^{-1} of meat.

Stated results indicate that by combining of crops favourable protein and energy ratio is achieved, which is significant for adequate balance of diets for ruminants.

CONCLUSION

Mixtures have realized higher yield of pure crops. The highest yield was obtained by mixture of corn and broad beans planted in the same row (5874 kg ha^{-1}), which is considerably greater difference in relation to yield of corn and broad beans grown as pure crops.

Yield in mixtures was by 17% and 18% higher compared to expected value. More exactly, it takes by 17 or 18% more area with pure crops to receive same yield realized in associated crops.

The highest net energy value in production of milk and meat was achieved by corn (5.88 and 5.97 MJkg^{-1} DM). Mixtures achieved higher production of NEL and NEM per unit of area.

Combining of crops results in more favourable protein energy ratio, which, besides higher yields of mixtures, provides possibility for higher production of meat and milk per unit of surface due to better balance of nutritive matters.

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MICROBIOLOGY AND CONTROL

OF FERMENTATION PROCESS

ENSILABILITY OF DIFFERENT GRASS/CLOVER MIXTURES

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INTRODUCTION

In Switzerland, grass/clover mixtures are sown for leys. Pure sown grass stands are not common. White and red clover have a central role in Swiss mixtures. They are highly palatable, well digestible and exhibit high contents of energy, protein and minerals. On the other hand, legumes are regarded as being unsuitable for ensiling. The various mixtures available in Switzerland are continuously revised on the basis of results from variety testing programs, mixture trials on field plots and of results on pilot scale under farm conditions (Kessler and Lehmann, 1998). Concerning the ensilability of the different mixtures, no systematic tests are carried out. For this reason, we tested in 2001 and 2002 different grass/clover mixtures.

MATERIAL AND METHODS

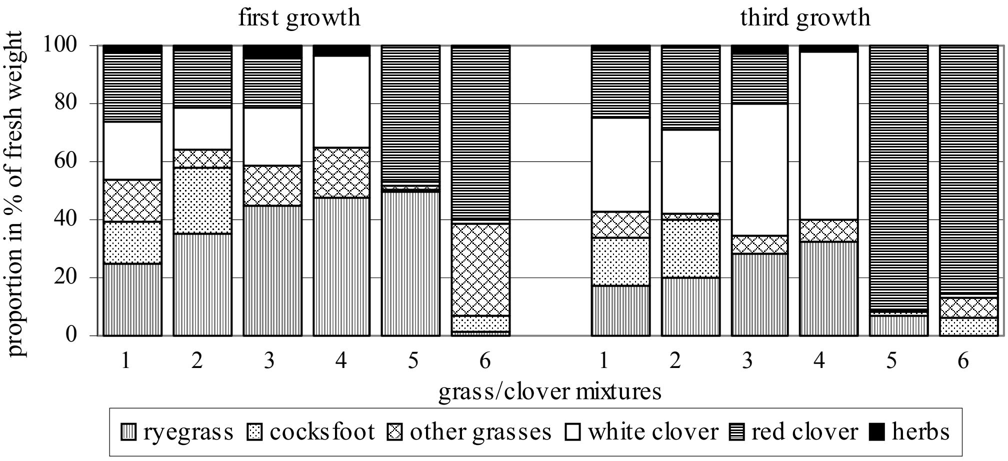
In 2001 and 2002, we ensiled different mixtures in laboratory silos. The mixtures were sown in 2000 as part of the testing program of the Swiss Federal Research Station for Agroecology and Agriculture in Zürich-Reckenholz. The mixtures 1 to 4 contained white and partially red clover as well as different grasses. These mixtures were cut 5 times a year. The mixtures 5 and 6 contained red clover and various grasses. They were only cut 4 times a year. For our experiment, we used the first and third growth. The forage was pre-wilted to attain DM contents of 25 to 30 %, short chopped and ensiled in laboratory silos each having a volume of 1.5 litres. The silos were stored at room temperature (approx. 20 °C) and weighed regularly to measure gaseous losses. Chemical parameters were analysed before ensiling and after a storage period of five months. In the silage, pH, fermentation acids, ethanol and ammonia were also analysed.

RESULTATS AND DISCUSSION

In the leys, the proportion of clover was in all cases higher in the third growth compared to the first growth (Figure 1). In the mixtures 5 and 6 the proportion of red clover (*Trifolium pratense*) reached nearly 90 % in the third growth. The proportion of ryegrass (*Lolium perenne* and *multiflorum*) increased from mixture 1 to 5. The mixtures 1, 2, 5 and 6 contained cocksfoot (*Dactylis glomerata*), contrary to the mixtures 3 and 4. Except for the mixture 6, ryegrass and cocksfoot were the dominant grasses. Both together made up more than 70 % of the grasses.

Concerning the nutrient contents, the mixtures of the third growth had higher crude fibre and lower sugar contents than the first growth (Tab. 1). The fermentability coefficients varied between 39 and 50. The nitrate contents were < 0.5 g per kg DM in all treatments.

Figure 1. Botanical composition of the six grass/clover mixtures of the first and third growth



Sugar was strongly reduced during the fermentation process. This caused higher ash, crude protein and crude fibre contents along with lower sugar contents following ensiling.

Except for butyric acid, the fermentation parameters significantly differed between the six mixtures. But also growth number and year contributed to significant differences in fermentation parameters. In spite of higher DM contents, the fermentation quality of third growth silages was worse than of first growth silages. This can be explained by the lower sugar and the higher crude fibre contents of the green forage. According to the DLG evaluation scheme developed by Weissbach and Honig (1997) the silages attained scores between 51 and 95 out of a maximum of 100. Differences were observed between mixtures and especially between growth number. Mixtures with cocksfoot had lower DLG scores. Wyss and Vogel (1998) showed that silage quality with cocksfoot as pure stand or in mixtures was always lower compared to ryegrass.

The correlation between DLG scores and the proportion of grasses was 0.23, between DLG scores and proportion of ryegrass 0.47. On the other hand cocksfoot had a negative effect on quality (-0.35). White and red clover had a small negative impact on silage quality. The corresponding correlations with DLG scores amounted to –0.14 and –0.08, respectively. Higher correlations were found between DLG scores and sugar (0.66), crude fibre content (-0.61) as well as fermentability coefficient (0.54) of the green forage.

Table 1. DM, nutrient contents and fermentation parameters of six green and ensiled grass/clover mixtures of the first and third growth (mean values of 2001 and 2002)

	Mixtures, first growth						Mixtures, third growth						Factors		
	1	2	3	4	5	6	1	2	3	4	5	6	M	G	Y
Green forage															
DM, g/kg	254	248	245	253	252	252	294	294	278	302	284	273	NS	**	**
Ash, g/kg DM	102	100	98	95	85	92	105	108	112	103	91	85	**	*	NS
Crude protein, g/kg DM	184	171	171	165	131	159	163	164	182	177	163	169	**	**	**
Crude fibre, g/kg DM	213	214	208	204	229	255	275	274	256	252	264	269	**	**	**
Sugar, g/kg DM	108	112	116	118	145	118	70	68	72	77	103	109	**	**	NS
Fermentability coefficient	42	42	43	45	50	43	41	41	39	43	44	44	**	**	*
Silages															
DM, g/kg	248	236	235	245	239	242	282	280	266	289	269	260	NS	**	**
Ash, g/kg DM	107	109	106	100	89	97	114	115	116	109	96	89	**	*	*
Crude protein, g/kg DM	196	187	185	179	138	165	173	174	189	185	170	174	**	NS	**
Crude fibre, g/kg DM	225	229	231	224	247	279	296	296	269	269	288	291	**	**	**
Sugar, g/kg DM	37	29	29	44	52	28	19	16	20	25	27	23	**	**	**
pH	4,5	4,6	4,2	4,3	4,3	4,6	4,8	4,7	4,6	4,5	4,6	4,5	**	**	*
Lactic acid, g/kg DM	25	23	46	46	50	34	13	14	20	31	35	53	**	*	**
Acetic acid, g/kg DM	16	14	20	21	29	11	12	11	12	10	8	10	**	**	**
Butyric acid, g/kg DM	2	6	2	1	0	8	8	10	10	6	6	6	NS	**	NS
Ethanol, g/kg DM	8	11	12	9	6	10	6	6	6	5	5	6	**	**	*
NH3-N, %	7	9	7	7	5	8	8	9	9	9	8	9	**	**	**
Gas losses, %	3,2	4,9	4,1	3,8	2,8	3,8	4,0	4,0	3,7	3,3	3,4	3,4	*	NS	**
DLG scores	82	69	95	93	95	63	51	53	57	64	59	66	*	**	NS

M=mixtures, G=growth, Y=year; Statistical significances: ** $P<0.01$, * $P<0.05$.

CONCLUSIONS

The results of the trial showed that nutrient contents and fermentation quality of six different grass/clover mixtures varied significantly. Growth number proved to be a major influencing factor. But also the botanical composition influenced silage quality. Ryegrass had a positive and cocksfoot a negative effect on quality. However, the influence of clover (red and white) on silage quality was limited and slightly negative.

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FERMENTATION CHARACTERISTICS AND NUTRITIVE VALUE OF RED CLOVER-GRASS MADE IN BIG BALES AND TRENCH

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ABSTRACT

The silages were made from a first-cut 10-20 h wilted red clover-grass (60 % - red clover, 25 % - thymothy, 10 % - fescue and 5 % - others) sward. Dry matter content of big bale silages was higher (308.5 g kg^{-1} *vs* 303.6 g kg^{-1}) and therefore the pH was higher (4.65 *vs* 4.52) and fermentation acid content lower (36.2 g kg^{-1} DM *vs* 39.7 g kg^{-1} DM) than that of chopped trench silage. There were no significant effects of type of silaging on the proportions of the fermentation acids (lactic, acetic, butyric). Positive was decreasing the proteolysis in big bale silages which achieved 45.6 g ammonia N/kg^{-1} N in comparison in trench silage -50.8 g ammonia N/ kg^{-1} N. The digestibility value of big bale silages were higher than these of trench silage (695 g kg^{-1} DM *vs* 692 g kg^{-1} DM). The digestible protein and energy contents of big bale silages were 1.4% and 2.5% higher than the chopped trench silage. Fattening bulls fed big bale silage showed 2.5% higher live weight gains than bulls on trench silage ($P>0.5$).

INTRODUCTION

Ensiled grass or grass-legume mixtures are presently the influential source of winter feed for dairy cows and other livestock in the Lithuania. About 70 percent of silage is ensiled into trench. Ensiling wilted grass into big bales increased during the last years.

Clamping is generally the most cost-effective method of producing silage, however if bales are prepared the ensiling process is quicker, resulting in more efficient use of available substrates (Fychan et al., 2002). The fermentation processes during ensiling alters the chemical composition that can affect both the nutritive value and intake of forage (Cushmahan and Gordon, 1995). However, big bales technology does not use chopped material and this means that the fermentation is not same as for clamp silage (Slotner, 2002). The objective of this trial was to examine the difference in silage fermentation characteristics when herbage is ensiled in big bales or in clamp and to investigate nutritive value of silages for fattening bulls.

MATERIALS AND METHODS

A legume-grass mixture (60 % to red clover, 25 % - thymothy, 10 % - fescue and 5 % - other) was harvested with the mower conditioner (Kverneland 347) at first cut on June, 2001. The crops were allowed to prewilt for approximately 10-20 h. From the one half of field legume-grass mixture was chopped with a chop harvester (E-281) and ensiled in ferro-concrete trench. From the another half of the field legume-grass was ensiled using chopper baler (Greenland RF 130). The bales were wrapped in 6 layers of 35 micron film and stored in a single layer.

During the ensilage, samples of herbage were collected to determine its chemical composition. The bales and trench were opened after 100 days ensiling. During the feed experiment the silages were sampled and analyzed for DM, pH, fatty acids (lactic, acetic, butyric), NH_3N. Silages were analysed for crude protein, crude fibre, crude fat, crude ach.

During 143 days of feed experiment trench silage were fed to 6 fattening bulls and round bale to another 6 fattening bulls. The daily feed intaked and refusals were recorded. Live weights were determined at the beginning and every month of the study. Statistical analyses were carried out by means of procedures described by STATISTIKA for Windows (Sakalauskas, 1998).

RESULTS AND DISCUSSIONS

The effects of method of harvesting and forage type on chemical composition of the ensiled material are summarized in Table 1. There were no significant differences between silages in DM, ash, CP, WSC and digestibility value. Ensiling legume-grass in bales resulted in a higher pH and higher residual WSC content, and lower acetic acid. Positive was decreasing the proteolysis in big bale silages which achieved 45.6 g ammonia N/kg^{-1}N in comparison in trench silage- 50.8 g ammonia N/kg^{-1}N. However, this small differences did not significantly influence voluntary intake or *in vivo* digestibility.

No significant differences were found between harvesting methods on silage intake and daily weight gain (Table 2). However voluntary dry matter intake and live weight gain tended to be higher for silage made in big bales.

CONCLUSIONS

The fermentation quality of both silages was good and they had a high nutritive value. However dry matter intake and weight gain tended to be higher for silage made in big bale. Therefore both baling and clamping are suitable methods for ensiling legume-grass, and the choice of which to use can be based on the availability of equipment and facilities.

Table 1. Chemical composition of the wilted herbage and legume-grass silage ensiled in different methods

	Herbage	Silage made in trench	Silage made in big bal	SEM	P
Dry matter (DM; g/kg^{-1})	315	303.6	308.5	7.2	NS
In DM (g/kg^{-1} DM):					
organic matter	901	900.4	895.3	2.6	NS
crude protein	128	139.8	143.3	2.6	NS
crude fibre	288	313.7	311.8	5.2	NS
WSC	92	20.3	21.1	1.3	NS
NDF	519	614.3	615.3	4.3	NS
ADF	303	362.4	359.2	2.6	NS
D-value		692.5	695.1	6.2	NS
Total organci acid		39.7	36.2	1.8	NS
Lactic acid		22.1	21.7	0.9	NS
Acetic acid		17.6	14.5	1.2	NS
Butyric acid		0.01	0.00	0.0	NS
Ammonia N (g/kg^{-1} N)		50.8	45.6	2.4	NS
pH		4.52	4.65	0.1	NS
ME MJ/ kg^{-1} DM		8.89	8.94	0.9	NS
FU/ kg^{-1} DM		0.806	0.817	0.2	NS

Table 2. Feed intake and animal performance in the experimental period (mean values ± SEM)

	Silage made in trench	Silage made in big bale
Net energy intake, MJ/ day^{-1}	88.91	89.82
Silage intake, kg^{-1} DM	7.19	7.26
Compound feed, kg^{-1} DM	1.85	1.85
Total dry matter intake, kg^{-1} DM	9.04	9.11
Initial live weight, kg^{-1}	356.33±18.64	354.60±19.17
Total live weight gain, kg^{-1}	159.44±14.13	163.50±4.35
Average live weight gain, kg day^{-1}	1.115±0.09	1.143±0.03

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EFFECT OF INOCULANT APPLICATION RATE AND POTASSIUM SORBATE ON FERMENTATION QUALITY AND AEROBIC STABILITY OF WILTED GRASS SILAGES

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ABSTRACT

Wilted first cut timothy meadow fescue grass (DM 298 g/kg) was ensiled into pilot scale silos (3 kg) for 110 days in three replicates. Eight treatments were 1) Untreated (UT), 2) Formic acid based additive 5 l/t (FA), 3-5) *Lactobacillus plantarum* VTT E-78076 (E76) at three levels: $1*10^5$ cfu/g, $5*10^5$ cfu/g, E76 $1*10^6$ cfu/g, and 6-8) the three levels of E76 in combination with 0.30 g/kg K-sorbate. Fermentation quality of the silages was analysed and aerobic stability measured. All inoculants improved fermentation quality compared to untreated silage. Increase in inoculation rate resulted in a small increase in WSC and decreased amounts of ethanol and ammonia-N. K-sorbate had a negligible effect on fermentation quality while it improved aerobic stability especially with the highest E76 level.

INTRODUCTION

A novel strain of *Lactobacillus plantarum* (VTT E-78076, E76) has been selected and tested in laboratory scale (Jaakkola *et al* 1999). It has proved to be an efficient inoculant in producing lactic acid, decreasing pH and to have a low proteolytic activity also in experiments conducted at farm scale (Saarisalo *et al* 2002, 2003). However, E76-silage appears to be prone to aerobic deterioration. Potassium sorbate (E202 $C_6H_7O_2K$) is effective preservative against yeasts and moulds, and it is regarded as safe food additive. The aim of the experiment was to study the effect of E76 application rate and of K-sorbate on fermentation quality and aerobic stability of wilted grass silage. Untreated (no additive) and Formic acid was used as negative and positive controls, respectively.

MATERIAL AND METHODS

Wilted (24 h) first cut timothy meadow fescue grass (DM 298 g/kg, CP 130, water soluble carbohydrates (WSC) 100 g/kg DM, and buffering capacity 427 meq/kg DM) was ensiled into pilot scale silos (3 kg) for 110 days in three replicates. Eight treatments were 1) Untreated (UT), 2) Formic acid based additive 5 l/t (FA), 3-5) *Lactobacillus plantarum* VTT E-78076 (E76) at three levels: $1*10^5$ cfu/g, $5*10^5$ cfu/g, E76 $1*10^6$ cfu/g, and 6-8) the three levels of E76 in combination with 0.30 g/kg K-sorbate. Fermentation quality of the silages was analysed and aerobic stability estimated by measuring temperature twice a day while silage was exposed to air. The data were tested using SAS GLM procedure. Sum of squares for the treatment effect was further separated into single degree of freedom comparisons using orthogonal contrast: FA *vs.* others, UT *vs.* all E76s, effect of K-sorbate, linear and quadratic effects of application rate, and interactions of K-sorbate and application rates.

RESULTS AND DISCUSSION

On average silage DM was 300 g/kg, Differences in fermentation quality between the FA- and other silages were typical for restrictively and extensively fermented silages as indicated by a smaller concentration of lactic acid (49.8 *vs.* 87.2, g/kg DM) and proportion of NH_4-N (33.0 *vs.*54.9, g/kg N) in FA-silage. However, there was more ethanol in FA-silage (11.8 *vs.* 8.1, g/kg DM), (all $P<0.001$). The amount of butyric acid found in any of the silages was minor, while more butyric acid has been observed in UT-silage in the farm-scale experiments (Saarisalo et al 2002, 2003).

The E76 inoculant improved silage quality compared with UT as indicated by lower pH (4.03 *vs.* 4.16, $P<0.05$) and proportion of NH_4-N (53 *vs.* 69 g/kg N, $P<0.001$) as well as increased lactic acid (88.6 *vs.* 78.2 g/kg DM, $P<0.001$) and WSC (11.5 *vs.* 19.4 g/kg DM, $P<0.001$). There was also less ethanol and acetic acid in E76-silages than in UT-silage. The effect of K-sorbate on silage fermentation was small. It increased slightly ethanol ($P<0.05$), and NH_4-N with the lowest level of E76 particularly (Interaction, $P<0.05$).

The effect of increasing E76 application rate on fermentation quality was constant but numerical differences were minor. Increase in E76 application linearly increased WSC ($P<0.01$) and lactic acid ($P<0.05$) while acetic acid ($P<0.05$) and proportion of NH_4-N ($P<0.001$) were decreased. Also pH was decreased though not statistically significantly ($P=0.15$).

The best aerobic stability was observed with the FA-silage which started to warm from seventh day while most of the silages started to warm from second day (figure not shown). However, statistically significant differences in cumulative temperature increase were only reached from seventh day due to substantial variation between the replicate silos. Also the effect of K-sorbate was significant from seventh day. E76 application rate had no effect on aerobic stability. From the inoculated silages only the highest application rate with K-sorbate was effective against aerobic deterioration. That was more stable than UT-silage but not quite as stable as FA-silage.

Table 1. The fermentation quality and aerobic stability of the silages treated with different additives. Mean of three silos

		WSC	Ethanol	Lactic	Acetic	Prop.	Butyric	NH_4-N	Cumulative temp. increase, °C			
	pH	g/kg DM						g/kg N	3 d	5 d	7 d	9 d
UT	4.16	11.5	9.2	78.2	16.8	0.10	0.13	69	1.6	5.6	8.4	11.8
FA	3.99	16.9	11.8	49.8	15.0	0.05	0.12	33	0.0	0.2	0.3	5.3
E76 10^5	4.05	18.7	8.3	88.7	10.5	0.04	0.11	51	2.2	7.8	14.3	26.5
E76 $5*10^5$	4.03	20.1	6.9	86.5	10.6	0.13	0.13	52	3.1	11.9	20.3	31.5
E76 10^6	4.00	21.3	7.0	88.8	9.9	0.04	0.15	42	1.3	8.1	21.5	36.3
E76 10^5 + KS	4.08	16.8	9.1	87.7	11.4	0.07	0.14	66	1.7	5.8	9.1	14.6
E76 $5*10^5$ + KS	4.04	19.1	8.6	88.9	10.1	0.10	0.13	57	1.8	8.1	16.5	27.7
E76 10^6 + KS	4.00	20.6	7.5	91.0	10.0	0.09	0.12	48	0.0	0.4	2.7	8.9
SEM	0.04	0.95	0.51	1.90	0.34	0.037	0.015	1.6	1.29	3.82	4.93	6.75
Statistical significance												
1) FA *vs.* ferm			***	***	***			***			*	*
2) UT *vs.* Inoc	*	***	*	***	***			***				
3) K-sorbate			*					***			*	*
4) E76 level linear		**	*		*			***				
5) E76 level quadr.								^{o}				
6) Interaction 3 * 4							^{o}	*				
7) Interaction 3 * 5								^{o}				

WSC = water-soluble carbohydrates, KS = Potassium sorbate, Contrasts: 1) FA *vs.* others, 2) UT *vs.* all E76s, 3) Effect of K-sorbate. Statistical significance: ^{o} P<0.10, * P<0.05, ** P<0.01, *** P<0.001.

CONCLUSIONS

Formic acid and E76-inoculant improved silage quality compared with untreated one. Increase in the inoculant application rate consistently improved silage quality though numerical differences were minor. Presumably DM and WSC contents and the microbial quality of raw material were good enough for even the lowest level of the inoculant to control fermentation process.

Potassium sorbate had a very small effect on silage fermentation. However, it improved aerobic stability of inoculated silages. Among E76-silages the best silage quality and aerobic stability was reached with the highest applicalition rate incombination with K-sorbate. Formic acid was the most efficient treatment in improving aerobic stability.

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THE EFFECT OF WILTING ON THE FERMENTATION QUALITY OF RED CLOVER SILAGE

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INTRODUCTION

In Slovakia, mainly in the submountainous and mountainous regions, growing of red clover is an important source of proteinous feeds.

According to Doležal (19989) the unfavourable course of the fermentation process of legumes silages is mainly caused by the unsuitable dry matter (DM) content of the ensilaged mass. Namely the dry matter content indicates at the level of water availability for the individual groups of microorganisms. From the practical point of view this means that increased DM levels have a selective, bacteriostatic, and thus a conservation effect. Low DM levels increase the intensity of fermentation so that degradability of organic nutrients may be decreased to less than 60%.

A number of authors (Carmeley and Thomas, 1987; Muck, 1990; Owens et al., 1999; Wilkins et al., 2001, etc.) were engaged in the study of the relation between DM contents, ensilageability of clovers and quality of the silages produced. From their data it follows that wilting increased the ensilageability of clovers and thus also the resulting conservation effect.

Our work focused on the effects of wilting upon clover silage fermentation.

MATERIALS AND METHODS

Tetraploid red clover from the first harvest in the vegetation stage prior to blooming was ensilaged under laboratory conditions. The green matter was allowed to wilt for 24, 48 and 71 hours. Following wilting the matter was cut, homogenized and filled into 1.7 l glass fermentors. Each variant was repeated 6 times.

The filled fermentors were placed in a dark room at 22°C. Silage weight losses were determined at regular 21-day-intervals by the gravimetric method. After 180 days the experiment was terminated and the following parameters were determined in the samples: nutrient contents, DM losses calculated in % of original DM contents, pH of silage extract (electrometrically), lactic acid and volatile fatty acid (VFA) levels by gas chromatography, carbohydrates, alcohol and NH_3 levels by microdiffusion according to Conway. From the concentrations obtained the total VFA and fermentation products (FP) content were calculated according to Sommer et al. (1994):

$$FP = \text{lactic acid} + VFA + \text{alcohol} \quad /g.kg^{-1}\ DM/$$

The results of the observations were statistically processed, evaluated by the single-factorial analysis of variance and compared by Student´s t-test.

RESULTS AND DISCUSSION

Tetraploid red clover was harvested following a rainy period which resulted in a low DM content of the ensilaged crops. Table 1 reports the qualitative indices of sown red clover that was let to wilt for 24, 48 and 72 hours. Comparison revealed that prolongation of the time of wilting slightly decreased the contents of fibre in the sown crops. Similarly to Jambor (1999) more pronounced changes were observed in the individual fibre fractions; ADF content decreased from 281.4 $g.kg^{-1}$ DM after 24 hrs of wilting to 267.5 $g.kg^{-1}$ DM after 72 hrs of wilting. On the contrary, NDF and hemicellulose contents increased with the duration of wilting. The increase of hemicellulose levels was particularly pronounced, rising from 79. 5 $g.kg^{-1}$ DM after 24 hrs of wilting to as much as 100.9 $g.kg^{-1}$ DM after 72 hrs of wilting.

Table 1. Red clover – original matter in $g.kg^{-1}$ dry matter

Parameter	wilted 24 hours	wilted 48 hours	wilted 72 hours
Dry matter ($g.kg^{-1}$ fresh matter)	150,14	231,54	405,21
Organic matter	900,62	901,73	900,35
Crude protein	215,26	210,06	221,36
Crude fibre	228,79	224,71	211,51
ADF	281,41	286,55	267,49
NDF	360,91	367,33	368,48
Hemicelullose	79,50	80,77	100,99
Nitrogen free extract	428,11	438,59	432,96
Total sugar	100,41	99,43	74,31
Reduced sugar	81,17	86,51	70,15
Fat	28,46	28,38	34,52
Ash	99,38	98,27	99,65

The levels of water soluble carbohydrates (WSC) in clover coincided with those reported by Wilkins (2001). In clover that was let to wilt for 72 hrs the WSC levels were reduced by as much as 26 % as compared to those determined after 24 hrs of wilting. Levels of reduced sugar appeared to be the most suitable after 48 hrs of wilting.

The mean nutrient levels and fermentation indices of the silages produced are given in Table 2. In silage that had been wilting for 72 hours crude protein contents were significantly decreased in comparison to silages that had been allowed to wilt for 24 and 48 hours. An opposite tendency was observed for the levels of the nitrogen-free extract, fibre and its fractions; these values were found to increase with the length of the wilting time. The most pronounced differences were observed with the WSC content of the individual silages. In silage produced from clover that had been wilting for 24 hours only 6.0 g WSC were stated per kg of dry matter whereas in silages wilting 48 hours the remaining amount of WSC was 4.6 times higher and even 6 times higher after 72 hours than in silages wilting 24 hours.

DM weight losses in our experiments ranged from 3.55 to 5.04%. The lowest and highest losses were observed with silage wilting 24 and 72 hours, respectively. Between these two silages statistically significant differences were stated.

Table 2. Nutrient composition and fermentation indices in red clover silage in g.kg^{-1} dry matter

Parameter n = 6	wilted 24 hours		wilted 48 hours		wilted 72 hours		Statistical significance of differences	
	x	s	x	s	x	s	P < 0,05	P < 0,01
Dry matter (g.kg^{-1} fresh matter)	145,40	1,30	222,37	0,86	387,19	1,48		1:2,3 2:3
Organic matter	893,09	0,86	894,12	0,75	894,19	0,91		
Crude protein	231,81	1,76	221,91	9,92	204,75	2,85		3 : 1,2
Crude fibre	233,91	4,00	237,85	4,85	240,69	6,98		
ADF	294,88	2,48	304,76	11,92	318,97	5,50		1 : 3
NDF	319,53	4,78	330,21	5,68	350,18	4,01		1:2,3 2:3
Hemicellulose	24,65	4,37	25,45	14,95	31,21	7,39		
Nitrogen free extract	393,56	9,95	395,65	7,86	421,84	8,72		3 : 1,2
Total sugar	6,00	2,03	27,72	3,54	35,60	3,84	2 : 3	1 : 2,3
Reduced sugar	4,09	0,94	23,94	2,84	30,21	5,15		1 : 2,3
Fat	33,81	6,01	38,71	2,05	26,91	1,10		
Ash	106,91	0,86	105,88	0,75	105,81	0,91		
Losses dry matter in %	3,55	0,87	4,41	0,39	5,04	0,38		1 : 3
pH	4,11	0,05	4,37	0,04	4,41	0,03	2 : 3	
Acids								
- lactic	88,10	6,54	60,54	10,37	49,41	6,27	2 : 3	1 : 2,3
- acetic	16,66	1,85	11,55	1,87	6,75	0,56		1:2,3 2:3
- propionic	2,12	0,24	0,42	0,33	0,32	0,16		1 : 2,3
- butyric + isobutyric	0,69	0,25	0,16	0,02	0,27	0,10	2 : 3	1 : 2,3
Total volatile fatty acids	20,59	4,26	12,22	2,12	7,50	0,62		1:2,3 2:3
Alcohol	9,49	0,57	6,08	0,96	3,32	0,22		1:2,3 2:3
Fermentation products	118,12	8,67	78,84	11,71	60,23	6,55		1:2,3 2:3
NH_3 - N of total N in %	10,44	2,43	8,56	0,49	6,98	0,20		3 : 1,2

It applies to legumes that the higher the availability of water for microbial activity in the ensilaged feed the more intensive and spontaneous is the fermentation process itself; in this way increased amounts of fermentation products, i.e. fermentation acids occur. The results of our experiments testify to this observation. The lowest pH levels were found in silage produced after 24 hours of wilting; with prolongation of the wilting time and thus also the DM level, the values of pH decreased. The highest content of fermentation products, i. e. also those of fermentation acids were observed in silage produced after a wilting time of 24 hrs. Prolongation of the wilting time resulted in a decrease of the acid levels in the silages produced. A similar tendency could be observed also in the NH_3-N levels of total N. For all indices of the fermentation process highly significant differences were stated between the individual silages.

The results obtained in our study coincide with those previously reported by Gallo et al. (2001, 2002) but also by Wilkins (2001), Bencová (1999) a. o.

CONCLUSION

Wilting of the fresh red clover mass resulted in decreased contents of WSC, fibre, ADF and increased contents of NDF and hemicellulose.

Increased intensity of the fermentation process during ensilaging of red clover that had been wilting for 24 hours and had the lowest DM levels became reflected in a decreased pH and increased levels of fermentation products as well as NH_3-N of total N. With prolonged wilting and thus with increased DM content of the ensilaged matter increased pH levels and decreased fermentation acid content but also a lower NH_3-N share of total N were observed. After termination of the fermentation process silages with increased DM levels were found to have higher WSC values than those with decreased DM levels.

EFFECT OF APPLICATION BIOLOGICAL ADDITIVE ON FERMENTATION QUALITY OF RED CLOVER SILAGE

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INTRODUCTION

Red clover is a frequent crops in Slovakia. In spite of good production results conservation of this crops is rather difficult since it is negatively influenced by frequent rains occurring during the period of the first harvest. It was the aim of this investigation to state the possibilities of using a biological additive in the conservation of red clover depending on different wilting levels of the forage intended for ensilaging.

MATERIAL AND METHODS

The experiments were run with tetraploid red clover from the first harvest (Table 1) that contained suitable amounts of sugars.

Table 1. Red clover - fresh matter

Wiltinig	Dry matter	OM	Crude protein	Crude fibre	ADF	NDF	Hemicelullose	Nitrogen -free extract	Sugar total	Fat	Ash
	in g	in g.kg^{-1} dry matter									
24 hours	150,14	900,62	215,26	228,79	281,41	360,91	79,50	428,11	100,41	28,46	99,38
48 hours	231,54	901,73	210,06	224,71	286,55	367,33	80,77	438,59	99,43	28,38	98,27
72 hours	405,21	900,35	221,36	211,51	267,49	368,48	100,99	432,96	74,31	34,52	99,65

Conservation of the cut forage was carried out 24, 48 and 72 hours after harvesting. Fermentation was observed in the untreated control and in the experimental variants treated with KOFASIL LIFE (T_1), a biological additive which contained *Lactobacillus plantarum* (DSM 3676 and 3677) and *Propionic bacterium* (DSM 9576 and 9577). The preparation was added to the wilted matter at a volume of 2 l per 1 ton of feeds.

The fermentors were then placed in a dark room at 25^0 C. After 170 days nutrient levels and the basic indices of the fermentation process were determined.

RESULTS AND DISCUSSION

The increase of DM contents in the ensilaged matter became reflected in increased pH and sugar levels in the silage (Table 2), decreased lactic, acetic and butyric acid contents as well as in the share of NH_3-N on total N. The best quality of fermentation was observed in silages with the highest DM contents. In all cases application of a biological preparation seemed to have positive effects on the fermentation process.

In comparison to untreated silages the treated ones were stated to have lower pH, acetic acid and NH_3- N of total N levels. In all three cases treated silages contained increased lactic acid levels. The differences between the sugar content as well as pH, lactic, acetic and butyric acid levels and NH_3- N of total N of untreated and treated silages were significant and highly significant, respectively. Similarly to the untreated silages the increasing DM content in the treated silages was accompanied by a growth of pH and sugars and a decrease in lactic, acetic and butyric acid levels with a decrease in NH_3- N of total N. The additive was stated to have the highest effect in medium-wilted silage whereas the least effect was observed in silages with the highest DM content. Based on these results it can be stated that the biological additive proved to have positive effects upon the fermentation process of silages containing higher amounts of DM; partly also the fermentation of silage prepared from fresh crops was improved. Improvement of the fermentation process in treated silages had a positive effect upon dry matter losses.

Hetta (1999) obtained similar results during the conservation of clover and grass crops using lactic acid bacteria. Fychan et al. (2002) reported similar results from observations of the effects of DM and lactic acid bacteria upon the fermentation of red clover, however, the forage they conserved contained higher sugar levels than it did in our experiment. In spite of that we were able to prove higher levels of lactic acid but also of NH_3- N of total N. The last mentioned authors also reported a decrease of pH, acetic acid levels and NH_3- N of total N in treated clover-grass silage. On the contrary Winters et al. (2002) who observed the effects of a biological additive upon the fermentation of red clover with decreased sugar levels reported fermentation results which were worse than ours. In agreement with our previous work (Gallo et al., 2001) the results obtained in the conservation of treated red clover proved to be better than those obtained with untreated forage. Similarly to our previous reports (Gallo et al., 2001, 2001) the positive effect of the biological additive in the conservation of red clover with increased sugar and even decreased DM contents could be confirmed again.

Table 2. Nutrient composition and fermentation parameters in red clover silage

Wilting	n = 6		DM in g	Losses DM in %	CP	CF	Sugar total	Fat	Ash	pH	Acid lactic	Acid acetic	Acid butyric	NH_3-N of total N in %
					in $g.kg^{-1}$ dry matter						in $g.kg^{-1}$ dry matter			
24 hours	U	x	145,40	3,55	231,81	233,91	6,00	33,81	106,91	4,11	88,10**	16,66	0,69	10,44
		s	1,30	0,87	1,76	4,00	2,03	6,01	0,86	0,05	6,54	1,85	0,25	2,43
	T_1	x	145,89	3,09	230,52	230,10	8,60	30,72	106,10	3,94**	104,98	16,28	1,37**	8,59
		s	1,00	0,66	3,18	1,64	2,30	0,71	0,64	0,01	5,31	0,82	0,46	1,69
48 hours	U	x	222,37	4,41	221,91	237,85	27,72**	38,71	105,88	4,37	60,54	11,55	0,16	8,56
		s	0,86	0,39	9,92	4,85	3,54	2,05	0,75	0,04	10,37	1,87	0,02	0,49
	T_1	x	223,50	3,77	211,17	235,90	19,57	32,82	103,76	4,06**	89,64**	6,32**	0,21	5,45**
		s	2,42	1,03	4,97	1,81	2,28	4,59	0,72	0,01	12,35	0,70	0,08	0,38
72 hours	U	x	387,19	5,04	204,75	240,69	35,60	26,91	105,81	4,41	49,41	6,75	0,27	6,98
		s	1,48	0,38	2,85	6,98	3,84	1,10	0,91	0,03	6,27	0,56	0,10	0,20
	T_1	x	384,23	5,65	201,53	236,69	29,93*	27,62	105,14	4,23**	53,36	5,00**	0,27**	6,09**
		s	5,09	1,25	3,74	5,37	2,97	0,83	0,99	0,03	6,61	0,58	0,06	0,28

U – untreated, T_1 - biological additive, CP – crude protein, CF – crude fibre
* $P < 0,05$ ** $P < 0,01$ The statistics is performed for the individual trials only.

CONCLUSION

The treatment of red clover with a biological additive became manifest in a decrease of losses and improvement of the fermentation process in all investigated silages. The treatment effect was more pronounced in silages with a higher DM content that in those with a lower one.

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SUMMARY

In experiments with red clover the effects of the dry matter content and application of a biological additive (Kofasil Life) on the fermentation process were investigated. Increasing dry matter levels and application of the additive improved the indices of silage fermentation. The best effects of the additive were observed during ensilaging of forage containing 23.15% of dry matter. The best level of fermentation was observed during the conservation of silage with an increased DM content (40.50%). In comparison to untreated silages the treated ones had a lower pH and contained more lactic acid and less acetic and butyric acid as well as NH_3- N of total N.

THE EFFECT OF STAGE OF MATURITY OF ALFALFA ON CONTENT OF NUTRITIVE VALUE AND DEGRADABILITY OF CRUDE PROTEIN

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INTRODUCTION

The importance of type and quality of forage in the diet of the rumunant has received much emphasis in recent years. The prediction of degradability of crude protein are essential measurements in formulation of ruminant diets (Givens D.I. and Rulquin H. 2002). A number of factors have been identified which can influence the rumen degradation of silage N. These include the use of silage additive, maturity of the crop at harvest and the extent of post-harvest wilting. Some reports have also shown that N - degradability in wilted silage can be similar or even higher than in non - wilted silages (Yan et al. 1998).

The objective in these study was to measure the impact of alfalfa maturity on content of nutritive value and degradability of crude protein.

METHOD AND MATERIALS

The six samples of alfalfa silages with different content of crude protein (177,0 - 263,3 $g.kg^{-1}$ DM) was prepare for chemical analyses - dry matter content, crude fiber, crude protein, crude ash, nitrogen free extract. Crude protein degradability of examined alfalfa silages were determined using the in sacco method (nylon bag technigue) described by Orskov and McDonald (1979).

RESULTS AND DISCUSSION

Chemical analysis of nutritive value of the alfalfa silages is given in table 1. Alfalfa silage with the lowest content of crude protein have the highest content of crude fiber and alfalfa silage with the highest content of crude protein have the lowest content of crude fiber. Degradability of the crude protein alfalfa silages is according crude protein content with high correlation coefficient $r^2 = 0,9252$.

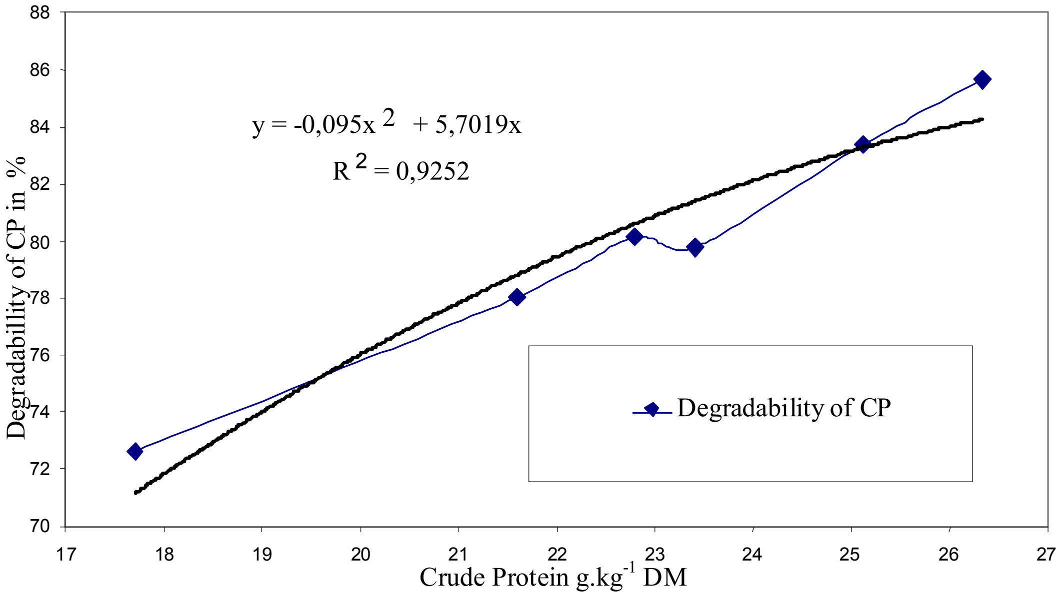
Table 1. Content of organic matter of alfalfa silges and degradability of crude protein

Sample	Dry Matter $g.kg^{-1}$	Crude Protein $g.kg^{-1}$ DM	Degradability of Crude Protein $g.kg^{-1}$ DM	Crude Fiber $g.kg^{-1}$DM	Nitrogen Free Extract $g.kg^{-1}$DM
1.	377,2	177,0	72,63	351,1	371,9
2.	373,6	215,9	78,02	325,4	358,7
3.	504,2	227,9	80,15	304,9	362,2
4.	311,4	234,0	79,77	275,0	391,0
5.	342,9	251,2	83,37	254,6	394,4
6.	478,5	263,3	85,65	239,7	396,9

Correlation of protein content of alfalfa silages and protein degradability estimeted by nylon byg technique was expressed in following polynomic regression equations (figure 1):

alfalfa silage $y = -0{,}095\,x^2 + 5{,}7019\,x$

Figure 1. The effect of content of crude protein of alfalfa silage on degradability crude protein



CONCLUSIONS

There is now evidence that the content of crude protein of alfalfa silages (different stage of maturity) change degradability of crude protein. When we can better determanated nutritive value, nutrition programm have to use actual degradability of fodder by regression equation.

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EFFECT OF DIFFERENT PROBIOTIC ADDITIVES ON FERMENTATION AND NUTRITIVE CHARACTERISTICS OF THE ALFALFA AND OAT-PEAS SILAGES

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ABSTRACT

The influence of microbial additives Microsil (*Enterococcus faecium, Lactobacillus plantarum, Lactobacillus casei, Pediococcus pentosaceus*), Silabac (*Enterococcus faecium, Lactobacillus plantarum*) and Bonsilage (*Enterococcus faecium, Lactobacillus rhamnosus*) was investigated for the preparation of alfalfa and oat-peas silages in the laboratory conditions in the one liter glass silos. The obtained data of the chemical analyses of the oat-peas silage indicate that the treatment with the probiotic additive Microsil, resulted in the more favourable fermentation characteristics in comparison with the additives Silabac and Bonsilage. There were not observed any significant differences between samples taken from the alfalfa silage treated with the above mentioned three biological additives. The only exception was the higher concentration of the butyric acid in the sample treated with the preparation Silabac.
Key words: silage, biological silage additive, probiotic, *Enterococcus faecium*

INTRODUCTION

Production of high quality silages with a good digestibility of nutrients is one of the most up to date problems of the nutrition of ruminants. There are many different probiotic preparations for the silage production. The producers of the biological inoculants have been promising a significant effect on the silage quality. Pahlow and Honig (1994) described better fermentation of silage with probiotics. Honig et al. (1996) and Yan et al. (1996) published results of better digestibility of silages treated with probiotic preparation. The expected effect was not always observed after the application of biological additives (Pavelek et al., 1997). In spite of this fact, the improvement of the fermentation process in the treated silages became obvious in decreased weight and nutrient losses (Gallo et al., 2001).

The objective of this study was a comparative evaluation of the effect of 3 microbial silage additives containing homofermentative lactic acid bacteria used as a silage starters on some fermentation characteristics of the ensiled alfalfa and the mixture oat-peas.

MATERIALS AND METHODS

The trials included the following forages: in the 1st experiment - the alfalfa var. Palava (*Medicago sativa L.*) and in the 2nd experiment - the mixture (2:1) oat var. Adam (*Avena sativa L.*) with the peas (*Pisum sativum L. subsp. sativum convar. speciosum*). The experimental forage crops were cultivated separately. The second cut of alfalfa and the first cut of the mixture of oat with peas were harvested, wilted and cutted by the static cutter with an adjusted length of the chaffed parts 3 – 4 cm. The forage crops were ensiled with the probiotic additives (Table 1) with the trade names a) Microsil (Medipharm Slovakia s.r.o., SR), b) Silabac (Pioneer HI Bred International Inc., USA) and c) Bonsilage (Schaumann GmbH, SRN). The additives were dosed by the spray applicator directly on the chaff. This one was filled into glass laboratory silos of the volume 1 liter. The fermentation process, in the glass laboratory silos, was carried out at the stable laboratory temperature in the darkness. Taking of samples, chemical analyses and evaluation of the silages were performed according to the standard STN 46 7012 as well as according to the Official publication of Ministery of Agriculture of the Slovak Republic number 39/1/2002-100.

Table 1. Application of probiotic additives into chaff - alfalfa and the mixture of oat with peas

Probiotic additive (samples)	Bacterial strains in preparations	Additives applied into forages ($g.kg^{-1}$)	Dosage of bacterial cells (10^6 $CFU.kg^{-1}$ FM)
Microsil (1, 4)	*Enterococcus faecium, Lactobacillus plantarum, Lactobacillus casei, Pediococcus pentosaceus*	0,015	150
Silabac (2, 5)	*Lactobacillus plantarum, Enterococcus faecium*	0,5	200
Bonsilage (3, 6)	*Lactobacillus rhamnosus, Enterococcus faecium*	0,5	200

Legend: CFU – colony forming unit, FM – forage matter

RESULTS AND DISCUSSION

The effects of biological additives (Microsil, Silabac and Bonsilage) on the fermentation pattern of the crops alfalfa (1st experiment) and oat-peas (2nd experiment) are shown in tables 2 and 3.

Experiment 1: The alfalfa silage treated with probiotic additive Microsil has the pH value (4,08), the content of lactic acid (1,90 %) and the ratio of lactic acid/ acetic acid (2,32) comparable to the alfalfa silages treated with the preparations Bonsilage and Silabac. The butyric acid was absent in the silages after the application of Microsil and Bonsilage. There were demonstrated the traces of the butyric acid in the silage treated with the additive Silabac (0,06 %). Experiment 2: The oat-peas silage treated with the biological additive Microsil has the lowest pH value (3,68), the highest content of lactic acid (2,15 %), the best ratio of lactic acid/ acetic acid (1,32). The concentration of the butyric acid was at the zero level in the all samples of silages.

Table 2. Chemical composition and some nutritive values of alfalfa silages

Parameter	Unit	Microsil (sample 1)	Silabac (sample 2)	Bonsilage (sample 3)
Dry matter	$g.kg^{-1}$	280,4	299,0	306,5
pH		4,08	4,05	4,06
Crude protein	$g.kg^{-1}$ DM	187,6	187,6	174,6
Crude fibre	$g.kg^{-1}$ DM	287,8	293,0	289,1
Crude fat	$g.kg^{-1}$ DM	36,7	36,5	36,5
Crude ash	$g.kg^{-1}$ DM	89,2	96,0	113,2
N-free extract	$g.kg^{-1}$ DM	398,7	387,0	386,6
Lactic acid	%	1,90	2,12	2,12
Acetic acid	%	0,82	0,73	0,99
Butyric acid	%	0	0,06	0
Lactic acid /acetic acid		2,32	2,90	2,14

Legend: DM – dry matter

Table 3. Chemical composition and some nutritive values of oat-peas silages

Parameter	Unit	Microsil (sample 4)	Silabac (sample 5)	Bonsilage (sample 6)
Dry matter	$g.kg^{-1}$	255,1	299,3	323,9
pH		3,68	4,45	3,98
Crude protein	$g.kg^{-1}$ DM	96,4	91,5	106,8
Crude fibre	$g.kg^{-1}$ DM	398,3	364,5	294,5
Crude fat	$g.kg^{-1}$ DM	43,5	43,4	43,5
Crude ash	$g.kg^{-1}$ DM	74,5	84,9	71,6
N-free extract	$g.kg^{-1}$ DM	387,3	415,6	483,5
Lactic acid	%	2,15	2,00	2,09
Acetic acid	%	1,63	1,87	1,64
Butyric acid	%	0	0	0
Lactic acid /acetic acid		1,32	1,07	1,27

Legend: DM – dry matter

CONCLUSIONS

The obtained data of the chemical analyses of the oat-peas silage indicate that the treatment with the probiotic additive Microsil, consisting of the homofermentative bacteria *Enterococcus faecium, Lactobacillus plantarum*, *Lactobacillus casei* and *Pediococcus spp*., resulted in the more favourable fermentation characteristics in comparison with the additives Silabac and Bonsilage which were produced from two bacterial strains *Enterococcus faecium* and *Lactobacillus spp.* There were not observed any significant differences between samples taken from the alfalfa silage treated with the above mentioned three biological additives. The only exception was the higher concentration of the butyric acid in the sample treated with the preparation Silabac. The probiotic preparation Microsil has the broader spectrum of bacteria and the higher quantity of germs for the weight unit. As far as the economical point of view is concerned, the costs of purchase of the starting probiotic preparation Microsil are from 23.95 $Sk.t^{-1}$. In comparison with the competing preparations, it is from 2 to 4 times lower investment for the preparation of the conserved forage.

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THE ENSILING PROFILE OF WHOLE-CROP PEA (*PISUM SATIVUM L.*) AND WHOLE-CROP BEAN (*VICIA FABA L.*) SILAGES

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INTRODUCTION

Leguminous crops such as peas and beans have the potential to supply an additional source of protein to both ruminant animals and the environment. The symbiotic *Rhizobium* bacteria can fix up to 70kg of nitrogen per hectare which is available to the following crop (Bergersen 1973). Farmers in Denmark have been growing bi-crops of peas with a cereal crop for a number of years and more recently peas and beans as sole crops (Kristenseen, 1992). Peas and beans have traditionally been thought of as being hard to ensile due to their high buffering capacity (McDonald and Henderson, 1962) and low water soluble carbohydrate content. Increasing the production of home grown (UK) protein from crops such as peas and beans would lead to a drop in animal feed costs and an increase in the traceability of feeds as well as ensuring a crops genetic origin (Merry *et al.* 2001). Previous work to date in the UK has focussed on forage varieties of peas and beans, either as sole forages or as bi-crops (Fychan *et al.* 1999a &. 1999b; Adesogan *et al.* 2000). However the way in which the key nutritive components change during ensiling has not been investigated.

MATERIALS AND METHODS

Two commercially managed varieties of spring sown semi leafless combinable peas and beans were grown during 2001. The varieties differed in flower colour, with coloured flowers (CF) indicating the presence of condensed tannin (CT) and white flowers (WF) indicating the absence of CT. The pea varieties used were Racer (Cebeco, Netherlands) and Croma (Cebeco, Netherlands), CF and WF respectively, the bean varieties were Piccadilly (Blondeau, France) and Avon (Cebeco, Netherlands), CF and WF respectively. The crops were sown in three blocks consisting of four plots per block, with each block containing all forages. The peas and beans were harvested at growth stage 205 and 207 (Knott 1987 & 1990) respectively in accordance with the finding by Fychan *et al.* (1999a & 1999b). The crops were harvested using a Hauldrup harvester, and were either ensiled immediately or allowed to wilt in field conditions for 24hrs prior to ensiling. Before ensiling the crops were processed by a trailer forage harvester (John Deere), giving an average chop length of 3cm. Chopped material was then spread out on a concrete pad and one of three additives was applied using hand held sprayers. The additives applied were, either a fermentation inhibitor (acid/formalin), a fermentation enhancer (bacterial inoculant) or water as a negative control. All additives were applied at the rate of 4 litres per tonne fresh weight. Treated material was placed into plastic bags (approximately 1.5kg fresh weight of forage per silo) which were evacuated using a vacuum line and sealed with tape. The bags were then allowed to ferment for 0, 12, 24, 48, 96 and 240hrs with fermentation being stopped by placing bags in a freezer at -20°C (there were two duplicate bags per time point per treatment). Bags were stored frozen at -20°C prior to subsequent analysis. Defrosted samples were analysed for oven dry matter (DM), nitrogen (crude protein (CP) nitrogen*6.25), ammonia nitrogen (NH_3-N) and pH. Nitrogen analysis was carried out by the Kjeldahl method. Results were analysed within each time period using a split/split plot ANOVA in Genstat (version 5).

RESULTS AND DISCUSSION

Crop type The main effect of crop type and time on chemical composition can be seen as Figures 1 to 4. Peas had a higher (P<0.001: Figure 1) DM compared to beans at all time points (247 g/kg vs. 184 g/kg, n=864, s.e.d.=1.7). The DM was expected to be similar between crops as the beans were harvested at a more mature growth stage which equated to an extra two weeks growing time. The drop in pH over time (Figure 2) was also significantly different (P<0.001) between the two crops with the beans reaching a lower pH than the peas (4.6 vs. 4.8, n=864, s.e.d.=0.02). Both crops reached an acidic stable pH (<4.5) after 96 hrs with little change over the subsequent 144hrs. Peas and beans were also different (P<0.001) in CP content at all time points measured. Peas had an initial CP of 156 g/kgDM compared to 121 g/kgDM for beans (n=144, s.e.d.=1.9). The CP of the silages increased over the experimental period (Figure 3) to 174 g/kgDM for peas and 138 g/kgDM for beans (n=144, s.e.d.=3.4) even though the proportion of nitrogen present as NH_3-N increased (Figure 4). A greater proportion of the total nitrogen (TN) in the beans was broken down during the ensiling process compared to the peas with averages of 8.7%TN vs. 6.0%TN at 240hrs (n=144, s.e.d.=0.26).

Additive The main effect of additive type on DM was to minimise the DM degradation in the samples treated with the fermentation inhibitor compared to the fermentation enhancer and control (217 g/kg vs. 214 g/kg vs. 215/kg,P=0.004 n=864, s.e.d.=0.87). The acid based additive decreased the initial pH of the test material compared to the fermentation enhancer and control (5.0 vs. 5.6 vs. 5.6, n=144, s.e.d.=0.07 P<0.001) but after 240hrs the pH was highest in the acid treatment (4. vs. 4.2 vs. 4.2, n=144, s.e.d.=0.02 P=0.021)

Wilt and tannin The most significant effect of allowing the crop to wilt was to increase the initial DM from 230 to 282 for peas and 176 to 205 for beans (n=144, s.e.d.=5.0 P=0.013) and to lessen the proportion of NH_3-N (%TN) from 2.0% with no wilt to 1.6% with a wilt (n=144, s.e.d.=0.13 P=0.021) . The coloured flowered variety of pea had a higher initial CP concentration compared to the white flowered variety (159 g/kgDM verses 155 g/kgDM, n=72, s.e.d=2.7 *P*=0.002) but the reverse was true in the beans (114 g/kgDM verses 129 g/kgDM, n=77, s.e.d.=2.7).

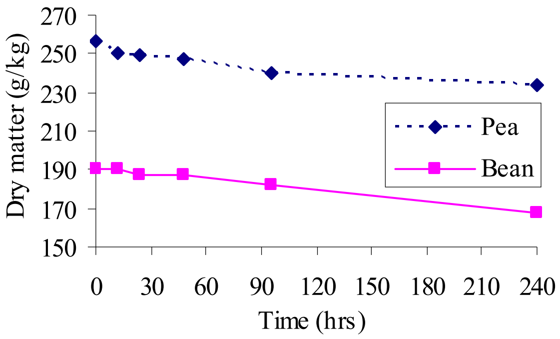

Figure 1. Change in DM of pea and bean silages over the first 240 hrs post ensiling

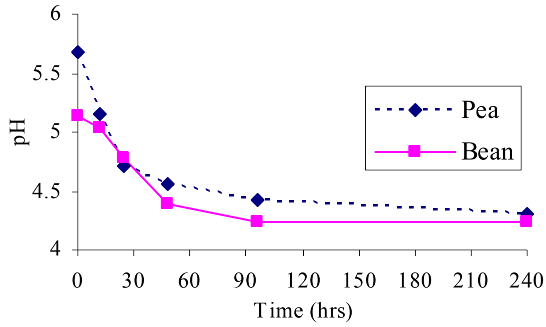

Figure 2. Change in pH of pea and bean silages over the first 240 hrs post ensiling

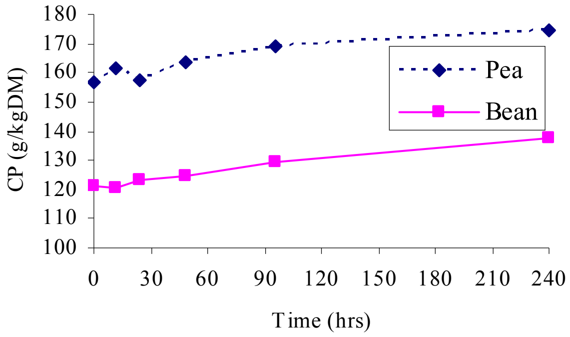

Figure 3. Change in CP of pea and bean silages over the first 240 hrs post ensiling

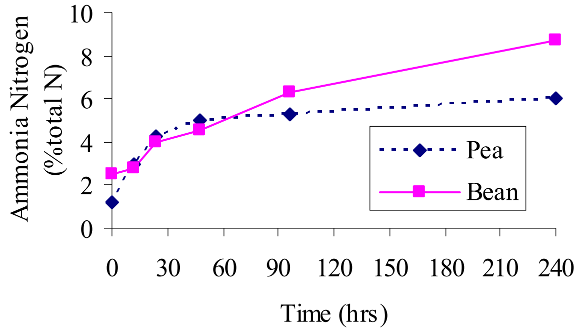

Figure 4. Change in NH_3-N of pea and bean silages over the first 240 hrs post ensiling

CONCLUSION

The current work has shown that both peas and beans can be successfully ensiled as sole forages, with both crops reaching and maintaining a stable acidic pH within four days post ensiling. However the higher CP and DM of the whole crop pea forage would seem to indicate that this crop has more potential for inclusion into ruminant diets than whole crop bean forage. Further work is necessary to determine the effects of incorporating whole crop leguminous forages (particularly peas) into ruminant diets.

ACKNOWLEDGEMENTS

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THE EFFECT OF CHEMICAL ADDITIVE ON FERMENTATION PROCESS AND NUTRITIVE VALUE OF SUGAR BEET PULP

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INTRODUCTION

Fresh pressed sugar beet pulp is the fibrous residue that remains after the extraxtion of sugar from beets and after a reduction of the initial water content (Wyss U. 2002). Pressed sugar beet pulp have high digestibility and high level of energie, but content of crude protein is low. Fresh sugar beet pulp is prone to aerobic decay and it needs to be ensiled to preserve its qualities. Recently, pressed sugar beet pulps is storage at different conditions and treated by different additives, but the quality is not good.

In this study we investigated the quality of pressed sugar beet pulp silage treated by chemical additive Kemisile 2 Plus on fermentation process and nutritive value.

MATERIALS AND METHODS

The experiment were carried out with pressed sugar beet pulps. The fodder were homogenised and treated with water (Control) and by chemical additive Kemisile 2 Plus (3 and 6 l per t of FM). Treated pressed sugar beet pulp were filled into 5 l minisilos (n = 4). The filled silos were placed in dark room at 25 °C. After 90 days of incubation the samples were examined for nutrient content, characteristics of fermentation process and effluents.

RESULTS AND DISCCUSION

The effect of chemical additive - Kemisile 2 Plus on the fermentation pattern of the sugar beet pulp silage is shown in table 1. The nutritive value is shown in table 2.

Table 1. Characteristics of fermentation process of sugar beet pulp silage treated by chemical additive of Kemisile 2 Plus

		Control	Kemisile 2 Plus 3 l.t	Kemisile 2 Plus 6 l.t
pH		4,01	3,88	3,55
Lactic Acid	$g.kg^{-1}$ DM	29,36	24,19	20,25
Formic Acid	$g.kg^{-1}$ DM	0	11,32	21,76
LA + FA	$g.kg^{-1}$ DM	29,4	35,5	42,2
Acetic Acid	$g.kg^{-1}$ DM	110,29	37,15	29,81
Propionic Acid	$g.kg^{-1}$ DM	11,53	2,97	0
Butyric Acid	$g.kg^{-1}$ DM	0	0	0
Total VFA	$g.kg^{-1}$ DM	121,6	40,1	31,7
Total Acid	$g.kg^{-1}$ DM	151,1	75,6	73,9
LA/VFA		0,24	0,6	0,64
LA+FA/VFA		0,24	0,88	1,33
Ammonia	%	0,015	0,015	0,015

Aplication of Kemisile 2 Plus proved to have a very positive effect upon the fermentation process. The pH of sugar beet pulp is going down according the level of Kemisile 2 Plus. Content of lactic acid is going down according of among of Kemisile 2 Plus, but content of formic acid is going up. A positive effect of the aplication of silage preparations was also observed in the total VFA and total acid.

The content of organic matter of the sugar beet pulp silages is given in table 2. The highest content of crude fiber, NDF and the lowest content of NFE is at control silage, because the control silage have the highest losses of dry matter. The changes of content of fibrous fraction have high the effect on content of NEL.

Table 2. Content of organic matter of Sugar beet pulp and silage treated by chemical additive Kemisile 2 Plus

		Sugar Beet Pulp	Control	Kemisile 2 Plus 3 l.t	Kemisile 2 Plus 6 l.t
Dry Matter	$g.kg^{-1}$	203,0	176,0	194,6	199,0
Recovery DM	%		84,4	95,4	96,7
Effluent	$l.t^{-1}$		64,6	52,1	52,4
Crude Protein	$g.kg^{-1}$ DM	107,5	115,7	104,3	105,9
Crude Fat	$g.kg^{-1}$ DM	45,0	44,2	43,9	45,1
Crude Fiber	$g.kg^{-1}$ DM	209,9	238,3	218,1	210,0
NDF	$g.kg^{-1}$ DM	425,2	542,1	494,1	469,8
NFE	$g.kg^{-1}$ DM	555,3	476,2	516,4	537,4
Ash	$g.kg^{-1}$ DM	82,2	125,6	117,3	101,6
Organic Matter	$g.kg^{-1}$ DM	917,8	874,4	882,7	898,4
NEL	$MJ.kg^{-1}$ DM	6,35	5,66	6,17	6,23
Index	%	100,0	89,1	97,2	98,1
Difference	%		-10,9	-2,8	-1,9

CONCLUSIONS

Aplication of chemical additive had a positive effect on the quality of the fermentation process and the content of fibrous fraction. The most interesting benefits are the improvement in higher content of NEL and lower losses of dry matter in silages treated by chemical additive Kemisile 2 Plus.

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THE INFLUENCE OF ADDITIVES AND STORAGE TIME ON THE AEROBIC STABILITY OF MAIZE SILAGE

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INTRODUCTION

It is recommended not to open a silo with maize silage before 3 – 4 weeks after filling in order to have a silage with a good aerobic stability. Is this time enough? Special additives to prevent aerobic instability are more and more used. How much storage time do they need to be effective? Two trials on two pilot farms combined with laboratory trials should answer these questions.

MATERALS AND METHODS

On two farms, whole crop maize was ensiled in a bunker silo. Seven additives were tested in the following way: From one load, some forage was taken and samples – non-treated or treated with the additives – were put into non-hermetic bags. These bags were put into the silo (buried bags) in three lines from one side to the other of the silo, ca. 50 cm below the forage surface. The samples with different treatments were present in the same line. All samples with different treatments in one line were unloaded at the same time. In such a way, different storage times for all treatments were achieved. In addition, laboratory silos (jars) were filled. With these laboratory silages, an air stress was carried out according to the DLG testing method: small holes in the lid and at the bottom of the jar were opened twice for 24 hours each time during the storage period, allowing air to enter and the fermentation gasses to escape. With this air stress, non-airtight sealing is simulated.

All silages were tested for aerobic stability. For this purpose, some 500 g of silage were put into an insolating box (in order to keep the heat produced by the aerobic processes) and the boxes were stored at an environmental temperature of some 20 °C. The temperature rise of the silage was measured twice a day. A temperature rise of 3 °C above the environmental temperature is considered to be turning point to aerobic instability. The ensiling technique in the two farms was very professional: high compaction of the forage and perfect sealing with two sheets of 0,04 mm and 0,150 mm, use of bags on the border line of the silo and use of a plastic net to protect the sheets. The silos were opened 3 weeks after filling. The bags of the first line were removed 42 days (farm 1) and 44 days (farm 2) after ensiling.

RESULTS AND DISCUSSION

The results are presented in table 1.

Table 1. Aerobic stability (the figures for the aerobic stability are the averages of three parallels)

Additive	Farm 1 39 % dry matter				Farm 2 33 % dry matter				
	Jar 1 litre	Bag	Bag	Bag	Jar 1 litre	Jar 1 ½ l	Bag	Bag	Bag
	Storage time until unloading, days								
	48	42	89	200	49	55	44	91	111
	Duration of the temperature trial, days								
	5	6	9	15	10	9	9	9	15
	Aerobic stability, days								
without	1,0	1,2	4,2	10,0	1,7	2,8	2,8	2,7	7,3
chemicals									
chem. 1	3,7	5,0	>9,0	13,0	-	8,7 2	>9,0	>9,0	>15,0
chem..2	3,7	6,0 1	>9,0	-	-	8,0 1	>9,0	-	>15,0
chem..3	-	-	-	-	9,0	-	3,0	-	7,5
combin.									
biol./chem.	1,2	3,3	8,7 2	12,0	1,8	3,5	4,0	4,2	11,3
biologicals									
biolog. 1	2,5	2,0	6,7	-	-	3,5	2,3	-	10,7
biolog. 2	1,7	1,5	8,7 2	-	1,7	3,8	2,3	3,3	>15,0
biolog. 3	1,3	1,5	8,7 2	-	-	4,0	2,7	-	>15,0

Chem 1: sodium benzoate, sodium propionate (Mais Kofasil liquid)
Chem.2: calcium formiate, sodium benzoate, NaCl (Eurosil Mais)
Chem.3: propionic acid, formic acid (Lupro Mix NC)
Combin.:homofermentative lactic acid bacteria, potassium sorbate (100 g/t) (Labacsil Duo)
Biol. 1: homo- and heterofermentative lactic acid bacteria (Bonsilage M)
Biol. 2: heterofermentative lactic acid bacteria (buchneri) (Kofasil life M)
Biol. 3: heterofermentative lactic acid bacteria (BioCool)

A number behind the value for the stability indicates, how many of the 3 parallels had a stability longer than the duration of the temperature trial. The duration of the temperature trial was taken as the duration of the stability when the stability was longer than the trial. In this case, the real average would be higher than the stated value.

Silages treated with heterofermentative lactic acid bacteria contain higher acetic acid contents und undergo higher losses. In the tables below it is shown that the acetic acid content was higher, but there was practically no increase of the fermentation losses.

Table 2. Fermentation losses (dry matter losses), calculated at the basis of the gas losses in jars

Additive	Farm 1	Farm 2	
	1 litre jar	1 litre jar	1 ½ litre jar
	Fermentation losses, in % of dry matter		
without	5,26	6,17	4,45
Bonsilage M	4,96	-	5,07
Kofasil life M	5,72	5,67	5,23
BioCool	5,66	-	5,01

Table 3. Fermentation characteristics (from bag silages with the longest storage time)

Additive	pH		Lactic acid, % in FM		Acetic acid, % in FM		Acetic acid, % in DM	
	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
without	4,0	3,7	1,75	1,91	0,67	0,62	1,74	1,80
Bonsil. M	4,0	3,8	1,60	1,35	0,85	0,81	2,24	2,42
Ko.life.M	4,1	4,0	1,32	1,46	1,02	0,88	2,74	2,63
BioCool	4,0	3,8	1,63	1,34	0,91	0,83	2,44	2,53

FM = fresh material, DM = dry matter

The results can be summarized as follows: With the jar silages (short storage period, air stress), only the chemical additives improved the aerobic stability, mostly to a large extent. The same trend is shown with the bag silages having the shortest storage time of 42 respectively 44 days. The aerobic stability of the bag silages improved with the longer storage time. In the bunker silos, there were anaerobic conditions until the silos were opened (three weeks after filling).The silage was well packed (in both farms 240 kg dry matter/m^3 even in the upper part of the silo). The advance at feed out was correct (1,5 m per week). Therefore, it seems that it is the short storage time (with the jars and the first bags removed) responsible for the rather bad aerobic stability. With the longer storage time, the aerobic stability was excellent even without additive. Whereas the efficacy of the chemical additive 3 (propionic acid and formic acid) has been excellent with the jar silages (improvement of 7 days compared to the silage without additive), the additive did not improve the stability with the bag silages. This is due to the specific experimental conditions: the bag samples have been stored outside the silo for 3 hours (they had to be prepared and had to be placed some 50 cm beneath the forage surface). In addition, the bag samples were placed into a forage not treated. Because of both these reasons, the volatile acids partly escaped from the bags. These experiments demonstrate that additives with heterofermentative lactic acid bacteria need a rather long storage time to be fully effective. It seems that the biological/chemical product takes an intermediate position between the chemical and the biological additives. Surely, the results would have been better with 300 g sorbate/t of forage instead of 100 g. In these trials, the biological additives with heterofermentative lactic acid bacteria have practically not led to higher fermentation losses, but have increased the acetic acid content. But the increase of acetic acid was limited so that the silage intake should not be affected negatively.

CONCLUSION

The aerobic stability improves with the duration of the storage time, under the condition that by good sealing anaerobic conditions are achieved. It is recommended not to open a silo with maize silage before 2 – 3 months after filling. With a longer storage time, the additives are more effective. This is true especially for heterofermentative lactic acid bacteria (like buchneri), which need a rather long time to convert lactic acid into acetic acid. The chemical additives have proved to be more effective than the biological ones under less good conditions (air stress, short storage time). The results underline the importance of good sealing for a good aerobic stability. But additives will be necessary in many cases under practical conditions to guarantee the aerobic stability.

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THE EFFECT OF BENZOIC ACID ON THE FERMENTATION OF MAIZE SILAGE

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INTRODUCTION

Ensiling is a complex biological process based on the conversion of plant carbohydrates into individual fermentation products. The principles of ensiling technology are generally known and the respective ensiling techniques are very well elaborated. however, the quality of silage is still rather problematic.

Reduced quality of silage is often encountered in the case of legumes and grass. Low level of dry matter (DM), insufficient wilting, failure to observe technological procedures and underestimation of the effect of preservatives are the main causes of the low quality of silage. The studies conducted worldwide focus not only on the effect of bacterial inoculants but also on the protective effect of organic acids (particularly formic acid) or their salts which are currently used to preserve legumes and grasses. Benzoic acid, especially sodium benzoate, is one of the intensively studied preservatives. Preservation of ensiled feed using benzoic acid or sodium benzoate has been thoroughly studied. Lättemäe et al. (1999) revealed a beneficial effect of additives containing sodium benzoate on the quality and storage stability of whole crop silage. The influence of different additives including sodium benzoate combined with lactic acid bacteria on the quality of bale silage was studded by Lingvall et al. (1999). The authors found that the addition of sodium benzoate and Lactisil to the silage improved the quality and storage stability of silage and reduced the number of spores which dropped below the detection limit.

The preservative effect of a mixture of organic acids containing 1% of benzoic acid during ensiling of grass-alfalfa mixed is reported by Potkanski et al. (1999). Thylin et al. (2000) describe the effect of biological additives and sodium benzoate mixed with LAB on the quality of silage. Analogous results were published by Rammer et al. (1999). A beneficial effect of benzoic acid on ensiling of sugar-beet pulp is reported by Nonn (1987) and Doležal (2002).

The main aim of the present paper was to evaluate the effect of benzoic acid on the fermentation of maize containing an increased level of dry matter and to compare the quality of chemically treated silage with that of the control silage (untreated) and of the silage treated with formic acid.

MATERIALS AND METHODS

The model experiment on maize containing 340.2 g of dry matter per kg on average was carried out in the laboratories of The Mendel University of Agriculture and Forestry in Brno. Both control maize (untreated) and the maize supplemented with either 1.0 kg of benzoic acid/t or 1 L formic acid /t were pressed into 50 L aluminium experimental vessels. The vessels were closed with a lid covered with a diluted solution of molasses and stored at 20-25^{0}C prior to analysis. After 6 months, 6 samples were taken from each experimental vessel and analysed for fermentation parameters.

Analytical methods:

Dry matter was determined at 105°C (drying till constant weight) according to Czech National Standard 467092-42. All analytical procedures including the preparation of aqueous extracts have been described previously (Doležal, 2002). The samples of silage were analysed for the content of main nutrients and energy (Directive No. 222/1996 Coll.). Individual fermentation parameters of model silages were worked up statistically using variation analysis.

RESULTS AND DISCUSSION

The average content of dry matter in ensiled maize was 340 g/kg. Ensiled maize contained 86.7 g of CP, 22.4 g of lipids, 564.4 g of N free extractives, 244.9 g of crude fibre, and 9.95 MJ of metabolisable energy per kg of dry matter. The concentration of WSC was 226.1 g/kg. The average values of fermentation parameters of model maize silage are provided in Table 1. It follows from the results in Table 1 that both acids (formic acid and benzoic acid) added to the maize silage at the given concentration did not significantly reduce the levels of lactic acid and acetic acid and did not affect the overall production of acids. The level of lactic acid in the maize silage treated with benzoic acid was only insignificantly increased compared with the control. Similarly, the presence of formic acid did not reduce the production of lactic acid and the level of acetic acid did not decrease significantly in comparison with that of other experimental silages. This indicates that formic acid might inhibit heterofermentative bacteria. However, the concentration used in the experiment (1 L/t) did not lead to significant inhibition of these bacteria. Our findings are in good agreement with the results reported by Thylin et al. (2000). Silage extracts differed significantly ($P<0.05$) by their pH values. Of all silages, the silage treated with benzoic acid showed the lowest pH (3.83 ± 0.01). The critical pH value, which is in agreement with our previous findings, was not exceeded. Unlike formic acid, benzoic acid is a weak acid, as can be concluded from its dissociation constant, and therefore requires less acidic environment to function as an efficient preservative. Furthermore, the above mentioned pH determined in the silage extract may have some beneficial effect on yeast and other fungi. The lowest pH value in the experimental silage is in good agreement with the overall titration acidity (1741.82 ± 11.31 mg KOH), which is significantly increased ($P<0.05$) in the silage treated with benzoic acid . The silage treated with formic acid showed the lowest titration acidity, which was lower ($P<0.05$) than that of the control (untreated silage). Low titration acidity of this silage may be a consequence of a decreasing production of lactic acid and acetic acid. No statistically significant differences between individual model silages were found in the production of fermentation acids. However, in the case of silage preserved with formic acid (11.5 %) the level of acetic acid was lower compared with that of the control. In the case of silage treated with benzoic acid the trend of increasing amount of acids was observed. This fact may result from the application of a low level of benzoic acid (1 kg/t). It is known that aromatic acids including benzoic acid have remarkable preservative and antifungal properties when present at certain concentrations (1.5-2.0 kg/t carbohydrate-containing crops). Benzoic acid can also be used as a suitable additive to preserve protein crops that are difficult to ensile. The amount of benzoic acid recommended for this purpose is 3-4 kg/t. Our results differ from the findings of Lingvall et al. (1999) who found that the levels of both fermentation products and spores of Clostridium sp. in the grass preserved with LAB and sodium benzoate (400 g/t) decreased. A significant decrease of fermentation acids in ensiled feeds treated with sodium benzoate or benzoic acid was also reported by Nonn (1987), Thylin et al. (2000), Potkanski et al. (1999) and other authors. Our experiment revealed significant differences in the value of $N\text{-}NH_3$/ N total that reflects the level of protein decomposition. The statistically lowest value of $N\text{-}NH_3$/ N total ($P<0.05$) was found in the case of silage preserved with benzoic acid (4.47 ± 0.17) while the control silage and the silage treated with formic acid showed a higher value of $N\text{-}NH_3$/ N total. It was found that the level of $N\text{-}NH_3$/ N total in silage is indirectly proportional to both titration acidity and the pH.

Table 1. Chemical composition of maize silages

Silage	DM (g/kg)	pH	TA (mg KOH/100 g)	LA	AA	Sum of acids	$N\text{-}NH_3$ / N total	LA/AA
				g/kg DM				
Control	330.97± 6,92	[b] 3.90 ± 0.01	[b] 1642.30 ± 8.05	62.30 ± 2.32	17.37 ± 2.19	79.67 ± 3.65	[b] 5.56 ± 0.23	3.64 ± 0.49
Formic acid	342.98 ± 5.11	[b] 3.95 ± 0.01	[a] 1512.12 ± 8.92	62.80 ± 11.61	15.40 ± 1.22	78.20 ± 11.26	[b] 6.72 ± 1.13	4.12 ± 0.95
Benzoic acid	335.10 ± 4.31	[a] 3.83 ± 0.01	[c] 1741.82 ± 11.31	65.13 ± 1.66	17.40 ± 1.61	82.53 ± 2.21	[a] 4.43 ± 0.17	3.77 ± 0.39

SUMMARY

The effect of formic acid and benzoic acid on the quality of fermentation process during maize ensiling was studied in a model experiment. Preservatives such as formic acid and benzoic acid were added to ensiled maize at the concentration of 1L/t and 1 kg/t, respectively. When benzoic acid was used as a preservative, the pH and the $N\text{-}NH_3$/ N total ratio decreased statistically significantly ($P<0.05$) while the titration acidity increased ($P<0.05$) in comparison with the control values. The addition of HCOOH to the maize silage reduced the level of acetic acid in dry matter by 11.3 % while the overall level of acids decreased by 1.8 %. The minimum loss of dry matter (2 %) was found in the silage treated with formic acid in comparison with that of the control (11.0 %).

CONCLUSION AND RECOMMENDATION

On the basis of literature data and the results obtained in our experiment the following conclusions can be drawn:

Chemical preservatives were shown to be useful in ensiling carbohydrate-containing feed such as maize. The use of chemical preservatives leads to the decrease of the pH while the titration acidity increases. Furthermore, chemical preservatives inhibit the growth of undesirable bacteria so that the level of volatile fatty acids (VFA) is low. Another advantage of the preservatives is that they reduce protein decomposition (CP) and the loss of dry matter. Chemical preservatives, which control the fermentation process, are necessary to maintain residual carbohydrates in silage. The main advantage of aromatic acids is that they show not only antibacterial effects but also antifungal effects. Suitable application dosage is a prerequisite. It was shown that the concentration of formic acid (1 L/t) and benzoic acid (1 kg/t) used in our experiment was not sufficient to maintain high quality of maize silage in all respects. The amount of both benzoic acid and formic acid to preserve carbohydrate-containing feeds should therefore be increased to 1.5-2.0 kg/t.

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OCCURENCE OF YEASTS AND AEROBIC DETERIORATION OF GRASS SILAGES WITH DIFFERENT SUGAR CONTENTS

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INTRODUCTION

In which cases can aerobic stability be predicted by the number of yeasts at the time of opening the silo ?
Can selective media, adjusted to the particular silage, give a more precise prediction ?
Which other parameters enhance the risk of aerobic deterioration ?

Since the question of aerobic stability has been raised already in the 60'ies many attempts have been made to explain the interrelationship between spoilage organisms and deterioration, but the role of the particular microbial groups is not yet fully elucidated. In this study grass silages with higher Water Soluble Carbohydrates (WSC) content were investigated in this respect.

MATERIALS AND METHODS

Participating in the EU-funded project SWEETGRASS in 2002/2003 laboratory scale silages were made from perennial ryegrass (*Lolium perenne*) with elevated sugar content (usually > 20 g WSC/kg DM).

Cultivars of *Lolium perenne* were wilted to DM contents of 25% and 40% respectively and ensiled in 1.5 l Weck™ jars. The laboratory silos were stored for either 49 days with defined infusion of air or completely gastight for 90 days at 25°C ambient temperature. The resulting silages were analysed for the fungal micro-flora, pH, WSC (anthrone reagent), and for their fermentation profiles by GC. The aerobic stability was determined by monitoring the temperature rise above ambient for 7 days in insulated containers. Silages were considered to be aerobically instable when temperature rose consistently >3° C above ambient temperature (20° C).

After opening silage serial dilutions were surface spread on different media for yeast growth: in the first year (2002) all variants on Malt Extract Agar (MEA) and Lactate Agar (LA) (pH 3.3 resp. 3.8, JONSSON & PAHLOW, 1984), in the second year (2003) diluents of high DM silages additionally on modified Lactate Agars: a) pH 4.5, b) increased osmolality with 8.3% KCl (~ 2 osmol) (GREENHILL, 1964; ZIERENBERG, 2000), pH 3.8, c) increased osmolality with 8.3 % KCl, pH 4.5.

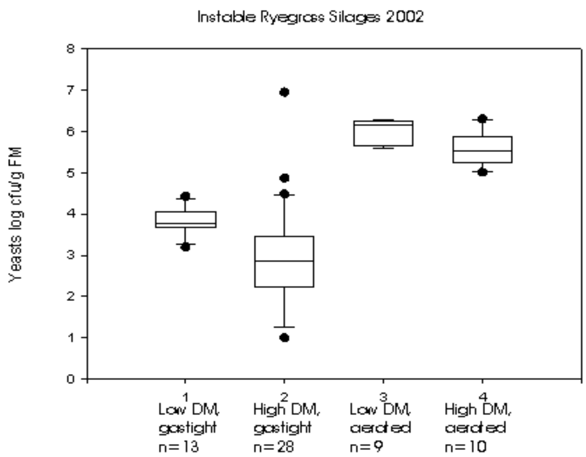
In 2002 yeasts were randomly isolated from the LA and identified mainly basing on the physiological testing kit API CH50 (Biomérieux) and the identification software "Yeasts of the World" (ETI 2002).

RESULTS AND DISCUSSION

For the evaluation only silages without additive treatment were considered.
Effect on aerobic stability during 7 days of temperature measurement:

- Aerated grass silages were generally aerobically unstable and contained yeast numbers between 5 and 6 log cfu/g FM
- High DM grass silages, stored gastight were more prone to aerobic deterioration than low DM silages: 28 out of 45 (62 %) high DM silages were instable, whereas only 13 out of 36 (36 %) low DM silages started to heat
- At opening in stable, low DM silages yeast counts were below the level of log 2 - 3, in unstable low DM silages the yeast population ranged from 3.2 to 4.4 log cfu/g FM
- In stable high DM silages yeast counts varied between < 2 to 3 log cfu/g FM, in unstable high DM silages yeast numbers were between < 2 to 4.9 log cfu/g FM

Figure 1. Frequency distribution of yeast counts (MEA) in unstable ryegrass silages



This indicates that there was a very clear relationship between yeast numbers (on MEA) and aerobic stability in aerated silages and in low DM silages stored gastight whereas the high DM grass silages gave a very heterogeneous picture in this regard.

Yeasts counted on LA, containing lactic acid as the sole carbon source at a pH < 4.0 did not show a clearer relationship.

This observation led to the idea to adjust the LA to the conditions occurring in high DM silages, *i.e.* a higher osmotic pressure and a pH > 4.0 in order to check whether relationships become closer. According to MIDDELHOVEN and FRANZEN (1986) the ability to assimilate lactate depends on the pH.

Preliminary results of 2003 gave the following yeast numbers on the different media (3 replicates each) in comparison of high DM aerated ryegrass silages.

Table 1. Yeast counts on Lactate Agar with different pH and osmolality [log cfu/g FM] (mean)

	Silage pH at opening	Total yeasts on MEA	pH 3.8	pH 4.5	pH 3.8 + 8.3 % KCl	pH 4.5 + 8.3 % KCl	Silage pH after 7 d aer. storage	Aerobic stability (d)
Control 1	5,55	6,52	6,46	6,36	6,42	6,44	8,06	1,50
Control 2	5,61	6,90	6,83	6,79	6,88	6,88	8,11	1,50
Control 3	5,84	5,70	5,70	5,75	5,83	5,82	7,92	1,75

These figures do not indicate big differences on different media.

The yeast identifications from 2002 have shown that the flora of lactate utilizers is dominated by *Pichia anomala* resp. *P. subpelliculosa* (36 of 58 identified isolates) and secondly *Saccharomyces cerevisiae* resp. *S. paradoxus* (13 of 58). *Pichia anomala* is characterized by the ability to metabolize a broad spectrum of carbohydrates. In another study on basal media (PRAPHAILONG and FLEET, 1997) *Pichia anomala* was quite osmotolerant growing in presence of 15 % NaCl. All investigated yeasts tolerated a pH from 2.5-8.0. However, to study further the aerobic deterioration by yeasts in high DM grass silages focusing on lactate assimilation further pH levels in LA have to be tried out also applying on particular isolates.

SUMMARY AND CONCLUSIONS

This study confirms a relationship between occurrence of yeasts and aerobic deterioration in grass silages stressed with air during storage as well as in low DM grass silages. It raises the question of yeast activity in high DM grass silages. If the deterioration is primarily initiated by yeasts there should be a correlation between yeast counts from selective media adjusted to conditions of high DM silages and results of stability measurements.

Otherwise it must be concluded that besides yeasts other factors such as a shift to even more osmotolerant moulds play a major role for causing spoilage in heavily wilted grass silages. This has to be investigated in more detail.

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THE INFLUENCE OF SOME BACTERIAL INOCULATES CONTAINING LACTIC ACID BACTERIES ON NUTRITIVE VALUE AND AEROBIC STABILITY OF GRASS SILAGE

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INTRODUCTION

Ensilage process of green herbage relies on the accumulation of organic acids, formed by homofermentative and heterofermentative lactic acid bacteria (LAB) in anaerobic conditions. The number of naturally occurring lactic acid bacteria on herbage is usually too small in relation to other organisms of the epiphytic microflora. To facilitate and ensure a successful ensilage process, silage additives containing LAB cultures should be added to the herbage at the ensiling time. They can be a fermentation stimulants and aerobic deterioration inhibitors (McDonald, Henderson, Heron, 1991). The additives are usually applied to the herbage in the chopper. Oxygenic deterioration is one of main problems, which occupy research workers in sphere of silage (Filya et al., 2002; Honig H.1999). It follows with the moment of opening the silo. Oxygen deterioration of silage results in the increase of temperature and pH, DM losses and surface mould growth. The aim of the study was to investigate the influence of bacterial additives containing LAB on quality and nutritive value of meadow silage.

MATERIALS AND METHODS

During the years 1999-2001 the study on the influence of domestic bacterial silage additives on chemical composition and aerobic stability of grass silage was conducted. The experiment was carried out in Experimental Station at Falenty near Warsaw in Poland. For ensilage was used meadow sward composed of 80% grasses (*Poa pratensis, Alopecurus pratensis, Dactylis glomerata, Arrhenaterum elatius*) and 20% weeds and herbs. The meadow herbage was made with addition of bacterial inoculants: K_1 (*Enterococcus faecium*, *Lactobacillus plantarum, Lactobacillus casei i Pediococcus spp.*), K_2 (*Lactobacillus plantarum K*) and without any additives (control sample). Before harvest the fresh grass was pre-wilted to a DM concentration of approximately 400 g kg^{-1}. Bacterial additives were put into herbage during the bales rolling in a variable bale chamber baler. The big bales (about 400 kg) after their transport to the place of storage were wrapped in four layers of stretch plastic film. The investigations were repeated in three cuts every year.

During the 100 day feed experiment, silage was fed to three groups of 10 heifers (200 kg). The heifers were fed *ad libitum*. The daily feed intake and refusals were recorded. Live weights were determined at the beginning, in the middle and at the end of the study. During feed experiment the silage samples were taken to chemical analyses.

The chemical composition and quality (according to Flieg-Zimmer scale) of feed samples was determined. Silage was analysed for: DM, crude protein, crude fibre, crude ash and crude fat concentration using NIRS technique. The organic acids were determined according to enzymatic method. Study of stability were conducted by monitoring the changes of temperature in silage samples placed in boxes in aerobic conditions (temp. about 21^0C) during 12 days. It was noticed twice a day in each group of silage.

RESULTS AND DISCUSSION

All tested silage were characterised by pleasant, wine-fruit smell. The colour of silage was from dark to light olive close to source material. Silage structure was in very good maintain alike in herbage material. The mean DM content of silage with inoculants was 399.6 g/kg (K_1) and 400.1 g/kg (K_2), and in control sample – 437.4 g/kg. Generally concentration of DM was found in silage on 400 g/kg. The level of DM had the influence on fermentation parameters. The mean pH values in silages were on the same level, but there was a tendency of lower pH value in silage made with K2 additive.

The content of organic acids in FM of silage was different. Among organic acids lactic acid was dominant. Silages made with addition of K_2 had a better process of fermentation. This silage had the highest level of lactic acid (26.1 g/kg in FM).

Silage had similar high nutritive value. Not significant differences in content of particular nutritive components were stated. The content of crude protein ranged from 137.6 g/kg (K2), by 136.4 g/kg (K1) to 129.3 g/kg in (Control). Also mean content of crude fibre in all silages was on level 260-270 g/kg. The content of crude ash in tested silages was on similar level, about 55 g/kg. Mean content of crude fat was 35 g/kg (tab.1).

The maximum level of temperatures silages prepared with additives attained after 7 – 9 days of test. For comparison silage prepared without additions reached the highest temperature already in 4 day. Stability of silage accepted necessary time to increase of temperature by 1^0C over air temperature. Stability of tested silage was 4 days (Control) and silages with addition of K_1 7 days and K_2 - 9 days. So addition of lactic acid bacteria during ensilage caused improvement of aerobic stability of silages.

Table 1. Quality and nutritive value of grass silage made with addition of LAB (1999-2001).

	Control	K_1	K_2
Dry matter (g/kg)	437.4	399.6	400.1
pH	5.09	4.72	4.58
Acids in fresh matter of silage (g/kg)			
- lactic	14.4	21.7	26.1
- acetic	4.5	3.7	4.0
- butyric	0.8	0.3	0.0
Points in Flieg-Zimmer scale	59	78	100
Quality	Satisfactory	Good	Very good
Stability (in days)	4	7	9
Content in DM (g/kg)			
Crude protein	129.3	136.4	137.6
Crude fibre	269.0	267.6	271.7
Crude ash	53.6	54.3	56.0
Crude fat	35.7	34.6	34.0
Nitrogen free extracts	512.9	507.1	500.7

Heifers fed tested silage daily took over 12 kg of fresh silage and 4.9 to 5.2 kg of dry matter. Initial weight of experimental heifers was over 150 kg. After feeding period (duration 100 days) animals weighted on average about 180 kg. During the whole research cycle the highest average weight increases were obtained with addition of K2 and control silage (0.66 kg). The lowest average weight increases were obtained on heifers feed with silage with addition of K1 (0.62 kg) (Tab. 2).

Table 2. Intake of silage (kg) by animals and their body gains (1999-2001)

	Control	K_1	K_2
Fodder given	4085.2	4271.7	4286.0
Refusals	524.6	567.1	554.2
Intake	3560.3	3703.2	3731.4
Silage	12.75	13.08	13.50
Dry matter	5.21	5.01	4.90
Initial weight (kg)	179.9	178.6	181.7
Final weight (kg)	245.3	240.0	247.5
Daily gain (kg)	0.66	0.62	0.66

CONCLUSIONS

Addition of bacterial inoculates improved a quality and aerobic stability of grass silage made in big bales. Among compared bacterial inoculates the most effective occurred inoculate K2 (*Lactobacillus plantarum* K). Used bacterial inoculates with LAB had no influence on nutritive value of obtained feeds.

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QUALITY, MICROBIOLOGICAL STATUS AND AEROBIC STABILITY OF WILTED GRASS-ALFALFA SILAGES MADE WITH DIFFERENT (CHEMICAL OR MICROBIOLOGICAL) ADDITIVES

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INTRODUCTION

The alfalfa silage is the most popular forage in cattle nutrition. This crop could be cultivate in mixture with grasses, what improve its fermentability. The standard method by its conservation is prewilting before ensiling. However in case of high dry mater concentration (very good weather - sunny and windy), obtained silage could be material with low aerobic stability. The use of different kind of silage additives, acts as aerobic deterioration inhibitors, will help to prevent secondary fermentation. The aim of conducted study was comparison the effectiveness such additives - chemical additive (in three doses), biological-chemical additive (bacterial inoculant + benzoate) and microbiological additive (inoculant with *L. buchnerii*) – applied in conservation of grass-alfalfa mixture with high dry matter content. This estimation was made on the basis of influence used additives on quality, microbiological status and aerobic stability of the silages.

MATERIAL AND METHODS

The 1st cut of grass-alfalfa mixture (French rye-grass – *Arrhenytherum elatior* + *Orchard grass – Dactylis glomerata*), harvested in bud of alfalfa and heading of grasses phases was the experimental material. The share of alfalfa in mixture was 45%. The time of wilting was 24 hours in very good weather conditions. During this time the content of dry matter increased rapidly from 190,2g/kg to 544,2g/kg. The mixture was chopped and ensiled in laboratory conditions in 3 dm^3 microsilos, in three replication for each treatment. Silages were made in six treatments: with use Agrosil additive (mixture of formic, lactic and propionic acids, and ammonium propioniate) in three dosage:- 2kg/t, 4kg/t and 6kg/t; with Feedtech (bacterial inoculant) and sodium benzoate (0,25kg/t); with Polmasil extra (bacterial inoculant with *L. buchnerii*), and without any additive (control group).

The content of lactic, acetic and butyric acids acc. to Lepper's method (Skulmowski, 1974), the concentration of N-NH_3 (Skulmowski, 1974) in silages, as well as its pH were determined. Additionally microbiological analysis, with use growing test on selective mediums: number of lactic fermentation bacteria - on agar MRS medium, yeasts (*Saccharomyces*) – on Sabouraud with chlorafenicol medium, moulds – on Czapek medium were carried out. All analyses were made in silages directly after microsilos' opening and after 7 days of its aeration. The aerobic stability of silages was determined on the basis of temperature's changes during one week-long aeration (by the temperature of environment = 21ºC).

Obtained results were statistically analyzed using one-factor variance analysis (for microbiological part – after previous logarithmic transformation) and multiple range test of Duncan.

RESULTS AND DISCUSSION

The use of chemical additive (in all dosage) increased lactic acid's level (from about 50g/kg DM to about 70g/kg DM) – table 1. For inoculants this effect was not observed. Adver tendency was note in case of acetic acid – its level was highest in silage from control group, and systematic declined with increasing of Agrosil's dosage (form almost 110g/kg DM to about 30 g/kg DM). The share of acetic acid in silage with Polmasil extra was characteristically high. This additive contains *L. buchnerii* – lactic acid bacteria belong to obligate heterofermenters. In silages the butyric acid was not detected. All silages, despite its high dry matter concentration (over 500g/kg), which is generally connect with lower acidification (Jones and Fychan, 1995; Haigh, 1990), were characterized by advantageous low pH value (<4,4) – table 1. Very good conditions of ensiling (very good material's compress in gas-tight microsilos) and high grass share in mixture (grasses are good source of WSC - Žilakova et al., 1994) can explained this situation. In this conditions of preservation with chemical additive Agrosil in dosage 4 and 6 kg per ton, as well as both microbiological inoculants positively increased the acidification to pH value 4,27-4,31. The amount of N-NH_3 (% of N-total) in silages was over 10% and depended on experimental treatments: in silages with Agrosil (6 kg/t) and with Feedtech + benzoate meaningly less of protein was converted to ammonia form.

The number of LAB was significantly high in silages with investigated additives (table 1). The highest number of those microorganisms was noted in silage with Polmasil extra, the lowest – in control group and in silage with Agrosil (2 kg/t). In all silages, after 7 days of aeration decreasing of LAB number was observed, but in silages with Polmasil extra and with Agrosil in dosage 4 and 6 kg/t number of these bacteria was still highest. The number of yeasts was highest in silage without additive, there is worth to note that in silages with Agrosil in dosage 4 and 6 kg per ton presence of yeasts was no detected. This testify about effectiveness of this chemical additive in inhibition of yeast growth. This effectiveness after aeration was also confirmed. Similar effectiveness in inhibition of yeast growth was observed for sodium benzoate use with Feedtech. Addition of Agrosil in dosage 6 kg per ton successfully decreased moulds number in silage before and after aeration.

The changes of temperatures of grass-alfalfa silages during aeration are presented on figure 1. During 168 hours of aeration increasing of silages' temperature wasn't observed. Therefore all silages could be accepted as stable silages. This is especially important in the case of silage with Agrosil additive (6 kg/t), which contained the highest amount of lactaic acid and the lowest level of acetic acid. Silages with such acid profile are more susceptible on secondary fermentation (Moon, 1983). Obtained data indicates that present in Agrosil active compounds effectively inhibits in presents of oxygen growth of spoilage microorganisms and improve aerobic stability.

CONCLUSIONS

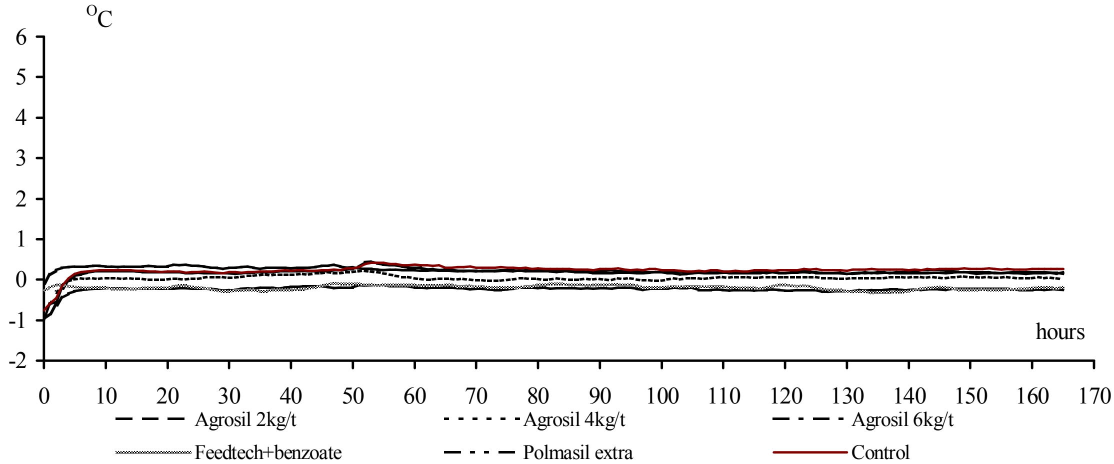
It may by concluded, that investigated additives can improve quality of wilted alfalfa-grasses silages. For examined additives there was also confirmed the capability to inhibition of aerobic spoilage. From among tested additives the most effective in ensiling of grass-alfalfa mixture with high dry matter content was chemical additive Agrosil in dosage 6 kg per ton.

Table 1. Quality and microbiological status of grass-alfalfa silages

Parameter	Type of additive					
	Agrosil			Feedtech + benzoate	Polmasil extra	Control
	2kg/t	4kg/t	6kg/t			
Lactic acid g/kg DM	72,21 a	69,65 a	70,66 a	63,18 ab	54,95 ab	49,76 b
Acetic acid g/kg DM	81,46 ABb	58,58 ABab	29,86 Aa	66,15 ABab	103,30 Bb	108,27 Bb
Butyric acid g/kg DM	0,00	0,00	0,00	0,00	0,00	0,00
pH	4,34 ABbc	4,31 ABab	4,31 ABab	4,27 Ba	4,28 Ba	4,36 Ac
$N\text{-}NH_3$ % N_{total}	15,07 Bb	14,63 ABb	11,77 Aa	12,29 ABa	13,02 ABab	15,09 Bb
LAB in silage CFU/g DM	$1,88\times10^{2}$ A	$8,31\times10^{2}$ B	$1,28\times10^{3}$ BCa	$4,08\times10^{3}$ CDb	$7,55\times10^{3}$ E	$2,09\times10^{2}$ A
LAB after aeration CFU/g DM	$6,19\times10^{1}$ Aa	$1,44\times10^{2}$ A	$1,82\times10^{2}$ ABb	$7,75\times10^{2}$ Bc	$4,51\times10^{3}$ C	$9,74\times10^{1}$ A
Yeast in silage CFU/g DM	$3,13\times10^{1}$ Aa	0,00 Ab	0,00 Ab	$1,27\times10^{3}$ B	$3,44\times10^{2}$ B	$4,00\times10^{3}$ B
Yeast after aeration CFU/g DM	$1,09\times10^{2}$ Aa	0,00 B	0,00 B	$1,99\times10^{3}$ CD	$5,87\times10^{3}$ Acb	$1,45\times10^{4}$ CD
Moulds in silage CFU/g DM	$1,65\times10^{2}$ ABCa	$3,40\times10^{1}$ AB	$1,63\times10^{1}$ Ab	$7,30\times10^{2}$ BC	$1,35\times10^{3}$ BC	$2,72\times10^{3}$ Cc
Moulds after aeration CFU/g DM	$9,68\times10^{2}$ BC	$1,25\times10^{2}$ ABa	$5,53\times10^{1}$ A	$1,88\times10^{3}$ BCb	$1,67\times10^{3}$ BCb	$4,27\times10^{3}$ BC

Values in the row with different letters a, b, c or A, B, C, D are significantly different at a value P≤0,05 or P≤0,01, respectively

Figure 1. Temperature of grass-alfalfa silages during 7 days aeration (0=21ºC – temp. of environment)



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THE EFFECT OF BONSILAGE PLUS ON THE FERMENTATION QUALITY OF GRASS SILAGE COMPARING TWO FORMS OF APPLICATION

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INTRODUCTION

Lactic acid bacteria are increasingly used as starter cultures for silage production. In the presented work two different application forms , liquid and granulate, of the DLG-proved silage additive Bonsilage Plus were compared. It should be investigated, if there is a difference in the fermentation pace in the first weeks after ensiling. A further aim of the work was to determine the influence of the starter cultures after a long fermentation period (90 days). Fermentation quality and aerobic stability was compared to an untreated control.

The trial was realized at the farm of Gerit van Ohlen (Uplengen-Südgeorgsfehn, Kreis Leer, Germany) in cooperation with LWK Weser-Ems and H. Wilhelm Schaumann Forschungszentrum Hülsenberg GmbH.

MATERIAL AND METHODS

Ensiling Material

Grass (70 % Lolium perenne), 1. cut, 29,5 % dry matter (DM) and 15,8 g/100g sugar.

Treatment with Silage Additive

Chopped grass was ensiled in 1,5 l tight sealed glasses and stored at 20 °C temperature till opening. The lactic acid bacteria were spread onto the chopped material, once in granulate form, once as a liquid bacterial solution. In parallel a untreated control was ensiled.

Measured Parameters

On day 1, 3, 7 and 14 after ensiling pH-value was measured by opening one glass each time.

Three glasses per treatment were opened after a storage period of 60 and 90 days to determine pH-value, fermentation pattern, fermentation losses and aerobic stability.

RESULTS AND DISCUSSIONS

In both inoculated silages the pH dropped more rapidly and to a lower value than in the control silage (data are presented in Table 1). This indicates, that the inoculation with lactic acid bacteria leads to a more efficient pH decrease, especially in the early fermentation phase compared to the untreated control. 90 days after ensiling the difference in pH was still detected. No variation in pH was measured for the two application forms of the silage additive.

Table 1. Development of pH-value in untreated and inoculated silage within the investigated fermentation period

fermentation time [d]		application of Bonsilage Plus	
	control	liquid	granulate
1	6,5	6,4	6,4
3	5,0	4,6	4,4
7	4,7	4,2	4,1
14	4,5	4,0	3,9
60	4,7	4,0	4,0
90	4,7	4,0	4,0

Table 2 shows the measured parameters of the silage after 90 days of fermentation. There were found significant differences in all relevant substances (butyric acid, lactic acid, acetic acid, ethanol and propanediol) between the data of fermentation quality of the control silage and the treated silages. Especially the high amount of butyric acid, found in the control silage, was completely avoided by inoculation of grass.

Applying the silage additive, Bonsilage Plus (a mixture of homo- and heterofermentative lactic acid bacteria) a high level of lactic acid (LA) was produced. LA indicates the activity of the homofermentative lactic acid bacteria. As a consequence the pH-value decreased clearly and all products responsible for a low silage quality (ammonia–N, ethanol and acetic acid), were produced to a lesser extent. Compared to the control, the fermentation losses also decreased.

Table 2. Analytic results and fermentation patterns after a fermentation period of 90 days

			application of Bonsilage Plus	
	unite	control	liquid	granulate
dry matter (DM)	g/100 g	26,8[a]	28,3[a]	27,2[a]
crude fiber	g/100 g DM	26,4[a]	23,6	24,0
crude protein	g/100 g DM	19,3[a]	19,2	19,0
butyric acid	g/100 g DM	1,1[a]	<0,07[b]	<0,07[b]
lactic acid	g/100 g DM	4,5[a]	12,3[b]	11,4[b]
acetic acid	g/100 g DM	4,5[a]	2,4[b]	3,1[b]
NH_3-N from total N	g/100 g	10,3[a]	7,3[b]	7,9[b]
ethanol	g/100 g DM	1,4[a]	0,5[b]	0,5[b]
propanediol	g/100 g DM	<0,07[a]	1,5[b]	2,6[b]
pH-value		4,7[a]	4,0[b]	4,0[b]
fermentation losses	g/100 g DM	11,3[a]	5,0[b]	4,6

numbers marked with different letters indicate statistically significant differences

A remarkable amount of acetic acid (2.4 and 3.1 g/100g DM) was detected in the inoculated silage. The acetic acid found in this silage is a fermentation product of the heterofermenative lactic acid bacteria and is responsible for high aerobic stability (Danner et al., 2003) of the treated silages (7.5 and 8.1 days). By measuring the amount of propanediol the activity of the heterofermentative lactic acid bacteria was proven. The control silage had a higher acetic acid concentration (4.5 g/100g DM) and also 1.1 g/100 g DM butyric acid. This indicates a undesirable clostridia fermentation and explains the high aerobic stability of 9 days in the control silage.

No significant differences could be found between the two application forms of Bonsilage Plus. Both products, liquid and granulate, work in the same way.

CONCLUSIONS

Using the bacterial silage additive Bonsilage Plus the fermentation process was speeded up and the pH-value decreased faster. These parameters are important to avoid the butyric acid fermentation in the long term. A certain amount of acetic acid was produced by the heterofermentative lactic acid bacteria, which is responsible for the high aerobic stability. In general a higher fermentation quality of the silage was reached and the fermentation losses decreased. With a dry matter content under 30 % no difference was found within the activity of the two silage additive application forms, liquid or granulate. It should be investigated, if the same results can be obtained by dry matter contents above 30 %.

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EVALUATION OF THE FERMENTATION QUALITY OF SILAGES FROM GRASS AND MAIZE

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INTRODUCTION

To evaluate the quality of silage fermentation a DLG-system is used, which was established in 1992 (A) (Weißbach and Honig, 1992) and improved in 1997 (B) (Weißbach und Honig, 1997). This system was derived from silages, which were produced under conditions of intensive fodder production, that means from green forage with high nitrate content. However, silages of green forage low in nitrate or even nitrate-free, which are now common in practice, are considerably over- or underestimated with this system. This discrepant assessment is caused by a significant different pattern of fermentation products between silages of green forage nitrate-free and nitrate-containing green forage (Weiß und Kaiser, 2001), showed in table1. The aim of this work was to derive an evaluation system for the fermentation quality, which is independent from the nitrate content of green forage.

Table 1. Pattern of fermentation products in silages depending on nitrate content in forage

Stage of fermentation	**content of nitrate in green forage** > 4,4 g NO_3 kg^{-1} DM **high in nitrate**	< 4,4 g NO_3 kg^{-1} DM **low in nitrate**
1. Anaerob stable silages (lactic acid fermentation)	**BA no** **AA < 30 g kg^{-1} DM** NH_3-N in Total-N < 100 g kg^{-1}	**BA** about **12 g kg^{-1} DM** **AA < 30 g kg^{-1} DM** NH_3-N in Total-N < 100 g kg-1
2. Anaerob unstable silages (malfermentation)	**BA partly existing** only when contents of AA high **AA > 30 g kg^{-1} DM** NH_3-N in Total-N > 100 g kg^{-1}	**BA extremely high** **AA < 30 g kg^{-1} DM** NH_3-N in Total-N from 20 g BA kg^{-1}DM > 100 g NH_3-N; increased

MATERIALS AND METHODS

Under laboratory conditions 570 silages were made from different green forages of well-known chemical composition. Among all analysed data of fermentation quality such parameters were selected, which were suitable to characterise all stages of fermentation quality independent of the chemical composition of green forage. On this basis an evaluation system was developed and applied to 3503 silages from green forage with unknown chemical composition obtained from farms of different regions in Germany.

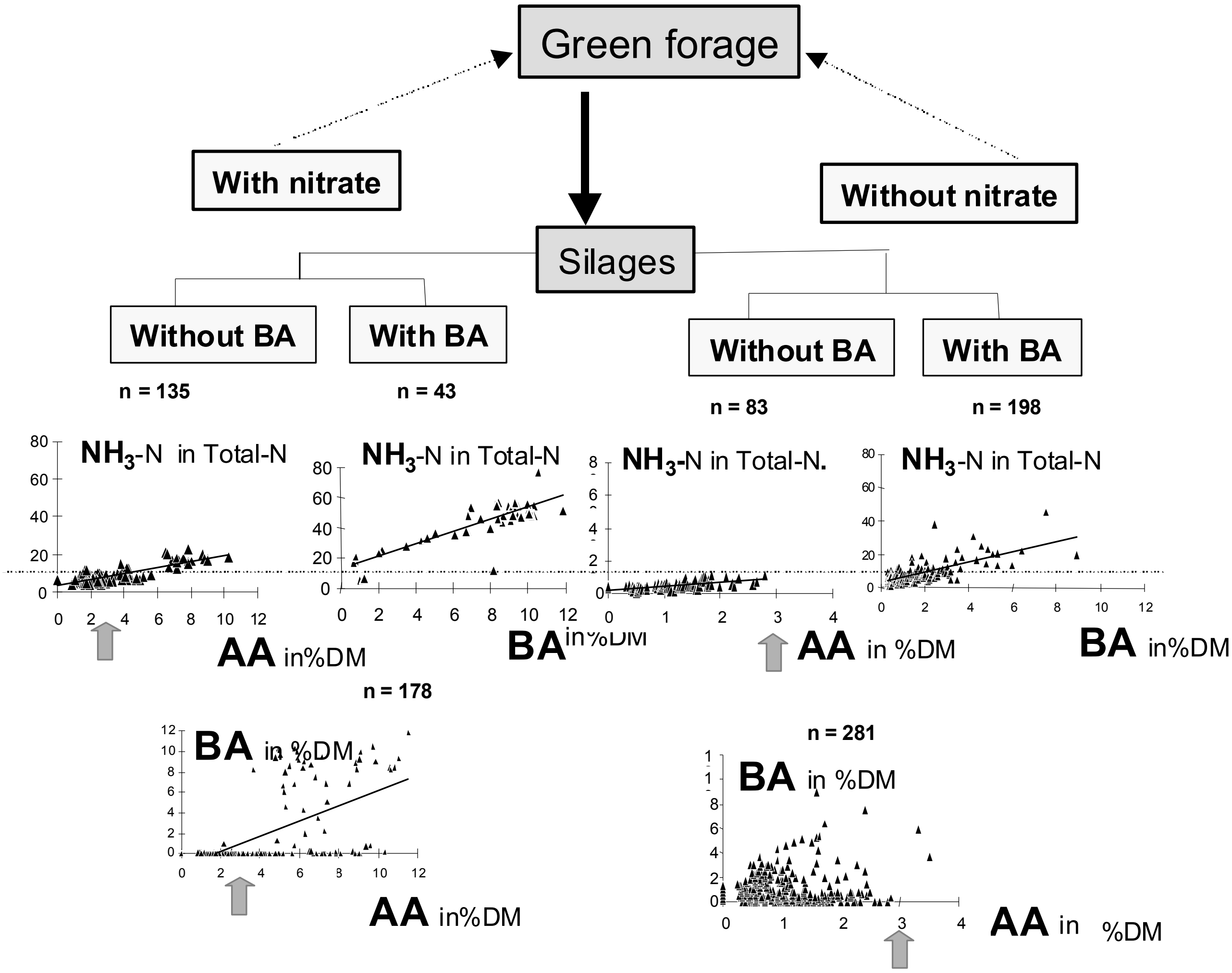
RESULTS

The results confirmed that all stages of fermentation quality (anaerobe stability, "turn over" of fermentation process and increased spoilage) can be estimated by butyric and acetic acid concentration alone (Kaiser et al., 1999 and 2000). On the other hand, the estimation of the pH-value and ammonia content in silages is not only not necessary to assess the fermentation quality, but both parameters are also very inappropriate for that purpose, because they are influenced by the variance of the chemical composition of green forage (see also Kaiser et al, 2000). In table 2 a suggestion for a new estimation system is presented.

Table 2. Evaluation system for the fermentation quality of silages by butyric and acetic acid content

Butyric acid [% DM]	Points	*Acetic acid* [% DM]	*Points* (Discount)	Evaluation Score	Mark
0 - 0.3	100	≤ 3.0	0	90 to 100	1
> 0.3 - 0.4	90	> 3.0 - 3.5	-10	72 to 89	2
> 0.4 - 0.7	80	> 3.5 - 4.5	-20	52 to 71	3
> 0.7 - 1.0	70	> 4.5 - 5.5	-30	30 to 51	4
> 1.0 - 1.3	60	> 5.5 - 6.5	-40	<30	5
> 1.3 - 1.6	50	> 6.5 - 7.5	-50		
> 1.6 - 1.9	40	> 7.5 - 8.5	-60		
> 1.9 - 2.6	30	> 8.5	-70		
> 2.6 - 3.6	20				
> 3.6 - 5.0	10				
> 5.0	0				

Figure 1. Relationshoip between parameters of not desired metabolism (Butyric acid (BA), Acetic acid (AA), Ammonia(NH_3)) with consideration of chemical composition of green forage



The content of 3.0 % acetic acid in DM as an upper limit for anaerobe stable silages is derived from statistical regressions (figure1). In case of low butyric acid concentration the classes are very narrow because a distinctive evaluation of the fermentation quality (production of butyric acid) in anaerobe unstable silages from green forage low in nitrate was possible by this differentiation only.

CONCLUSIONS

After the evaluation of 3503 silages made under practical conditions it can be concluded that the presented new system, which is based on the concentration of butyric and acetic acid only, is valuable to characterise the fermentation quality of all green forage silages, included maize, exactly.

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DYNAMIC OF FERMENTATION OF HARD WILTED LUCERNE WITH BIOLOGICAL PRESERVATIVE

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INTRODUCTION

Lucerne is one of the most valuable protein-feedstuff of Hungary. 60-65% of the lucerne is consumed by farm animals as fresh forage or hay, while the remaining 35-40 % is used for production of haylage or silage. The natural fermentability of fresh legumes may be improved also by the usage of some kind of silage additives. Nowadays, the spreading of biological preservatives can be observed. In the majority of them contain *Lactobacillus plantarum* cultures (Appendix of Farmers Weekly 1998.).

The *Lactobacillus plantarum* is favourable because it is homofermentative, it has good pH tolerance, and weak proteolytic activity. It has a further advantage namely, that it is able to reproduce in circumstances of little water activity during the ensilage of wilted forages (Schmidt et al. 2001).

The effect of the inoculation of starter culture is most spectacular during the first few days of fermentation. This is important because in respect of the quality of silage the first days of fermentation are determinant (Schmidt 1997).

A further advantageous effect of bacterial inoculation is that the NH_3 content of silage will decrease. The final results are, smaller loss of fermentation and better silage quality, due to which animals are willing to consume more of this forage (Avasi et al. 1999, Schmidt et al. 2001).

The aim of our experiment was to study the effect of biological preservative on the fermentation of high dry matter lucerne silages.

MATERIALS AND METHODS

We ensilaged firmly wilted alfalfa and as silage additive we applied powdery but water diluted biological preservative containing homofermentative cultures Lactobacillus plantarum PA28 and Lactobacillus plantarum K270.

We prepared micro-size silos, and opened them in different days of fermentation until 60th day.

The basic row material originated from third cut lucerne. The alfalfa cut in the beginning of blooming, was wilted on swath. The ambient temperature reached even 35 C° in the daylight so after a short time (half day) of wilting the dry matter content of alfalfa was of 53 %. The chopping took place at 9 am. after the drying up of dew, with Hesston-chopper. Chop length: 2-4 cm

We took samples from the starting material of ensiling and examined it in laboratory - like 0 day samples - immediately.

Applied treatments:
1. Untreated control
2. Inoculated with biological inoculant at rate of 1 g/tonne wilted lucerne

In each treatment we used 30 small sized containers of 4.2 l cubic capacity each, closed by screwed hat, altogether 60 pieces. We stored the filled micro containers for 60 days. Storage took place in 20-22 C° interior temperature. We opened the containers on the 1st, 2nd, 4th, 10th, 30th and 60th days following the day of ensilage (5 pieces / treatment / opening day) and we performed laboratory examinations on them.

The examination focused primarily on the products of fermentation and the dynamics of fermentation.

RESULTS

The results are shown on table 1.

The dry matter content of starting material was high (53 %), its buffer capacity was 47. This figure is significantly lower than the buffer capacity of green alfalfa.

During the first 2 days of fermentation the concentration of acetic acids increased significantly. Besides the formation of acetic acid, the development of propionic acid also could be perceived. The microbial activity quickens for the 4th day and increases until the 30th day considerably. This is indicated by the increasing of lactic acid and volatile fatty acid content and by the significant decrease in pH. However, the change in these parameters indicate that the content of lactic acid produced in biological preservative treated haylages, is significantly more than in the control haylages. The amount of volatile fatty acids were somewhat less in the biological preservative treated haylages than in the control ones. We also found that in the biological preservative treated haylages the fermentation seems to be become stable from the 30th day while in the control haylages it continues slightly.

The WSC content reduced to a greater extent (in a more rapid race) in alfalfa inoculated during the first 10 days following ensilation, however, the amount of WSC measured on the 30th and 60th days was nearly identical in the control and treated silages.

The NH_3 - content of lucerne inoculated was lower during the 30th to 60th days of fermentation. The amount of ethanol, indicating the breaking down of carbohydrate content of ensilaged forage, increases till the 30th day in all cases. However, by the 60th day, part of the ethanol content breaks down and can be found only a small amount of it in the haylages.

The pH of the ensilaged forages is formulated by the lactic acid and volatile fatty acids produced during the fermentation and the NH_3 content. We found that the pH-decrease in the treated haylages was of greater extent until the 10th day than in the control haylages. From the 10th day the pH changes only to a small extent in the haylages treated with biological preservatives which indicates that fermentation takes place more quickly with them.

On the results of *sensory tests* applied on the haylages on 60th day we found deterioration and moulding on the surface of untreated control haylages. Haylages inoculated however, had a pleasant smell and were completely undeteriorated (intact).

CONCLUSION

We found that the alfalfa, ensilaged with high dry matter content (53%) ferments well both in itself, and when treated with biological preservative. With the assistance of biological inoculant (*Lactobacillus plantarum* PA28 and *Lactobacillus plantarum* K270) the fermentation begins with higher intensity, more acetic and lactic acid is produced and fermentation terminates earlier. This encourages the more effective conservation of nutrients.

The effect of biological preservatives applied by us on fermentation appeared most favourable on lucerne of 30-40% DM content. Therefore, wilting for high dry matter content is not recommended for practice, because this results in significant nutrient-loss even before ensilage and the actual effect of preservatives cannot be utilized with full capacity, either.

Table 1. Dynamic of fermentation of wilted control and inoculated lucerne haylages on the dry matter basis

Samples* Opening day	DM %	Crude protein g	WSC g	Lactic acid %	Acetic acid %	Bytiric acid %	Propionic acid %	Ammonia in % of N	Ethanol %	pH
CONTROL										
1st Mean*	52,8	202	87	0,00	0,12	0,0	0,13	1,21	0,00	5,5
2nd Mean*	53,0	195	88	0,13	0,32	0,0	0,14	1,79	0,00	5,5
4th Mean*	52,6	195	71	0,65	0,37	0,0	0,16	2,75	0,00	5,5
10th Mean*	54,1	194	61	1,33	0,51	0,0	0,02	5,27	1,09	5,1
30th Mean*	51,6	193	24	2,79	0,70	0,0	0,04	5,76	1,43	5,0
60th Mean*	52,2	189	22	3,38	1,19	0,0	0,01	17,08	0,41	4,8
INOCULATED										
1st Mean*	53,6	200	55	0,00	0,18	0,0	0,22	1,19	0,00	5,5
2nd Mean*	53,1	198	48	0,21	0,34	0,0	0,18	1,56	0,00	5,3
4th Mean*	53,2	198	39	1,00	0,24	0,0	0,07	2,38	0,00	5,1
10th Mean*	53,3	197	28	1,70	0,73	0,0	0,06	5,22	0,92	4,5
30th Mean*	53,7	196	26	4,46	0,60	0,0	0,05	3,91	1,51	4,6
60th Mean*	53,0	195	20	4,02	076	0,0	0,02	12,07	0,56	4,5

Samples*: *number of samples 5 / treatment / opening day*

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CONSERVATION OF MAIZE CORN WITH HIGH MOISTURE BY ORGANIC ACIDS

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INTRODUCTION

Maize corn is very important source of energy in feed rations of livestock. The utilization of the technology of the cereal corn harvest with higher level of moisture is more effective from the economic point of view. The advantages are lower costs related to corn drying and its storage. Additionally, it allows maize (with utilization of corn) growing in nontraditional areas and it deteriorates the negative effects of bad weather. Cereal corn with higher level of moisture can be biologically oz chemically conserved. In case of the storage of corn with higher level of moisture there exists the risk of declining the nutritional and hygienic value of corn caused by unfavourable microorganisms. The unfavourable yeast and mould consume sugar and produce toxins and other metabolites that negatively affect taste and intake (Bíro, 2001). One of the possibilities to eliminate storage losses is to application of the conservative additives (acids, and their mixtures, salts of acids, hydroxides and urea). Organic acids the utilization in a process of corn, with higher level of moisture, conservation prevents from the growth and the reproduction of mould and unfavourable groups of microorganisms. It is extremely efficient to use chemically additives for the treatment of corn based on organic acids (Volkov et al., 1999).

MATERIAL AND METHODS

In experimental conditions we conserved of maize corn (*zea mays*) with high moisture. Whole maize corn contained 781,6 g/kg of dry matter (Table 1). Trial had two variants: K – control variant, we conserved maize corn without treatment, A – experimental variant, we applied on the corn 13 litre of chemical additive (composed two organic acids: propionic acid and formic acid) per one tone. The fermentation process run seven months in aerobic conditions with 18-22 ^{o}C temperature in variant A, but in variant K was maize corn pressed by pneumatic press into the units with capacity of 15 dm^3 and hermetized. Each variant was conserved in 3 repetitions. After seven months we sampled of average samples to assessment quality of the fermentation process (pH, lactic acid, formic acid, volatile fatty acids and alcohol) and for chemically analyses on the content of nutrients. The value of pH was determined with a pH meter. For the determination of acids, a portion of maize corn (200g) was mixtured with water and homogenized with hand mixer for 3 min. The sample was transfered into vessel and filled in 2000 ml of water. Solids were removed by filtration and clear filtrate was injected on a separation capillary after dilution. Capillary zone elektrophoresis was carried out on EA 100 analyzer (Villa-Labeco, Slovak Republic) with capillary (lenght: 160 mm and calibre: 0,3 mm). Content of alcohol was determined in water extract of sample by micro-diffusion method. Differences between of variants was evaluated statistically by program Statgraphics.

Table 1. Chemical composition of maize corn before conservation (in g/kg of dry matter)

Dry matter	Crude protein	Fat	Crude fiber	Ash	Nitrogen free extract	Starch	Organic matter
781,6	102,0	55,9	30,5	19,8	791,7	676,9	980,2

RESULTS AND DISCUSION

After seven months the experiment resulted in the highest losses of dry matter in maize corn without additive (K) stored in anaerobic conditions. The value of pH was the same in both variants, however the maize corn in variant K was moulded in all folds, when the samples were taken. After having silo hermetized the amount of oxygen among the corns was sufficient for the mould growth. In contrast the corn was without mould with slight odour to acids after the addition of additive based on organic acids (A). The same results were found by Filipovič and Ristič (2001) after addition of propionic acid. In the corn of the experimental variant (A) we found statistically significant content of lactic acid ($P<0,001$). In the maize corn without the addition of additive we found small amount of lactic acid (1,27 g/kg of dry matter) and no acetic acid, propionic acid, formic acid was found. It means, that there was only negligible process of fermentation. In variant A (with addition of propionic acid and formic acid) the maize corn contained the highest content of propionic acid (15,08 g/kg of dry matter). Lactic acid (produced from lactic acid bacteria) does not preserve high moisture corn as well as propionic acid. Propionic acid has long been a standard for treating grains because of its ability to control yeast and molds (High Moisture Corn Advantage).

The corn of the experimental variant A had higher content of volatile fatty acids. Furthermore the total content of acids in variant A was higher in comparison to the corn stored without the additive in anaerobic conditions ($P<0,001$). We found statistically higher content of alcohol ($P<0,05$) in maize corn with organic acids additive.

Table 2. Result of fermentation in maize corn (in g/kg of dry matter)

n = 3	Control K			With additive A			Statistical significance	
	$\overline{x}$	s	v	$\overline{x}$	s	v	P<0,05	P<0,001
Dry matter	779,5	0,081	0,104	781,0	0,318	0,407		
Value of pH	4,11	0,075	1,828	4,11	0,021	0,506		
Acid								
lactic	1,27	0,012	0,907	4,01	0,301	7,494		+ + +
acetic	ND	-	-	0,25	0,031	12,059		
propionic	ND	-	-	15,08	0,718	4,763		
formic	ND	-	-	1,89	0,085	4,492		
Total volatile fatty acids	ND	-	-	15,33	0,728	4,748		
Total acids	1,27	0,012	0,907	21,23	1,004	4,73		+ + +
Alcohol	3,74	1,038	2,774	5,9	0,023	0,391	+	

ND: non-determination

CONCLUSIONS

Based on our results we found, that conservation of whole maize corn was successful in aerobic conditions with organic acids additive. After seven months of storage the treated corn was compactible it had slight odour to acidulate, unchanged colour and without mould. In corn we found the highest content of propionic acid and the second highest content of lactic acid as the result of the fermentation process. We revealed, that the conservation of moistured maize corn in anaerobic conditions without additive was unsuccessful by dry matter content cca 780 g/kg. We suggest, that as a result of higher content of dry matter no fermentation of lactic acid bacteria has taken place due to high osmotic pressure in cells as well as compactibility of corn. Whereas the corn was sensorially moulded in all folds and losses of dry matter were at the highest point after opening the storage units.

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THE EFFECT OF *LACTOBACILLUS BUCHNERI* ON FERMENTATION AND AEROBIC STABILITY OF MAIZE SILAGE

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INTRODUCTION

With increasing dry matter content in maize the lactic acid fermentation is less intensive (Wyss 2002). Produced silage is not aerobic stable when is feed to animals, especially in summer. However using for maize silage preservation inoculants with homofermentative lactic acid bacteria (for example: *Lactobacillus plantarum, Enterococcus faecium*) not always improved the stability (Owen 2002). Nowadays heterofermentative lactic acid bacteria are also used to produce inoculants. They increase in silage concentration of acetic acid, propionic acid and volatile fatty acids (VFAs), which inhibit the growth of fungi and yeasts, what enhance silage aerobic stability (Uriate et al. 2001). One of heterofermentative lactic acid bacteria is *Lactobacillus buchneri*. The aim of this study was to determine the effect of adding *Lactobacillus buchneri* bacteria on fermentation process and aerobic stability of maize silage.

MATERIALS AND METHODS

Whole-plant maize (variety – Matilda, FAO 240, Pioneer Hi-Bred firm) was cut in the first decade of September, at the end of dough stage of maturity. Green forage was cut into chaff 20 mm long and ensilaged in 5-liters laboratory mini-silos. Silage was made with and without *Lactobacillus buchneri* additive (Pioneer 11A44 Silage Inoculants). Inoculant was applied at 0.5 g per kg, according to producer's recommendation. Each variant of silage was made in 5 repetitions. After 42 days quality and chemical composition of silage was evaluated. Aerobic stability was determined in room with constant temperature $20^0C \pm 0.5$. Temperature of silage was measured every 1 hour during 7 days. To take temperature measurements Squirrel 2000 device was used.

RESULTS AND DISCUSSION

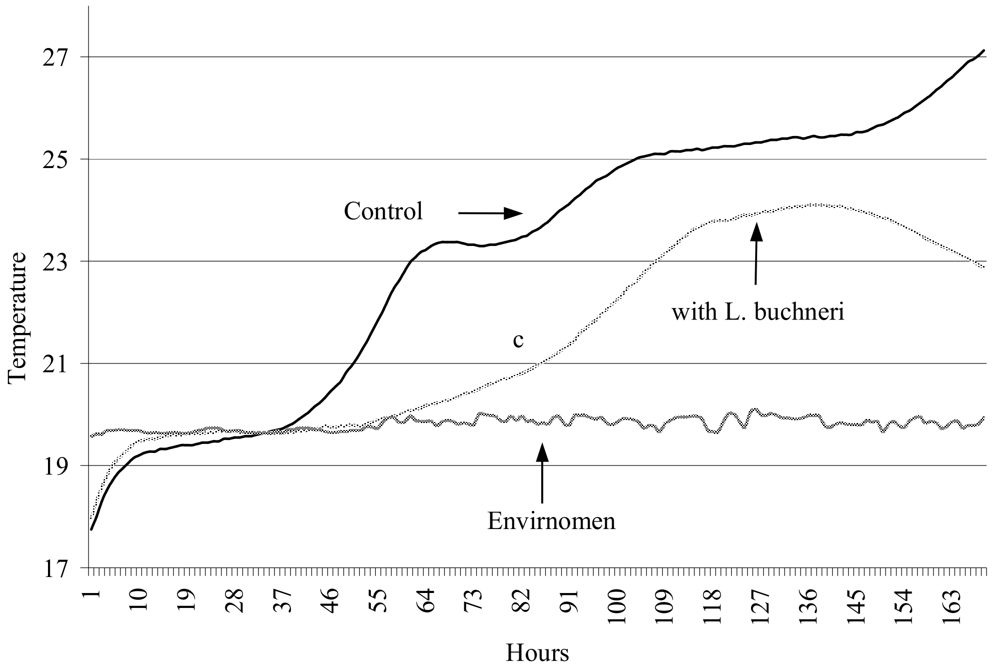
Green maize used to ensiling consisted of 40.45 % of dry matter (10.2 % of crude protein, 19.0 crude fiber in DM). Green maize characterized good ability to ensiling, because WSC/BC (water soluble carbohydrates sugar to buffering capacity) ratio was 2.5 and fermentation coefficient was 61. In both produced silages lactic acid was predominant and there was no butyric acid (table 1). However in control silage there was less acetic acid level than in silage made with *L. buchneri*; that's why the first silage was very good, and the second was good when evaluated with Flieg-Zimmer scale. Stability of produced silages is shown in figure 1. Through the first two days of observing aerobic stability temperature in both silages was similar. Later temperature increased faster in silage without additive. Silage became aerobic unstable when it's temperature exceed temperature of environment over 1.5^0C (Uriarte-Archundia et al. 2002). In this study silage made without additive lost aerobic stability after 51 hours, and silage made with *L. buchneri* after 91 hours.

Table 1. Maize silages quality

Silage	pH	Lactic acid (g/kg DM)	Acetic acid (g/kg DM)	$N\text{-}NH_3$ do N_{total} (%)	quality
Control	4,27	$60{,}3^a$	$12{,}2^A$	6,2	very good
L. buchneri	4,37	$84{,}6^b$	$41{,}7^B$	5,4	good

a,b - within a column, means followed by different letters differ significntly $P<0{,}05$
A, B - within a column, means followed by different letters differ significntly $P<0{,}01$

Figure 1. Aerobic stability of silages.



CONCLUSION

Adding inoculant with *Lactobacillus buchneri* to ensiling green maize enhanced aerobic stability of produced silage. Long term aerobic stability of maize silage is very important in summer bovine nutrition.

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EFFECT OF CHEMICAL AND BIOLOGICAL ADDITIVES ON QUALITY, MICROBIOLOGICAL STATUS AND AEROBIC STABILITY OF MAIZE SILAGE

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INTRODUCTION

In yearly feeding systems for cattle maize silage plays major role. This crop is commonly know as easily ensilaging, but especially during summer (high temperature of environment) frequently occurs secondary aerobic fermentation. In prevention of this process could be useful different additives acting as inhibitors of secondary fermentation (Driehuis and van Wikselaar, 1996; Driehuis et al., 1997, Harrison et al., 1997). The goal of conducted experiments was comparison of effectiveness of different additives use in preservation whole maize crop harvested in wax stage - chemical additive (applied in three dosage), biologic-chemical additive (bacterial inoculant + benzoate) and microbiological additive (*L. buchnerii*). This estimation was made on the basis of influence used additives on quality, microbiological status and aerobic stability of the maize silages.

MATERIAL AND METHODS

The maize was harvested on 10 September, in wax stage and dry matter content 394,8g/kg. Whole maize crop was chopped and ensiled in laboratory conditions in 3 dm3 microsilos, in three replication for each treatment. Silages were made in six groups: with use Agrosil additive (mixture of formic, lactic and propionic acids, and ammonium propioniate) in three dosage:- 2kg/t, 4kg/t and 6kg/t; with Feedtech (bacterial inoculant) plus sodium benzoate (0,25kg/t); with Polmasil extra (bacterial inoculant with *L. buchnerii*), and without any additive (control group). Microbiological additives were use according to producers instructions.

The content of lactic, acetic and butyric acids acc. to Lepper's method (Skulmowski, 1974), the concentration of N-NH_3 (Skulmowski, 1974) in silages, as well as silages' pH were determined. Additionally microbiological analysis, with use growing test on selective mediums: number of lactic fermentation bacteria - on agar MRS medium, yeasts (*Saccharomyces*) – on Sabouraud with chlorafenicol medium, moulds – on Czapek medium were carried out. All analyses were made in silages directly after microsilos' opening and after 7 days of its aeration. The aerobic stability of silages was determined on the basis of temperature's changes during one week-long aeration (by the temperature of environment = 21ºC). Obtained results were statistically analyzed using one-factor variance analysis (for microbiological part – after previous logarithmic transformation) and multiple range test of Duncan.

RESULTS AND DISCUSSION

There was detected differences in lactic acid concentration in maize silages– table 1. Silages with Agrosil in dosage 4 kg/t and 6 kg/t as well as silage with Polmasil extra contained higher level ($P \leq 0,05$) lactic acid in comparison to control group (without additive), silage with Agrosil in dosage 2 kg/t, and to maize ensilaged with Feedtech + benzoate additive. Greater differences between silages were observed in the level of acetic acid: the lowest concentration of this acid stated for silage with Agrosil additive – in dose 6 kg/t (above 40 g/kg DM), and the highest level - in silages from control group (130 g/kg DM). This differences were confirmed statistically ($P \leq 0,01$). The increase lactic acid together with decrease acetic acid level in maize silages with inoculants observed Dvořaček and Doležal (1997). In silages presence of butyric acid was not detected. The pH values for all silages were similar and were relatively low (ranged from 3,79 to 3,85). The favorable acid profile in silages with additives (which was probably the effect of good quality fermentation) corresponded with lowest proteins loses (ammonia number) noted for this fodders in comparison to control group.

There also noted profitable influence applied additives on number LAB: in silages with Agrosil (dosage 4 and 6 kg/t), with Feedtech plus benzoate as well as with Polmasil extra number of this bacteria increased in comparison with silage without any additive and silage with Agrosil in dosage 2 kg/t. In all silages, after 7 days of aeration decreasing of LAB number was observed and the highest concentration of this microorganisms was detected in silage with Feedtech and benzoate additive. The application of examined additives positively modified number of yeast: all additives decreased yeast number, the most effective in this area was Agrosil applied in dosage 6 kg/t – in this case the presence of yeast was no detected. After aeration number of this microorganisms was the highest in silage from control group and the lowest number in silage preserved witch chemical additive in dosage 6 kg/t. Agrosil was also the most effective in inhibition mould growth, but there was no differences between dosage 4 and 6 kg/t – for both levels the numbers of moulds were similar. The number of moulds was the highest in silage from control group.

The changes of temperatures of maize silages during aeration are presented on figure 1. Maize silage without any additive (control group) wasn't stabile, in its case after 74 hours aeration noted visible and rapidly increasing of temperature. On the other hand silages with addition of examined additives were stabile in aerobic conditions.

CONCLUSIONS

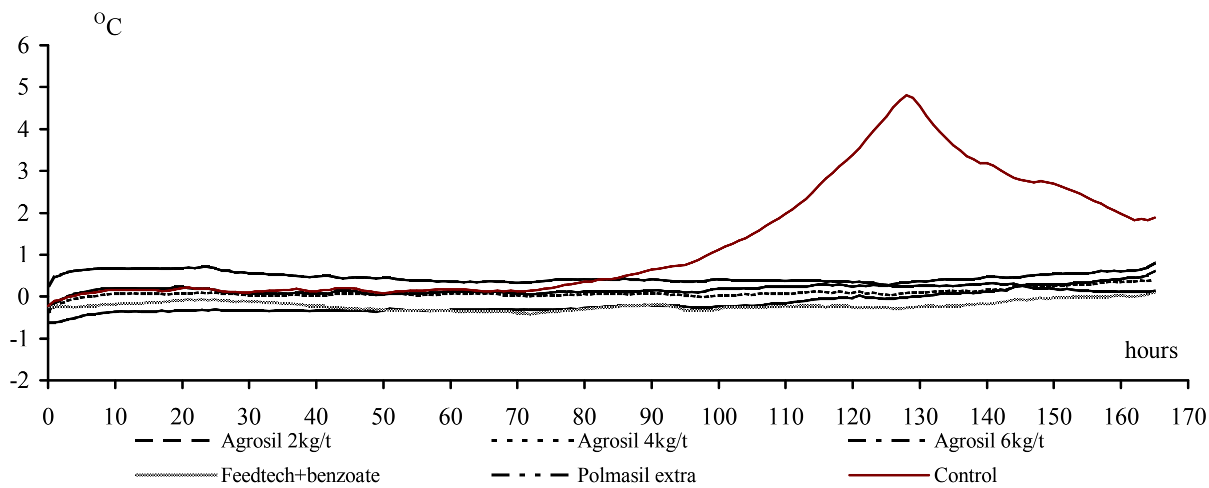
In spite of general opinion, that maize is very good ensilage material and during its preservation there in no necessary of application any additives, in our experiment indicated distinct and beneficial influence tested additives on quality, microbiological status and aerobic stability of the silages. The ensiling of this crop in late stage of growth could be difficult, what is testify by high level of acetic acid and low level of lactic acid in silage obtained with no additives.The application of examined additives could positively modified this proportion. The positive effect was also confirmed by improvement aerobic stability of silages with additives. From among tested additives the most effective in ensiling of whole maize crop was chemical additive Agrosil in dosage 4 kg per ton.

Table 1. Quality and microbiological status of maize silages

Parameter	Type of additive					
	Agrosil			Feedtech + benzoate	Polmasil extra	Control
	2kg/t	4kg/t	6kg/t			
Lactic acid g/kg DM	32,69 a	61,11 b	68,12 b	38,17 a	62,73 b	27,63 a
Acetic acid g/kg DM	112,31 BCcd	56,99 ABab	40,48 Aa	88,83 ABCbc	74,71 ABCabc	130,06 Cd
Butyric acid g/kg DM	0,00	0,00	0,00	0,00	0,00	0,00
pH	3,79	3,82	3,85	3,85	3,79	3,79
$N\text{-}NH_3$ % N_{total}	7,21 ab	6,71 ab	5,13 a	6,71 ab	6,24 ab	8,19 b
LAB in silage CFU/g DM	$8,16\times10^{3}$ A	$5,35\times10^{4}$ C	$1,17\times10^{4}$ ABa	$5,12\times10^{4}$ BCb	$6,72\times10^{4}$ C	$4,94\times10^{3}$ A
LAB after aeration CFU/g DM	$2,42\times10^{3}$ ABa	$8,99\times10^{3}$ BCb	$4,22\times10^{3}$ AB	$3,10\times10^{4}$ C	$2,27\times10^{3}$ ABa	$1,47\times10^{3}$ A
Yeast in silage CFU/g DM	$7,94\times10^{2}$ C	$4,97\times10^{1}$ B	0,00 A	$6,94\times10^{2}$ C	$6,07\times10^{1}$ B	$6,41\times10^{3}$ D
Yeast after aeration CFU/g DM	$1,91\times10^{3}$ C	$1,42\times10^{3}$ C	$1,23\times10^{1}$ A	$1,84\times10^{3}$ C	$1,19\times10^{2}$ B	$1,09\times10^{4}$ CD
Moulds in silage CFU/g DM	$3,80\times10^{1}$ ab	$1,23\times10^{1}$ a	$2,27\times10^{1}$ ab	$6,15\times10^{2}$ b	$6,00\times10^{1}$ ab	$7,80\times10^{1}$ ab
Moulds after aeration CFU/g DM	$1,34\times10^{2}$ AB	$3,20\times10^{1}$ A	$3,29\times10^{1}$ A	$7,25\times10^{2}$ AB	$3,84\times10^{2}$ AB	$9,26\times10^{3}$ B

Values in the row with different letters a, b, c, d or A, B, C, D are significantly different at a value $P\leq0,05$ or $P\leq0,01$, respectively

Figure 1. Temperature of maize silages during 7 days aeration (0=21°C – temp. of environment)



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INFLUENCE OF BONSILAGE PLUS ON FERMENTATION QUALITY OF SILAGE, FEED INTAKE AND MILK YIELD OF DAIRY COWS

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INTRODUCTION

The aims in milk production are clearly drawn with high milk yield, good health status and fertility of the cows. Next to animal specific factors, mainly feed dependent parameters determine feed intake of animals. For high yielding dairy cows only high quality forage can be fed to get a satisfying output. Herein, increasing attention has to be given to the forage in the feeding rations. The hygienic and energetic state of grass silages has to be improved. A method to improve silage fermentation is the addition of starter cultures. In this trial the influence of Bonsilage Plus on fermentation quality, feed intake and milk yield of dairy cows was studied.

MATERIALS AND METHODS

Ensiling

At Hülsenberg, a research farm in Germany, the first grass cut (dominated by *Lolium perenne* and *Lolium multiflorium* was ensiled in two separate clamp silos (40 % DM), one untreated and one inoculated with Bonsilage Plus. Bonsilage Plus is a biological starter culture composed of: *Lactobacillus plantarum*, *Lactobacillus rhamnosus*, *Pediococcus pentosaceus*, *Lactobacillus buchneri* and *Lactobacillus brevis*. The conditions of ensiling, like compressing and sealing were constant for both variants. After 6 months of storage the silage quality was determined and feeding trials were started.

Feeding trial

The feeding trials were completed with 48 dairy cows of high yield, kept in a free stall barn. Both silages were fed in a TMR. The feed intake was measured in troughs with an automatic weighing system. This enabled the measurement of feed intake of each single cow. The ration was composed to 53% of forage (28.9% grass silage, 20.2% maize silage and 3.9% of straw) and to 47% of concentrate.

After administering an identical diet for three weeks (preliminary period) the cows were separated into two groups. For the trial period of 5 weeks lactation number, lactation days, milk amount, milk composition and feed intake were measured.

Samples were taken from the forages two times a week to determine the dry matter contents. Milk yield and feed intake were registered daily and milk composition was measured once a week.

RESULTS AND DISCUSSION

The crude nutrient composition of the silages was almost the same. The differences in the fermentation patterns were therefore only caused by the additive. In Table 1 the results of the chemical analysis are presented. The treatment with Bonsilage Plus resulted in higher lactic acid and acetic acid contents. The amount of ethanol and butyric acid was reduced in the silage inoculated with Bonsilage Plus. The changes in the fermentation pattern connected with the lower pH, achieved in the treated variant, resulted furthermore in higher aerobic stability and a higher feeding value. 1,2-propanediol was only determined in the silage treated with Bonsilage Plus. This compound is usually formed in fermentations with *Lactobacillus buchneri* (Holzer et al., 2003) containing starters.

Table 1. Silage composition after 6 months of fermentation

(g/100 g DM)	Control	Bonsilage Plus
Dry matter (g/ 100 g FM)	41	43
pH	4.8	4.2
Lactic acid	4,2	7,4
Acetic acid	1,5	1,9
Butyric acid	0,5	0.0
Ethanol	1,0	0,2
1,2-Propanediol	0.0	1,2

In Table 2 the development of milk yield in the feeding trial is presented. During the 5 weeks lasting trial period the group fed with Bonsilage Plus treated silage resulted in a 2.2 kg higher milk yield. Like the animals of this group showed already in the preliminary period a 0.6 kg higher milk yield, an improvement of performance of 1.7 kg milk was determined by the Bonsilage Plus addition. The differences in fat and protein content did not change – no effect due to the treatment was determined. In Table 3 all results of the feeding trial regarding the milk yield are listed.

The feed intake of the group fed with Bonsilage Plus silage is 0.4 kg DM higher than in the control group. Considering the higher feed intake and the higher energy content of the silage the energy intake is improved by 5 MJ NEL. This value is almost equivalent with the higher energetic requirement for the higher milk production.

These results clearly show that the additive Bonsilage Plus has increased the value of grass silage. The higher efficiency of the feed was confirmed in the feeding trials by higher feed intake and higher milk yields.

Table 2. Milk yield

Week	Control	BONSILAGE PLUS	Difference	BONSILAGE PLUS- Effect
Start	36.8	37.4	0.6	
1	36.8	38.2	1.4	0.8
2	36.8	38.6	1.8	1.2
3	35.7	38.9	3.2	2.6
4	35.2	37.8	2.6	2
5	35.2	37.2	2	1.4

Table 3. Milk composition and milk yield

	control group	Bonsilage Plus group
milk (kg)	35.9	38.1
FPCM (kg)*	34.9	36.8
fat (%)	3.86	3.76
fat (kg)	1.39	1.43
protein (%)	3.19	3.28
protein (kg)	1.15	1.25
urea (mg/l)	240	255

* fat and protein corrected milk yield

CONCLUSION

Bonsilage Plus treated silage resulted in a better fermentation quality, higher feed intakes and higher milk yields in dairy cows compared to the corresponding control group.

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THE INFLUENCE OF DEVELOPMENT PHASE AND DRY MATTER LEVEL ON QUALITY AND NUTRITIVE VALUE OF ORCHARD GRASS SILAGE

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ABSTRACT

I n this paper the influence of development phase and dry matter level of unwilted and wilted orchard grass (*Dactylis glomerata*)–cv Krusevacka rana, harvested at the beginning of earing (24.04. 2000) and beginning of flowering on ensiling suitability, nutrients content and fermentation process was examined. Wilting of orchard grass biomass reduced sugar concentration (109,2 and 118,6 g/kg DM compare to 66,7 and 76,0 g/kg DM) butyric acid (22,95:4,17 g/kg DM), acetic acid (24,8:15,1 g/kg DM) and loss of crude protein (183,5:194,0 g/kg DM). Wilting also provided better conditions for lactic acid fermentation and one class better silage quality. Cutting in beginning of earing phase in relation to beginning of flowering, improved the quality of silage (increasing concentration of crude protein and ash) with simultaneous worsening of fermentation conditions and getting one or two classes worse silage.

INTRODUCTION

The basic cause of a little dairy and meat (cattle and sheep) production in Serbia is an insufficient and low quality forage production. The improvement of forage quality can be made by cutting in an earlier development phase. This can be confirmed by the research of Dinic et al. (2002) who showed that cutting of perennial ryegrass and Italian ryegrass in the phase of initial earing in relation to flowering could significantly provide silage of higher quality. Dry matter content in biomass for ensiling is one of the most important facts related to the loss of dry matter content and the course of fermentation in silage mass.

Increasing of dry matter content in biomass for ensiling by wilting is one of the most important factors of the improvement of quality of the lactic-acid fermentation and providing a good quality and stable silage (Zimmer and Wilkins, 1984.). The aim of this experiment is getting high quality forage concerning the nutrients contents and providing stable and high quality silage with as least as possible presence of unfavorable substances.

MATERIAL AND METHODS

Biomass of orchard grass (*Dactylic Glomerata*)- cv Krusevacka rana, was cut in the beginning of earing phase (24.04.2000) and in the beginning of flowering phase (04. 05. 2000.) and was ensilaged both fresh and wilted. Ensiling was done by the method of two factors experiment 2x2 with three replications in which the phase of plant development is factor A, and wilting is factor B. Ensiling was made in experimental pots- 500 l and the opening and samplings were 100 days after ensiling.

In fresh biomass the suitability for ensiling was determined by parameters of dry matter (DM), water soluble carbohydrates (WSC) (Dubois et al., 1956), buffer capacity (BC) (Weissbach.1967) and WSC/PK ratio. The chemical composition of biomass and silage was determined by standard chemical methods that gave following parameters: DM, crude protein (CP), crude cellulose (CC), ash, Ca and P. In silage were determined acidity (pH), NH_3-N and fatty acids (acetic, butyric, and lactic). The results of the chemical analysis were processed by the analysis of variance and tested by LSD test.

RESULTS AND DISCUSSION

Year 2000 was with very little precipitation during vegetation period, and the average temperatures were very high, which made the period between starting earing and starting flowering very short (10 days). WSC content was higher in unwilted orchard grass biomass (109,2 and 118,6 g/kg DM) in relation to wilted (66,7 and 76,0 g/kg DM), which could be due to fact that they were utilized in the process of wilting. BK value of wilted biomass is somewhat higher compare to unwilted. However, WSC/BC ratio is higher in unwilted biomass, the least was almost 3,0, which should have provided a good quality and stable silage in all the treatments.

DM content of unwilted orchard grass biomass was 195,5 g/kg and wilted 357,7 g/kg, and high significance was found only for the factor of wilting (Table 1). The degree of acidity of all silage treatments was good taking into account the level of DM. High statistic significance (LSD 0,001) was among the silages from different phases (pH 4,16:4,95). NH_3-N was low, which indicate that there was not high degradation within the process of fermentation. However, the determined differences between the silages of wilted and unwilted biomasses were highly significant, and in the silages of different phases they were significant (Table 1). The concentration of fatty acids in the silage (acetic and butyric) tends to be lower with wilting, especially the butyric acid. On the other hand, lactic acid tends to be higher with wilting in the first phase. By applying DLG method for estimating the silage quality, it can be noticed that wilting provides better quality silages. The fewest number of points (16-class 5) was given to the silage of unwilted orchard grass from the first phase. Such a bad quality is hard to explained, knowing that WSC/BC was favorable. Wilting helped to get one or two classes better silage. One class better silage was gain by cutting at the beginning of flowering phase in relation to beginning of earing phase.

In regard to nutrient content it was noticed a very high concentration of CP (190,5 and 205,3 g/kg DM) in the silages from first and from second phase (176,4 and 182,6 g/kg DM) which, in ruminants diet can result in a high dairy and meat production, even without concentrated feed, as Schneeberger claimed (1987.). Difference in CP content between silages from different phases was 18,5 g/kg DM, although it was determined that wilting also protect protein (10,5 g/kg DM). Quite a lower CP was found in the work of Dinic et al. (1999.). Statistically significant differences in nutrients (SP, NFE and ash) were found among the silages of different phases of plant development, whereas with CC, Ca and P there have not been determined statistically significant differences in relation to factors of examination.

CONCLUSIONS

Cutting of orchard grass in beginning of earing phase in relation to beginning of flowering phase improves the quality of silage (it increased CP and ash) and causes a simultaneous worsening of fermentation conditions and getting one or two classes worse silages. Wilting of biomass helps to provide better conditions for lactic acid fermentation, provides one class better quality silage and reduces loss of CP.

Table 1. Chemical composition of biomass and silage

Development phase	Begining of earing (a_1)		Begining of flowering (a_2)		Significance	LSD	
Chemical parameters	Unwilted	Wilted	Unwilted	Wilted	Factors of examination	0.05	0.01
CP, g/kgDM	190,5	205,3	176,4	182,6	A**, Bns, AxBns	10,7	16,2
CC, g/kgDM	285,4	278,9	282,5	295,0	Ans, Bns, AxBns	14,9	22.5
NFE, g/kgDM	355,9	360,7	390,2	390,4	A*, Bns AxBns	31.9	48.3
Ash	122,5	117,6	107,8	104,9	A**, Bns, AxBns	7.0	10.6
Ca, g/kgDM	4,0	3,8	3,8	4,2	Ans, Bns, AxBns	ns	
P, g/kgDM	3,7	3,9	3,9	3,9	Ans, Bns, AxBns	ns	
DM, g/kg	205,7	352,0	193,3	363,3	Ans, B***, AxBns	18.5	28.0
pH	4,24	4,07	4,68	5,21	Ans, B***, AxB*	0,30	0,46
NH_3-N, %	1,3	2,2	1,0	1,7	A**, B*, AxBns	0,34	0,52
Acetic acid, g/kgDM	30,2	17,9	19,3	12,3	A**, B*, AxBns	5,7	8,6
Butyric acid, g/kgDM	38,9	4,2	7,0	4,1	A***, B***, AxB***	1,7	2,7
Lactic acid, g/kgDM	9,6	41,2	27,5	20,1	A***, Bns, AxB***	2,7	nz
Scores- classes (DLG)	16 (V)	47 (I)	36 (III)	37 (II)	-	-	-

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INTENSITY OF BIOCHEMICAL CHANGES IN ALFALFA SILAGES SUPPLEMENTED WITH ZEOLITE AND FORMIC ACID

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INTRODUCTION

Due to high buffer capacity and small quantity of fermentable sugars alfalfa cannot be ensiled alone, therefore in numerous experiments various solutions were determined such as: wilting, combining with plants that are easily ensiled, stimulation of lactic-acid souring by addition of carbon hydrate feeds and bacterial-enzymatic inoculants, etc. Recently, much attention is directed towards zeolites – additives from the group of mycotoxine adsorbents, since they reduce considerably toxic effect of metabolic products of mildew present in many feeds. Certain results of previous research indicated that zeolite had positive effect on quality of corn silages and silages of crude sugar beet pulp, in way that they bind moisture and improve the activity of bacteria causing lactic acid souring (Adamović et al., 2001; Koljajić et al., 2003).

MATERIAL AND METHODS

In the trial alfalfa from the fifth cut in stage of bud formation was used. Experiment was set according to scheme 2×2×2, and investigated factors were: A = content of dry matter (A_1 = 220.81 and A_2 = 357.23 g/kg); B = level of pressing (B_1 = 520 g/kg and B_2 = 380 g/kg) and C = type of conservation preparation (C_1 = formic acid, concentration 85%, dosage 5 g/kg of green mass, and C_2 = zeolite-organically modified mineral mycotoxine adsorbent ("Minazel Plus", dosage 2 g/kg of green mass). Applied dosage of zeolite was the same as in trial with corn ensiling (Adamović et al., 2001), where positive effect of this preparation on fermentation was established and production of mildew reduced.

RESULTS AND DISCUSSION

Souring and additive type significantly affected the quantity of dry matter (P<0.05) (Table 1). Treatments with addition of zeolite had significantly higher quantity of ashes which is consequence of use of mineral adsorbent zeolite. Quantity of lipids varied considerably under the influence of all three factors, which is difficult to explain considering numerous shortcomings of the method for determination of lipids by diethyl extraction (Barrnet, 1954).

Table 1. Chemical composition of alfalfa silage, g/kg DM

Parameters	A_1	A_2	B_1	B_2	C_1	C_2
DM, g/kg	201.06 b	320,66 a	262.68	259.04	272.92	248.80
Crude proteins	209.18	216.68	215.41	210.58	214.14	211.71
Crude fat	87.02 b	102.57 a	85.27 b	104.44 a	88.24 b	101.35 a
Crude fiber	210.08	207.26	207.94	209.41	208.47	208.87
BEM	355.34	335.11	352.99	337.46	352.75	337.70
Ash	138.37	133.41	138.64	133.14	131.42 b	140.36 a

a,b,c,d,e - Values in the same row with different letters are statistically different (P<0.05)

When formic acid was used as conservation preparation, considerably lower pH values were achieved in relation to treatments with zeolite (Table 2). High degree of formic acid dissociation enabled better souring, but values obtained in mentioned way (4.90) were too high for providing of stabile silage. Explanation should be searched for in high protein percentage, but also percentage of mineral substances which are carriers of alfalfa buffer capacity.

Souring of alfalfa has lead to intensifying of lactic acid production in absolute and relative sense, and to reduction of acetic and butyric acid, since lactic bacteria use water batter in conditions of increased osmotic pressure (Table 2). Lower degree of pressuring had positive effect on development of butyric bacteria. In silages with added zeolite intensifying of acetic and butyric fermentation occurred as well as reduction of products of lactic acid.

Significantly higher quantity of ammonium nitrogen as indicator of final degradation of protein was determined in silage treated with zeolite, more exactly in silage with considerably higher pH values (Table 2). Same silages had considerably higher quantities of soluble nitrogen, which is indicator of inadequate conditions of ensiling, firstly in regard to high pH values.

Based on quantity of ammonium nitrogen and relative ratio of lactic, acetic and butyric silage, with the use of DLG method, silages that were supplemented with formic acid were ranked highest (II class). Contrary, silages made of green alfalfa and silages with added zeoilte had average evaluation/rank of quality IV.

Dosage of applied zeolite of 2 g/kg of green mass had no effect on biochemical parameters of the alfalfa silage quality. Investigations must continue in direction of increase of zeolite dosage, since it is obvious that dosages applied for corn ensiling can not be used for alfalfa. There are results of similar trials but with simultaneous use of natural zeolite and carbon hydrate additives (Grubić et al., 2003).

Table 2. Biochemical changes in silages, g/kg DM

Parametri	A_1	A_2	B_1	B_2	C_1	C_2
pH	5.41	5.39	5.36	5.44	4.90 b	5.90 a
Lactic acid	47.39 b	55.74 a	52.33	50.80	61.18 b	41.94 a
Acetic acid	62.51 a	49.20 b	53.37	58.34	44.71 b	67.00 a
Butyric acid	2.80	1.95	3.77 a	0.98 b	0.00 b	4.75 a
Lactic acid/total acid ratio	0.42	0.52	0.48	0.46	0.58	0.37
NH_3-N, g/kg N	177.20	155.85	162.66	170.40	114.19 b	218.86 a
Soluble N, g/kg N	729.50	741.12	721.08	755.61	675.72	794.90
Quality class by DLG method	IV	III	III	III	II	IV

a,b,c,d,e - Values in the same row with different letters are statistically different ($P<0.05$)+

CONCLUSION

Based on obtained results the following can be concluded:

Application of formic acid as conservation preparation provides stabile silage only with souring, whereas application of zeolite in quantity of 2 g/kg of green mass had no effect on biochemical parameters of quality of alfalfa silages.

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NEW TECHNOLOGIES

IN FORAGE CONSERVATION

PICK UP TRAILERS IN PROCESSES OF FORAGE HARVEST

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ABSTRACT

Pick up trailers play an important role in processes of forage harvest for forage preservation with drying to hay or in processes of swath-made straw harvest. Newly developed pick up trailers equipped with robust feeding mechanism and cutting mechanism enable cut all collected matter to theoretically 40 mm size green chaff. This fact makes pick up trailers useful in harvest of forage for forage preservation with haylage and ensilage. In the contribution, the results of pick up trailers monitoring during the forage harvest and the comparison of their technical and economical parameters with forage harvester are presented.
Key words: Pick up trailers, forage harvest, technical and economical parameters, forage harvester

INTRODUCTION

For achievement of high-quality harvested forage is essential quickness of harvesting. This factor is playing important role mainly in the first year harvesting of forage. Delay in a time of harvest leads to losing of quality harvested material. With delay or extension for just two weeks can be lost more than 1 MJ NEL/kg of dry matter. (Buchgraber 1998). For catching of potential quality of forage, is necessary to harvest it in a short time. This is possible to make for example by technology of haylage to the manger with using pick up trailers or forage harvester. Newly developed pick up trailers equipped with robust feeding mechanism and cutting mechanism enable cut all collected matter to theoretically 40 mm size green chaff can be comparable with forage harvest not just in efficiency but in quality of cutting material.

The aim of our research is find out if pick up trailers with theirs specific property, represents effective procedure of forage harvest. Pick up trailers, for forage harvest, were studied from efficiency and economical point of view. The results of these measurements were published recently. In this contribution are represented results of measurements some others qualitative parameters eg. size of green chaff, quality of haylage or energy audit of cutting.

MATERIALS AND METHODS

Achievements were determined by the norm ČSN 470120. Based on time segment and known amount of processed material is determined effective efficiency W1 and operative efficiency W02. Turning moment and rotational speed were measured on tractor power take-off by the sensor for turning moment and rotational speed and data was stored in measure. Tractor used for measurements CASE 5150. For comparability of results was unit achievements choose as 50 t/h for on-loading. For determinate of degree of cutting, the size of green chaff, was divided in to categories according the length of chaff. In the case of material after cutting was chaff divided by the length 10mm till overall length was 200 mm. Up to 200 mm 100 mm criteria were used. In uncut material 100mm criteria was used. All length categories were weigh, their portion on overall weight of the sample was determined and weighted average was calculated. For determined of quality of cutting the chaff was divided to the length groups 0-40 mm, 41-80 mm 81-160 mm and longer than 160 mm. Weight of the row was determined by weight of 10m of the row. Dry matter in the row was measured too. Compression of material in a manger was measured by 1.20 m long and 50 mm caliber probe. In each sample was measured weight and analysis of the dry matter, crude proteins, crude fibre, ash matter, digestible protein minerals, pH and fermentation acides. Capacity utilization of the manger was measured by measuring of the highs, width and overall length of the manger in different level.

RESULTS AND DISCUSSION

Values of compression of the material in the manger after end of preservative procession are showed in Table 1. Haylage was done by wheel loader (12 t).

Table 1. Capacity utilization of the manger (kg dry matter.m^{-3})

	forage harvester theoretic length of the chaff 17 mm kg/m'	pick up trailer theoretic length of the chaff 34 mm kg/m'	pick up trailer theoretic length of the chaff 42 mm kg /m'
manger A	193		
manger B	194		
manger C		210	
manger D			177

Values are between 177 – 210 kg/m^3. According to methodology has to be this value at least 150 kg/m^3. Very big value 210 kg/m^3 was achievement by using pick up trailer with theoretical length of chaff 34 mm. This value is enabling due to using so heavy tamping machine, but first of all relatively small level of the matter produced by dosage roll.

Analysis of the matter according to the length of chaff

Length of chaff was measured evaluated for forage harvester with theoretical length of chaff 17 mm, pick up trailer with theoretical length of chaff 34mm and pick up trailer with theoretical length of chaff 90 mm. When was used pick up trailer long chaff (teor. length 90 mm) just 16 % of sample weight was found in region under 80 mm. For pick up trailer with shorter chaff (34 mm) was found that 67 % of sample weight lay under value of 80 mm and for forage harvester (17 mm) is the value biggest 81% of sample weight. Big differences is in length category to 40mm (forage harvester of 60 % sample weight, pick up trailer 32 % of sample weight).

Table 2. Effective and operative efficiency

Pick up trailer	Loading time	Weight of harvested matter	Moisture of harvested matter	Weight recalculated on the 100%dry matter	Efficiency W1	W1	W02	W02
	[s]	[kg]	[%]	[kg]	[kg/s]	[t/h]	[kg/s]	[t/h]
Rapid 130	790,8	9110	74,5	122,28	0,155	0414	0,132	0.475
ROYAL 28 S / 2. 66 100	560,4	8490	63	134,76	0,241	0.867	0,145	0.522
SUPER VITESSE	364,8	5730	63,5	90,236	0,247	0.890	0,212	0.756
GREEN-Trans L-16000	1569	9430	43,7	215,79	0,138	0.470	0,115	0.414
745	492,6	9590	63	152,22	0,309	1.112	0,276	0.993
SP3-340.2 EXPERT	445,8	3070	52,3	58,70	0,132	0.475	0,094	0.338

Table 3. Working speed of pick up trailers during harvesting of forage on the distance of 100 m

Pick up trailer	Time for run over 100m [s]	Working speed [m/s]	Working speed [km/h]
Rapid 130	41,19	2,43	8,75
ROYAL 28 S / 2. 66 100	32,63	3,06	11,02
SUPER VITESSE	41,99	2,38	8,57
GREEN-Trans L-16000	41,59	2,40	8,64
745	49,26	2,03	7,31
SP3-340.2 EXPERT	41,60	2,40	8,64

Average working speed was measured and acquired data are shown in Table 5. The best effective efficiency had pick up trailer Mengele 745. Efficienci 1.112 t/h with 100% dry matter corresponds to the efficiency of 55.6t/h with 50% dry matter. The highest working speed had pick up trailer ROYAL 28 S / 2. 66 100.

Table 4. Pick up trailer: SCHUITEMAKER RAPIDE 130

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	7,6 - 9,5	8,8
Efficiency	t/h	50,9 - 63,6	58,3
Turning moment	Nm	325,0 - 438,0	382,9
Power requirement	kW	32,9 - 41,6	36,2
Idle run - Turning moment	Nm		19,4
- Power requirement	kW		1,9
Average power requirement on one cutter	kW		1,06
Average length of chaff	Mm		71

Table 5. Pick up trailer: BERGMANN ROYAL 28 S

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	7,0 - 9,2	8,1
Efficiency	t/h	46,9 - 61,6	54,3
Turning moment	Nm	294,6 - 473,7	373,3
Power requirement	kW	29,5 - 42,6	35,6
Idle run- Turning moment	Nm		31,7
	kW		3,3
Average power requirement on one cutter	kW		0,87
Average length of chaff	Mm		68

Table 6. Pick up trailer: STRAUTMANN SUPER VITTESSE

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	7,1 - 8,7	7,3
Efficiency	t/h	48,3 - 59,2	49,6
Turning moment	Nm	240,5 - 349,4	311,6
Power requirement	kW	24,2 - 34,3	30,6
Idle run- Turning moment	Nm		21,5
	kW		1,5
Average power requirement on one cutter	kW		0,83
Average length of chaff	Mm		69

Table 7. Pick up trailer: KEMPER GREEN - TRANS L - 16000

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	6,2 - 9,2	7,4
Efficiency	t/h	49,1 - 71,8	57,7
Turning moment	Nm	360,0 - 465,0	425,6
Power requirement	kW	33,8 - 43,2	39,9
Idle run- Turning moment	Nm		23,1
	kW		2,2
Average power requirement on one cutter	kW		0,97
Average length of chaff	Mm		72

Table 8. Pick up trailer: MENGELE 745

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	6,6 - 8,3	7,3
Efficiency	t/h	51,5 - 64,7	56,9
Turning moment	Nm	329,6 - 438,0	382,9
Power requirement	kW	30,9 - 41,6	36,2
Idle run- Turning moment	Nm		23,8
	kW		2,2
Average power requirement on one cutter	kW		0,95
Average length of chaff	Mm		68

Table 9. Pick up trailer: SP3-340.2 EXPERT

Characteristic	Unit	Measured value	Average value
Specific length row weight	kg/m	5,4 - 9,0	7,8
Efficiency	t/h	42,1 - 70,2	60,8
Turning moment	Nm	395,1 - 467,7	426,2
Power requirement	kW	37,6 - 44,1	40,3
Idle run- Turning moment	Nm		27,6
	kW		2,7
Average power requirement on one cutter	kW		1,00
Average length of chaff	Mm		74

It was found that pick up trailers used in this test have comparable parameters. Differences between these pick up trailers are minimal as shown in Table 10.

Similarly as for energy audit there are no important differences for tested pick up trailers in length of material after cutting as is shown on degree of cutting in Table 11.

Table 10. Specific energy consumption for on-loading and cutting of haylage.

Pick up trailer	Specific power drain	
	On weight unit of the matter (kWh/t)	*On weight unit of the matter recounted to the one cutter* (kWh/t)
Schuitemaker Rapide 130	0,62	0,018
Bergmann Royal 28 S	0,65	0,016
Strautmann Super Vittesse	0,62	0,018
Kemper Green-Trans L-16000	0,69	0,017
Mengele 745	0,64	0,017
SP3-340.2 Expert	0,66	0,017

Table 11. Degree of cutting

Pick up trailer	Degree of cutting[1)]
Schuitemaker Rapide 130	0,14
Bergmann Royal 28 S	0,14
Strautmann Super Vittesse	0,14
Kemper Green-Trans L-16000	0,15
Mengele 745	0,14
SP3-340.2 Expert	0,15

[1)] Degree of cutting is ratio between average length of material after cutting and before.

CONCLUSION

If is possible use different harvest procedure is economically profitable to used pick up trailer with medium loading volume for worked distance to 3km, with large loading volume for worked distance from 3 to 7 km. Only for bigger distance (up to 10km) can forage harvester apply its fast working efficiency. Technology using of forage harvester is characteristic with high efficiency 5-7 ha/h. But this methodology is more exacting for work organization. For simpler work organization, costs and quality of product on the small to middle work distances (3-7km) is become very interesting using pick up trailers. Some disadvantages of this methodology is necessity used strong tractor (150kW and more) for pic up trailers with loading volume about 78 m3 (corresponding to the loading volume DIN 50 m3). But this can be solved by using of smaller pick up trailers with efficiency about 2.5ha/h. In this cases can be used tractor with power 100 – 120 kW. Another disadvantages is a weight pick up trailer set (more than 22t) which can be unused in some cases on some field.

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EFFECT OF USING ADDITIVES, HERBAGE WILTING AND DIFFERENT CROPS ON QUALITY OF BIG BALE SILAGE

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ABSTRACT

Big bale silage making technology has become popular among the farmers. However, the silage quality of big bale is often poor. The aim of the present study was to investigate the effects of additives, herbage wilting and different crops on quality of big bale silage. The silage crops were fresh cut and wilted red clover-grass mixture and fresh cut ryegrass. The crop was cut by a mower conditioner, baled by John Deere baler and wrapped into the plastic by McHale wrapping machine. The additives used were chemicals AIV-2000 and Niben, each added at an application rate of 4 l/t fresh matter. The airtight conditions in bales were determined by using special Ekolag AB equipment. Application of additives improved fermentation and silage quality. The silage quality was also improved when the crop was wilted. The airtight conditions in bales varied to a great extent. Ryegrass resulted in better silage quality compared to red clover-grass mixture.

Keywords: big bale silage, silage quality, fermentation, additive, wilting

INTRODUCTION

Considering the real climate conditions, silage is the best method for preserving fresh forage with minimal losses in Estonia. When the proper ensilage techniques are used, silage will have a high nutritive value and hygienic quality. However, the results in practice indicate that the quality of silage is often poor or even unsatisfactory. These results are usually achieved when the fermentation conditions are difficult or varying such as in big bales or when long-cut herbage is used. The main reason why the fermentation conditions in the bale are difficult is that the air can easily leak into the silo. Bale silage is usually made of non-chopped or restricted cut grass. Such kind of herbage may be difficult to ensile due to delay in fermentation or material heterogeneity. It is also difficult to achieve sufficient density of silage and mix additive in such material. Herbage wilting can improve fermentation conditions but the risk for fungi growth even increases. Certain crops, such as legumes or legume-grass mixtures, do not easily wilt and the silage may remain heterogeneous (Lättemäe et al., 1998).

The results have shown that silage additives can be effective under difficult and variable fermentation conditions and may reduce these adverse effects of silage crop (Lättemäe, 2001). In Estonia, the liquid silage additives Siloben and Superben are available. Both are based on sodium-benzoate (NaB). The results in practice have shown that these additives improve silage quality and increase aerobic stability. However, when fermentation conditions are difficult as in big bale, the additives are less effective. To increase the efficacy of additives, sodium nitrite ($NaNO_2$) should be used to reduce clostridial activity. The $NANO_2$ produces gases that inhibit clostridial activities even at high pH- values. In this study NaB was used in combination with $NaNO_2$ (Niben). The second additive was AIV-2000, containing formic acid, ammonium formate and esters of benzoic acid.

MATERIALS AND METHODS

The field of red clover-grass mixture where experiment was conducted consisted of about 30% of red clover and 70% of grasses (about 10% of perennial ryegrass, 55 % of meadow fescue and 5% of timothy). The ryegrass field consisted of about 95% of perennial ryegrass. Silage crop was harvested by a mower conditioner and baled by a John Deere baler (6 June 2002). Baler was provided with a passive chopper, resulting in herbage being chopped into length measuring from 5 to 20 cm. Silage was made of direct cut red clover-grass mixture and wilted mixture being wilted for 5 hours in the field. Ryegrass silage was made of direct cur herbage. All bales were wrapped with a McHale wrapper (0,025 mm plastic film, four layers). Niben and AIV-2000 were each added at an application rate of 4 l/t fresh matter and the treatments were conducted in four replications. A total of 36 bales were ensiled.

The airtight conditions in bale were determined by using special Ekolag AB equipment. This equipment enables to measure under- and overpressure in the bale. The timing is regarded to be as a base for airtight estimation.

The chemical composition of fresh red clover-grass mixture before ensiling was as follows: dry matter (DM) 327 g kg^{-1}, crude protein (CP) 149 g kg^{-1} DM, crude fibre (CF) 205 g kg^{-1} DM, crude ash 82 g kg^{-1} DM. The chemical composition of ryegrass: DM 308 g kg^{-1}, CP 132 g kg^{-1} DM, CF 199 g kg^{-1} DM, crude ash 74 g kg^{-1} DM. Herbage in bales was ensiled for three months, after which samples were taken for chemical and microbial analyses.

RESULTS AND DISCUSSION

The results of analyses are presented in Tables 1 and 2. By the results the silage quality was rather good. In most cases treatments did not contain butyric acid and the concentration of ammonia was low. In most treatments the aerobic stability (5.3 - >7 days) as well as microbial composition was also good (data not shown). However, there were significant differences in chemical composition between treatments. The silage quality of red clover-grass mixture was dependent on the use of additive and herbage wilting. The lowest quality of silage was obtained when the fresh cut mixture was ensiled without additive (average DM 295 g kg^{-1}). This treatment contained approximately of 3.0 g kg^{-1} DM butyric acid and the ammonia concentration was the highest one. Both additives AIV-2000 and Niben reduced clostridial fermentation and protein degradation, whereas Niben was more effective (Table 1).

Herbage wilting (average DM 409 g kg^{-1}) improved fermentation conditions and reduced proteolysis. The butyric acid concentration of untreated silage was 0.9 g kg^{-1} DM. As for the results it was expected that in high DM concentration the fermentation was inhibited. Therefore, the risk of clostridial fermentation is also low.

The ryegrass silage quality was also dependent on the use of additive (Table 2). The results were similar to the ones of red clover-grass silage. However, the average silage quality was higher, obviously due to better fermentation properties of ryegrass.

By the results the air-tightness between separate bales varied to a great extent. It is regarded to be a good air-tightness of bale when the under-pressure in bale declines from 200 Pa down to 150 Pa not less than for 60 seconds. Despite the fact that visible plastic damage was not found, the most results were poor or only satisfactory (data not shown). The air linked into the silo probably trough plastic layers or invisible damage. However, as the analysis showed, the silage quality of specific treatment was not related to air-tightness of silo.

Table 1. The chemical composition of red clover-grass silage depending on the use of additive and herbage wilting (6 June 2002). Red clover-grass mixture was cut by a mower conditioner Kuhn, baled by a John Deere baler and covered with plastic by a McHale wrapping machine (4 layers, white plastic film). Silage was made of fresh cut crop and wilted crop (wilted for 5 hours in the field)

Treatment	Dry matter (DM) g kg^{-1}	Crude protein g kg^{-1} DM	Crude fibre g kg^{-1} DM	pH	Amn. N, % total N	Butyric acid g kg^{-1} DM
Fresh-cut crop						
Untreated control	294	150	211	5.3	6.2	3.0
AIV-2000, 4 l/t	296	145	198	5.0	5.6	2.4
Niben, 4 l/t	296	142	196	5.1	3.9	0.2
Mean	295	145	195	5.1	5.1	1.9
$LSD_{0.05}$	48.9	14.9	15.0	0.43	0.99	2.0
Wilted crop						
Untreated control	394	144	208	5.5	3.5	0.9
AIV-2000, 4 l/t	418	144	217	5.2	3.1	0.0
Niben, 4 l/t	415	136	210	5.4	2.2	0.0
Mean	409	141	212	5.3	2.9	0.3
$LSD_{0.05}$	42.1	12.1	15.2	0.26	1.2	0.9

Table 2. The chemical composition of ryegrass silage depending on the use of additive (6 June 2002)

Treatment	Dry matter (DM) g kg^{-1}	Crude protein g kg^{-1} DM	Crude fibre g kg^{-1} DM	pH	Amn. N, % total N	Butyric acid g kg^{-1} DM
Fresh-cut crop						
Untreated control	289	132	200	5.4	5.2	2.5
AIV-2000, 4 l/t	350	136	198	5.5	3.3	0.0
Niben, 4 l/t	366	133	210	5.7	2.3	0.0
Mean	335	134	202	5.5	3.6	0.8
$LSD_{0.05}$	36.9	9.6	10.4	0.29	0.95	0.96

$LSD_{0.05}$ –Least significant difference at the probability level of 5%, n=3
Niben –Chemical additive, based on sodium benzoate
AIV-2000 –Chemical additive, based on formic acid

CONCLUSIONS

The results showed that application of additives improved fermentation and quality of big bale silage. The quality was also improved when the herbage was wilted in the field. There was interaction effect of using additive and herbage wilting. Better silage quality is also expected when easily fermented grasses will be used. The airtight conditions in bales varied. However, as there were no visible damages of plastic film, the reason of that remained obscure. The air can leak into the silo through plastic layer or due to invisible plastic damage. When the silage density is low, air influx into the silo is expected as well.

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GRASS SILAGE IN AGBAG SAUSAGE OR ROUNDBALES

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INTRODUCTION

The AgBag Silotuber has high capacity, and can produce silage from crop with different chopping lengths, that are harvested with different harvesting machines. The method has no system for collection of silage effluent. Wet crops may cause problems, since effluent will be squeezed out from the sausage simultaneously, and at the same place where new crop is fed into the sausage. Like for roundbales, the AgBag method requires no fixed plant on the farm, so farmers using contractors may choose between these systems for silage making.

The aim of this study was to compare the fermentation quality of grass silage in AgBag sausage with the quality of roundbale silage. The effect of different chopping lengths for crops to be ensiled in sausages was also studied, and the effect of a formic acid based additive for grass silage in AgBag sausages and roundbales.

MATERIALS AND METHODS

A meadow fescue/timothy grass crop was harvested at August 15, 2001, after wilting for one day, to 300-380 g/kg dry matter (DM). Two AgBag sausages, each of them 15 m long, and with 2.40 m diameter, were used, whereas the normal length for a sausage is approximately 60 m. The first AgBag sausage was filled with grass harvested with a self loading wagon (Krone Titan 4/25), and the crop for the first half of this sausage was treated with a formic acid based additive (GrasAAT, Norsk Hydro, Oslo, Norway, 4 L/t (645 g/kg formic acid, 60 g/kg NH_3)). The second sausage was filled with precision chopped grass (Taarup 602 B), and the last half of the crop was treated with the same additive. Six roundbales (Welger 220 RP Profi with 23 fixed knives), three untreated and three additive treated, were baled when the first sausage was filled, and another six bales, three untreated and three additive treated, were baled when the last sausage was filled. In total 30 tonnes of crop was ensiled in each sausage, and in total 10.5 tonnes in the 12 roundbales. Median chopping length, which indicates that a half of the harvested mass was chopped shorter, and a half of it was chopped longer, was measured to be 107 mm for the crop harvested with the self loading wagon and 33 mm for the precision chopped crop. Six silage samples, three from treated and three from untreated crop, were taken from each sausage, and one sample was taken from each roundbale.

RESULTS AND DISCUSSION

Both the AgBag sausages and the bales were stored at the grass turf. Mainly rhodents, but also birds, damaged the plastic cover of the sausages and the bales repeatedly during the autumn and the winter. The affected areas were repeatedly taped. At the time the two sausages were initially produced, the grass in the final ends was not squeezed together with the same strength as the grass in the beginning of each sausage. This made the final ends less dense, and consequently more susceptible to detrimental processes caused by air leakage when the plastic cover was damaged. When the silage was opened in April 2002, it was evident that rats had used the final end of the second sausage (precision chopped, untreated grass) as their winter residence. Wasted silage, as a proportion of harvested mass, was for crop harvested by the self loading wagon 3 and 89 g/kg for treated and untreated grass, respectively. From the precision chopped crop ensiled in AgBag sausage, 136 g/kg of the treated, and 629 g/kg of the untreated silage was wasted. From the roundbales, 64 g/kg of treated silage and nil of the untreated silage was wasted.

Samples for silage analyses were taken only from silage that appeared to be well preserved, and that was fed to cattle. The fermentation quality of the silage is presented in Table 1. The effect of different chopping lengths, and of sausages versus bales, is presented in Table 2. The silage was in general well fermented, with a low concentration of fermentation acids and a high concentration of water soluble carbohydrates (WSC). Only traces of propionic acid, and no butyric acid were detected. The concentration of ammonium-N and of ethanol, however, was somewhat higher than desired. No significant differences were found in fermentation quality between silage harvested with the self loading wagon or the precision chopper, in spite of clear differences between the two techniques in chopping lengths of the grass.

Roundbale silage contained more WSC and less acetic acid and ethanol than silage from the AgBag sausages. Roundbale silage was therefore considered to be slightly superior, although the AgBag silage was also well fermented.

Formic acid treated silage contained more WSC, and less lactic acid, acetic acid and ammonium-N than untreated silage, irrespective of storage in AgBag sausage or roundbales. The effect of formic acid treatment was greater than expected, the relatively high DM concentration of the crop taken into consideration. There were no interaction between additive treatment and the silage storage method.

CONCLUSIONS

Due to damage by rhodents, the proportion of wasted mass of the untreated, precision chopped silage was unacceptably high. This problem should, however, not totally be attributed to the AgBag system. The storage of the sausage at the grass turf in the field, and the poor compaction of the silage mass in the final end of the sausage may have contributed to the attack, and to the serious result of the plastic damage. With normal length of the AgBag sausage, 60 m in contrast to 15 m in this study, the wasted mass would have made up a smaller proportion of the ensiled crop. Anyway, the study shows that plastic is an insecure cover for silage, and that the final ends of AgBag sausages are points that are exposed to damage. Short chopping length of the crop is usually an obvious advantage in silage making, because it improves the compaction of the mass and the silage quality. In this study the densities of the two sausages were similar, which suggests that the pressing tool of the AgBagger was strong enough to make the method independent of good cutting systems in the harvesting machines. However, cutting systems will facilitate the emptying of the sausage, and increase silage intake. The need for additive treatment of silage crops relates to the DM concentration, and other characteristics of the crop, and to a lesser extend to the choice of silage system.

Table 1. Fermentation quality of untreated and additive treated grass silage from AgBag sausages or roundbales

	Crop harvested at 10.30-17.10				Crop harvested at 18.50-22.20				SEM
	Self loading wagon AgBag sausage		Roundbales		Precision chopped AgBag sausage		Roundbales		
	Un-treated	GrasAAT 4.01 L/t	Un-treated	GrasAAT 4.36 L/t	Un-treated	GrasAAT 4.22 L/t	Un-treated	GrasAAT 4.10 L/t	
No. of samples	3	3	3	3	3	3	3	3	
DM, g/kg	300	363	307	345	336	361	384	377	10.1
<u>g/kg DM</u>									
Crude protein	119	105	114	114	118	111	107	108	4.2
WSC	76	189	109	217	115	169	189	206	22.3
NDF	559	549	557	549	540	542	536	547	10.0
Lactic acid	62	46	73	34	65	42	52	29	6.2
Formic acid	0.3	4.1	0.1	6.1	1.6	6.0	0.0	5.2	0.9
Acetic acid	13.5	8.0	10.9	5.0	12.9	10.6	9.3	4.6	1.1
Total acids	76	60	84	45	80	58	61	39	6.7
Ethanol	20.9	27.0	18.2	10.4	25.7	14.0	11.1	12.3	4.8
NH_3-N, g/kg TN[1]	87	99	105	107	91	105	90	98	4.4
NH_3-N, g/kg TN[2]	87	71	105	77	91	77	90	71	5.2
pH	4.19	4.08	4.05	4.20	4.12	4.09	4.29	4.38	0.06

[1] As analyzed
[2] Corrected for NH_3-N derived from the silage additive

Table 2. Effect of different chopping lengths of the grass crop for AgBag sausage, and of sausage versus bales

	AgBag sausage		Round-bales	Chopping lengths		AgBag vs. roundbales	
	Selfloading wagon	Precision chopped		SEM	***P***	SEM	***P***
No. of samples	6	6	12				
DM, g/kg	332	349	353	7.0	NS	4.9	0.07
<u>g/kg DM</u>							
Crude protein	112	114	111	3.5	NS	2.0	NS
WSC	133	142	180	20.4	NS	10.9	0.01
NDF	554	541	547	9.2	NS	4.9	NS
Lactic acid	54	54	47	4.8	NS	3.2	NS
Formic acid	2.2	3.8	2.9	0.7	NS	0.4	NS
Acetic acid	10.7	11.7	7.4	1.0	NS	0.6	<0.001
Total acids	68	69	57	5.4	NS	3.4	0.03
Ethanol	24.0	19.9	13.0	4.7	NS	2.6	0.02
NH_3-N, g/kg TN[1]	93	98	100	3.8	NS	2.2	NS
NH_3-N, g/kg TN[2]	79	84	86	3.5	NS	2.5	NS
pH	4.13	4.10	4.23	0.06	NS	0.03	0.02

[1 2] See Table 1

JOINT GROWING AND SILAGE MAKING OF MAIZE WITH SORGHUM AND EVALUATION OF MIXED SILAGES

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SUMMARY

The authors studied certain early maturing (290-350), medium maturing (FAO 350-450) and late maturing (> FAO 450) maize hybrids (12), grown alone and jointly (2x2) with Sucrosorgo silage sorghum (1 hectare per each hybrid). Based on the results the authors found that Vasalica, LG2470 and Coralba are maize hybrids which grown alone or jointly with Sucrosorgo silage sorghum (2x2) equally produce good results in green, dry matter and energy yields. We also highlighted Geyser and LG 2483 as maize hybrids with excellent results, but in their case pairing with sorghum is highly recommended. The maize hybrids SZETC 465, DK 527 and DK 557 however, yield good results grown on their own only, i.e. they do not tolerate the presence of silage sorghum. Where drought can be expected during the July-August period, the available acreage is limited or crop conditions are not ideal for any other reason, it is recommended to grow maize hybrids which perform well with sorghum and produce together a large green and dry matter yield safely. Where no such limitations exist, maize and the higher energy yielding maize hybrids sown on their own are more important. In this case the primary task is not simply providing a feed basis, but to improve the performance of animal nutrition, and of animal product production.

INTRODUCTION

The basis of ruminant nutrition is high quality forage rich in structural fibre. Our key forage crop is silage maize, in arid regions, however, the joint growing of maize and sorghum is increasingly important. The reason is, that sorghum varieties tolerate well the various ecological stresses (late spring, drought, soils of poor fertility or structure, late sowing) (Harangozó, 1988). The joint growing of maize and sorghum varieties has several advantages in respect of yields, safety of production, and fermentability of the green crop, the nutrient content of the mixed silage, however, is poorer than that of maize silage (Avasi, 2001, Avasi et al, 2000, Bocz, 1993, Schmidt, 1993, Woolford, 1984). The basis of realizing the complementary qualities of the two crops and of the successful joint growing and preservation is the suitable pairing of hybrid varieties.

MATERIALS AND METHODS

The authors tested in the autumn of 2002 at the Experimental and Pilot Farm of Szent István University at Józsefmajor 12 maize hybrids grown alone and jointly (2x2) with Sucrosorgo silage sorghum (1 hectare per each hybrid alone and with sorghum, respectively). The authors studied early maturing (290-350), medium maturing (FAO 350-450) and late maturing (> FAO 450) maize hybrids. The harvest was carried out in medium stage of maturing of maize in the joint growing, when the corn-sorghum mixture achieved at least the 25%DM content. The crude protein, crude fat, crude fibre, crude ash and energy content of the silage maize plant and maize-sorghum mixture were analysed according to the Hungarian National Standards (Hungarian Feed Codex, 1994). The green-, dry matter-, crude and metabolisable protein- , crude fibre-, crude fat and energy yield per ha of silage maize plant and maize-sorghum mixture were measured and calculated. The green-, dry matter- and net energy yield per ha were the main parameters for the evaluation and ranking. The preservation and storage were carried out in plastic tubes (60 m long with diameter of 3,0 meters and 0,27 mm thickness, Ag-Bag type plastic) in large scale circumstances. The Amity SP M10 type machine was used for pressing of the green mixture into the plastic tube. In the experiment 3 tubes were filled: 6 different maize hybrids with sorghum in the 1st tube (approximately 40 t/mixture), another 6 different maize hybrids with sorghum in the 2nd tube (approximately 40 t/mixture), and 12 maize hybrids (the same maize hybrids as in the mixtures) alone in the 3rd tube (approximately 20 t/maize hybrid). The changes of the pH, the lactic- and volatile fatty acid content were measured to control the fermentation process.

RESULTS AND DISCUSSION

The green yield of the maize-sorghum mixtures (33-44 t/ha) was higher with 40-120% compared to maize hybrids sown on their own (18-29 t/ha). The relative deviation of the green yield of the maize hybrids sown alone was higher than of the mixtures (maize hybrids alone: 13%; maize and sorghum mixtures: 7%, respectively). These data show that the maize-sorghum joint growing provides higher yield in a safe way compared to the maize hybrids sown in their own. The results of dry matter yield per ha were not so homogenous. In 3 cases (Vasalica, DK 527 és Szetc 465) the maize hybrids sown in their own provided higher dry matter yield than the same hybrids with sorghum. Presumably, owing to the high dry matter content (Vasalica: 42 DM%, DK 527:42 DM% és Szetc 465: 47DM%) of the hybrid maize. In the case of Coralba, the dry matter yield of the maize hybrid and the mixture were similar to each other, although there was big difference in green yield (1st table). In the left 9 cases (1st table) the joint growing provided higher dry matter yield than the maize hybrids alone (with 7-51%). Considering the lactation net energy yield per ha the authors found: in 3 cases (LG 2483, DK 366, Maxima) the joint growing provided the higher results compared to maize alone, in one case (Káma) there was no considerably difference between the maize and the mixture, while in 8 cases the maize hybrids grown alone provided better results (higher net energy yield per ha) compared the maize-sorghum mixtures (+7-32% of NEl/ha)

Table 1. The green-, dry matter-, lactation net energy and crude protein yield per ha of the different maize hybrids grown alone or with sorghum

Maize hybrids	Green yield (t/ha)		Dry matter yield (t/ha)		Net energy yield for lactation (GJ/ha)		Crude protein yield (t/ha)	
	With sorghum	Without sorghum	With sorghum	Without sorghum	With sorghum	Without sorghum	With sorghum	Without sorghum
LG2483	42,2	23,1	11,0	8,3	63,2	52,4	726,6	665,9
LG2470	44,4	27,4	11,1	10,4	61,9	67,9	816,3	736,0
GEYSER	41,5	24,4	11,3	10,2	62,1	66,7	871,9	687,8
VASALICA	40,5	27,2	11,0	11,3	61,0	75,5	701,2	893,2
CORALBA	41,6	29,2	10,8	10,7	60,6	71,2	756,1	742,4
DK 527	38,8	25,2	10,3	10,5	57,4	69,9	870,7	711,9
DK 523	39,4	23,2	10,5	9,5	59,3	63,5	790,1	733,7
DK 557	39,4	27,3	10,7	10,3	59,1	68,0	634,0	712,9
DK 366	39,2	17,5	10,8	7,2	60,3	47,7	814,8	639,0
MAXIMA	39,1	21,4	10,1	8,0	56,7	53,0	726,6	572,8
KÁMA	36,7	22,0	10,2	8,4	56,5	56,6	716,4	588,1
SZETC 465	33,3	23,5	9,0	11,0	49,5	73,2	653,8	771,1

Based on the results the authors ranked the maize hybrids and selected the 5 maize hybrids which provided the best results (green, dry matter- and lactation net energy yield per ha) sown alone and with sorghum (2nd table). The authors found that Vasalica, LG2470 and Coralba are maize hybrids which grown alone or jointly with Sucrosorgo silage sorghum (2x2) equally produce good results in green yield. The LG 2470 and Vasalica provided good results in the case of dry matter yield grown both alone and jointly, also. Considering the energy yield per ha, the Vasalica and LG 2470 were also in the top 5 grown in their own or with sorghum. Therefore Vasalica, LG2470 and Coralba are maize hybrids which grown alone or jointly with Sucrosorgo silage sorghum (2x2) equally produce good results in green, dry matter and energy yields. We also highlighted Geyser and LG 2483 as maize hybrids with excellent results, but in their case pairing with sorghum is highly recommended. The maize hybrids SZETC 465, DK 527 and DK 557 however, yield good results grown on their own only, i.e. they do not tolerate the presence of silage sorghum.

Table 2. The top 5 of maize hybrids and maize-sorghum mixtures considering the green-, dry matter- and lactation net energy yield per ha grown alone or with Sucrosorgo silage sorghum (2X2)

Rank	Green yield, t/ha		Dry matter yield t/ha		Net energy yield, NEl GJ/ha	
	Maize-sorghum	Maize alone	Maize-sorghum	Maize alone	Maize-sorghum	Maize alone
1.	***LG2470***	**CORALBA**	GEYSER	**VASALICA**	LG2483	***VASALICA***
2.	LG2483	***LG2470***	**LG2470**	SZETC 465	GEYSER	SZETC 465
3.	**CORALBA**	DK 557	LG2483	***CORALBA***	***LG2470***	**CORALBA**
4.	GEYSER	**VASALICA**	***VASALICA***	DK 527	***VASALICA***	DK 527
5.	VASALICA	DK 527	DK 366	LG2470	***CORALBA***	DK 557

CONCLUSIONS

Where drought can be expected during the July-August period, the available acreage is limited or crop conditions are not ideal for any other reason, it is recommended to grow maize hybrids which perform well with sorghum and produce together a large green and dry matter yield safely (Vasalica, LG2470, Coralba, LG 2483 and Geyser). Where no such limitations exist, maize and the higher energy yielding maize hybrids sown on their own are more important (Szetc 465, Vasalica). In this case the primary task is not simply providing a feed basis, but to improve the performance of animal nutrition, and of animal product production.

RELATION BETWEEN CROP DM, CROP MATURITY, ROUNDBALE SYSTEM, BALER SPEED AND BALE DENSITY COMPARING A FLEX- AND A FIX CHAMBER BALER

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INTRODUCTION

Magnus Ohlsson and Daniel Wilsson conducted this study as part of the University Diploma program of Agricultural and Rural Management.

The aim of this study was to measure the effect of bale density (kg DM/m^3) and bale losses in relation to crop DM, crop maturity, type of round baler and baler speed.

MATERIAL AND METHODS

A flex chamber baler (New Holland 658) and a fix chamber baler (Claas 255) were compared in an experiment covering

- Two crops – first cut and second cut differing in fibre content / maturity
- Two speeds – 6 and 8 km per hour in the first and 8 and 10 km per hour in the second cut

In both harvests the grass were mowed in order to wilt at least one day before baling. The baling started with the low speed treatment. These bales were then moved to the storage area for wrapping, weighing and measuring. This was done within 2 hours from baling. Due to weather conditions the DM-level were lower in the first cut than in the second cut. All bales had 8 stretch film layers.

The flex chamber baler had straps which starts the compression as soon as the grass gets in to the baler. For cutting the grass there were 7 fixed knives in the bottom of the baling chamber and the forage were cut when rotating. The knives were not in use in the outer layers of the bale. The baler was powered by a 70 kW tractor

The fix chamber baler had a fixed chamber of rolls except of two rolls which in the beginning of the baling process were swinged into the chamber starting the compaction earlier. The main compaction were still when the bale chamber was filled. For cutting the baler had a rotor with 14 knives which fed the forage into the baling chamber. The baler was powered by a 100 kW tractor.

RESULTS AND DISCUSSION

All bales (80 pcs) are included in the result. Four bales indicated small leakage and one was considered as not airtight.

The bales in the first cut had an average of 170 kg DM per m^3 with 398 g/kg DM content. In the second cut the average DM was 531 g/kg which made it possible to produce bales with 227 kg DM per m^3. This difference was significant

When looking at the balers the only significant difference between them was at low speed in the second cut where the flex chamber baler produced heavier bales. Other studies have shown greater difference between balers. Looking closely into the results the Fix-baler has a constant DM density in the same crop and this does not change with speed or DM content. The Flex-baler produce bales with higher DM density from the first to the second cut and when the DM increase in the second cut. But there is also a tendency that this baler produce bales with lower DM density when the speed increases.

The nutrient losses were at average of 6 kg/bale in the study with small variations. Looking at losses calculated as g/kg DM there are significant differences between the first (56 g/kg DM) and the second cut (40 g/kg DM).This difference could be an effect of more gas exchange due to longer storage in high temperature and/or difference in empty space in the bales from the first to the second cut causing over- and under-pressure within the bales.

The losses compared to tower or bunker silos are common when bales are well wrapped and stored.

Table 1. Results from the study comparing crop DM, crop maturity, roundbale system, baler speed and bale density for a Flex- and a Fix chamber baler

Treatments	DM g/kg	Volume/bal M^3	DM-density kg ts/m^{-3}	Losses kg/bale	Nutrient losses g/kg DM
First cut 10,3 MJ/kg DM, NDF 455					
Flex-baler 6 km/h	399^a	1.65^a	180^a	6.4	55^a
Flex-baler 8 km/h	402^a	1.66^a	168^a	5.8	53^a
Fix-baler 6 km/h	381^a	1.81^b	164^a	6.5	55^a
Fix-baler 8 km/h	408^a	1.78^b	170^a	7.1	59^a
Average	**398**		**170**	**6.5**	**56**
Second Cut 10,4 MJ/kg DM, NDF 390					
Flex-baler 8 km/h	520^b	1.65^a	241^b	6,4	40^b
Flex-baler 10 km/h	540^b	1.66^a	230^b	5,9	37^b
Fix-baler 8 km/h	522^b	1.78^b	219^c	7,0	45^b
Fix-baler 10 km/h	540^b	1.79^b	218^c	6,4	40^b
Average	531		227	6,4	40
$LSD^{p<0,05}$	29	0,04	14,2	1,4	9

CONCLUSIONS

- By using grass with low fibre content and heavily wilted grass the density increased from 170 to 230 kg DM/m^3
- Nutrient losses varied from 40 to 60 g/kg DM which are low figures compared to bunker or tower ensiling.
- The DM-density in bales produced by the Fix-baler is mainly influenced by the crop fibre content in this DM interval.
- The DM-density in bales produced by the Flex-baler is influenced by the DM-content, the crop and in some degree speed.

Crop maturity, crop DM and optimal use of baling and wrapping technology is very important factors in reducing

WHAT IS LOW COST BALE SILAGE PRODUCTION?

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INTRODUCTION

The objective of forage production is:

- to provide the animal with a palatable, nutritional and healthy feed
- to optimise the productivity and sustainability of the landscape including use of animal manure and nitrification crops
- to create and improve flexible and cost efficient conservation systems
- to provide wholesome and safe foods.

The consumer's interest in animal welfare and healthy food free from undesirable bacteria and/or mycotoxins has influenced increased controls of food quality and security. Problems relating to the production of hygienic food reduce both the price to the farmer and his productivity, and bad silage often causes such hygienic problems.

Problems can start with field preparation, seeding and fertilizing to get an even surface and well distributed manure in order to avoid soil and/or manure contamination of forages at loading, and later bad silage fermentation.

The crop, and its stage of maturity at moving, have a strong impact on feed intake, nutritional efficiency and animal productivity. The dry matter content, chemical composition and hygienic quality of the forages at loading all influence the silage fermentation and animal productivity.

The conservation systems, including moving, conditioning, loading and storing, should be optimized in order to reduce enzymatic and microbial losses. We know that fresh forage has higher nutritional value than silage from the same crop. Oxygen and effluent cause the main part of the losses and undesirable microbial growth. A good forage conservation system will enable moving at the optimal stage of maturity and prevent metabolisable energy (ME) losses. Bale silage technology is a good example of optimal and flexible conservation of forages as each bale acts as its own silo.

Palatable, nutritional and healthy feed

Feed accounts for more than 50 % of the total production costs of one kg of milk. The forage intake varies from 35 to 60 % of the total energy intake. There is a large variation in veterinary costs to keep a good health standard – on average 30 to 300 Euro per cow, according to a recently published investigation of the relationship between veterinary-treated clinical mastitis and some environmental and management factors in high yielding dairy herds with a low incident of sub-clinical mastitis (Arvidson, A.K. 2000).High nutritional value of good hygienic quality silages results in higher forage intake, lower concentrate percentages and fewer veterinary problems (158 herds of 9000 kg ECM milk per lactation and low cell counts and mastitis frequency). Clostridia-contaminated milk will cause a reduction in milk price for the farmer of 3.5 – 8 %. In both situations bad silage quality is a major part of the problem. Conclusion – Take care of your forage production!

Optimize the productivity and sustainability

Healthy crop rotation is necessary to keep reasonable productivity in a sustainable milk- or beef- production system, particularly in organic farming. By using several forage crops and adopting the conservation technology to a system that enables harvesting at the optimal nutritive value of each single crop, you can optimize the feed ration and avoid leakage and permeation of nutrients to the environment. This is an important EU goal. Bale silage is a good solution on typical family farms of 40 - 80 cows in order to avoid high investment costs and achieve a flexible feeding strategy.

The increasing interest in feeding silage to horses will also lead to more availability of grassland and help create a sustainable landscape. Well-prepared silage production for horses by use of wilting and baling is today an established method of transporting silage. Silage feeding also has decreased respiration problems among horses, according to breeders.

Improve flexible and cost efficient conservation systems

There is a wide variation in nutritional value between crops, harvests and fields. We know that feed intake and utilization are related to this variation. Farms that only have one or two bunker- or tower silos have to cut more than one field to fill these silos in a reasonable time. The average nutritional value will decrease. The crop also matures during filling. A big tower silo often has the best feed in the bottom and cannot be used for the high yielding cows when needed. Bale silage on the other hand gives the farmer total choice of adapting his feed to any animal. Cost comparisons between bunker-, tower- and bale silage systems show significant differences both in investment and in cost for ME or kg DM when fed to the cow. A fully automatic feeding system, where the silage is distributed in front of the cow, will cost 1.5 to 1.7 times more when stored in a silo compared to a bale (Halvarsson, H. 1991). In recent years, baling technology has been improved for silage. By use of an optimal moving / conditioning technology and a good baler, the costs have decreased during the latest years (Lingvall, P. 2002).

Add value to the crop

By following the crop maturation and systematically harvesting at the optimal nutritional stage, you can increase the feed value by 10 – 15 %. This is one of the advantages with the bale system.

Avoid heat stress!

Film colour has an impact on film and forage temperature. A white film reflects 25 – 30 % of the light, whereas a black or dark green film reflects only 5 – 10 %. This means that the difference in temperature a sunny day can be 30 - 35º C. Gas permeation increases tremendously and doubles the nutrient losses (Lingvall, P. 1999). The increase in temperature stimulates growth of clostridia and enterobacteria and is a risk for the milk quality and animal health. A carbon-dioxide ”tight” bale keeps the gas inside the bale and prevents the growth of microbes that ferment nutrients - a type of self-producing conservation (Auerbach, H. 1996)

Help the forage crop to ferment!

The hygienic quality of forage has the first priority – difficult weather conditions and poor wilting can be overcome by use of silage additives such as Kofasil Ultra or Lactisil 200 NB. Bad silage quality resulting in clostridia in the milk and reduced milk price will cost the farmer 0.027 Euro per kg DM. A well-adopted silage additive costs 0.0043 – 0.0076 Euro per kg DM (Lingvall, P. 2002).

Use good technology – and save money!

Forage maturity and DM, loading / baling efficiency and choice of baler have great influence of costs. An increase in NDF content from 400 to 500 g per kg DM reduces the bale density by 20 %. An increase in forage DM from 200 to 500 g per kg DM increases the bale density from 100 to 230 kg DM per m^3. The differences between balers in condensing the forage can be 10 to 20 %. A high density reduces the costs and stimulates fermentation. An optimal use of available technology reduces the costs by more than 50 % (Lingvall, P. 2003).

Keep the parcel tight!

The handling of the bale when moved from the wrapper / field to the store place is the most important factor preventing puncturing of the bale. REMEMBER – silage conservation is based on fermentation in an oxygen-free atmosphere. Every leak will cause losses and allow undesirable microbial growth. Use of high quality stretch film is necessary. Stretch film quality is related to the resins used, the production technology and the film colour. A punctured film or leakage between the layers creates losses and causes bad fermentation. Going from 4 to 6 layers of white stretch film per bale reduces the ME losses by 5 – 7 %, equivalent to 5 Euro per bale (Sweden). The cost of 6 layers of Trio Wrap, which uses DOWLEX* 2045S PE Resin, a high quality resin specifically designed by Dow for silage application, is 3.3 Euro per bale and covers of the reduction in losses.

Provide wholesome and safe foods!

Milk and beef production or horse breeding involve a long chain of activities. Feed production and feeding strategies influence animal productivity and animal welfare as well as food quality. Society’s opinion about healthy food and animal behaviour, as well as the handling of the animals and use of antibiotics, has a great impact on the market. The market will pay according to quality. The use of simple and secure forage conservation methods for safe and economic food production is an important part of a quality-based system.

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NUTRITIVE VALUE AND FEEDING SILAGES

THE EFFECT OF STAGE OF MATURITY AND ADDITIVE TYPE ON AEROBIC STABILITY AND CHEMICAL COMPOSITION OF PROCESSED WHOLE CROP WHEAT

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INTRODUCTION

Whole crop wheat has traditionally been harvested at approximately 450 g/kg dry matter (DM) and preserved by ensiling, or at a higher DM (500 to 700 g/kg DM) with the addition of urea (Hill and Leaver, 1999). Jackson *et al* (2002), recently reported that a forage mill specifically designed for small grained cereals increased the digestibility of the starch component of urea treated whole crop wheat. This now results in a wider harvest window for whole crop wheat (up to 850 g/kg DM). The conversion of urea to ammonia relies on the presence of moisture and the plant enzyme urease (Sahnoune *et al*., 1991), the activity of which may be reduced at higher forage DM contents. This has led to the development of urea + urease additives to preserve the forage at high crop DM contents. In addition, inoculant additives designed to work at higher crop DM levels have also been developed. However, the conditions under which the use of these additives is beneficial are unclear. The objectives of the current experiment were to compare the effect of liquid urea, prilled urea, urea + urease or an inoculant additive on the aerobic stability and chemical composition of processed whole crop wheat.

MATERIALS AND METHODS

Experiment 1 - A commercially managed crop of winter wheat (c.v. Equinox) was harvested at one of two dry matters (DM): 550 and 800 g/kg. Upon ensiling the crop received one of five treatments, no additive (NC), an inoculant (Inoc) additive (microbial + enzyme combination Whole Crop Mill Gold, (Biotal, Cardiff, UK) or one of three forms of urea: urea + urease (U+, Home 'n' Dry, Volac, Royston, UK), liquid urea (LU) or prilled feed grade urea (PU). All sources of urea were applied to provide an equivalent of 30 kg urea/t DM of WCW. Material was well mixed and ensiled in four replicate drum silos (80 litres per silo) per treatment. Silos were lined with a plastic liner, double sheeted and weighed down with sand and remained sealed for 100 days. On opening two samples were taken, one sample was frozen (-20^{o}C) for subsequent chemical composition and the second sample was used to determine aerobic stability. Aerobic stability was determined by placing the sample in a polystyrene box (3800 cm^3) containing holes sufficient for the passage of air into the forage. The boxes were kept in a temperature controlled room (15^{0}C) with forage temperature being recorded daily for 21 days. Forages were analysed for DM, crude protein (CP), ammonia nitrogen (NH_3N), pH, Neutral Detergent Fibre (NDF), starch, sugars and Neutral Cellulase Digestibility (NCD). Results were analysed as a 5 x 2 factorial design with aerobic stability data being analysed using a linear model.

Experiment 2 - A commercially managed crop of winter wheat (c.v. Consort) was harvested at one of three dry matters; 600, 700 or 800 g/kg. The crop received one of three additive treatments; no additive (NC), prilled feed grade urea (PU) or a urea + urease product (U+, Home n' Dry, Volac, Royston, UK). All additives were applied to provide an equivalent of 30 kg urea/t DM. Forages were ensiled in small scale silos (silo volume of 1150 litres) with 3 replicates per treatment. Silos were sheeted and weighed down with sand and remained sealed for 100 days. Samples were then taken for aerobic stability as described for experiment 1, and for determination of yeast numbers. Microbiological count data and aerobic stability data was analysed using a linear model.

RESULTS AND DISCUSSION

Experiment 1. Additive had an effect ($P<0.001$) on forage CP with those receiving the urea based additives having higher CP at both DM harvests (means of 194, 179 and 207 g/kg DM respectively for additives U+, LU and PU; Table 1). Forage CP also differed with DM at harvest with those harvested at 800 g/kg DM having lower a CP (mean 151 g/kg DM) compared to the forages harvested at 550 g/kg DM (mean 171 g/kg DM). There was also an interaction between DM and additive on forage CP ($P<0.05$): forages receiving Inoc had the lowest CP content at 550 g/kg DM (106 g/kg DM) but at 800 g/kg DM forages receiving NC had the lowest values (105 g/kg DM). Compared to treatments NC or Inoc, forages receiving urea based additives had higher ammonia-N levels (mean of 1.7, 1.2, 28.2, 9 and 14.1 % total N for NC, Inoc, U+, LU and PU respectively). Increasing DM increased forage NH_3N content ($P<0.001$, mean of 7.82 and 13.86 % total N for 550 g/kg and 800 g/kg DM). There was an interaction between DM and additive in terms of NH_3N, ($P<0.001$); forages receiving LU and PU had similar NH_3N contents at 550 g/kg DM (mean 5.3 % total N) but PU had a higher NH_3N content (22.8 % total N) at 800 g/kg DM (12.7 % total N). All forages harvested at 550 g/kg DM with the exception of those receiving the urea+urease, fermented as indicated by their low pH (mean 3.22, $P<0.001$). There was an interaction between DM and additive in terms of forage pH ($P<0.001$); forages receiving the PU and LU additives at 550 g/kg DM had a lower pH (mean 4.2) compared to that at 800 g/kg DM (mean 8.75). Forage NDF content was not affected by DM but was affected by additive ($P<0.001$) with material receiving PU having the highest NDF content at both maturity stages (mean 439 g/kg DM). The lowest NDF content for material harvested at 550 g/kg DM and 800 g/kg DM was observed for material receiving the urea+urease additive (377 and 352 g/kg DM respectively. Forage starch content increased with increasing crop maturity ($P<0.001$, mean of 376 g/kg DM and 286 g/kg DM for material harvested at 800 and 550 g/kg DM respectively). An interaction was observed between DM and additive for starch content ($P<0.05$); the highest starch content when harvested at 550 g/kg DM was observed for forage receiving no additive (NC, 334 g/kg DM). However, at 800 g/kg DM the lowest value was recorded for the Inoc treatment (403 g/kg

DM). NCD was not affected by crop maturity but was affected by additive (P<0.01) with material receiving any of the urea based additives having a higher NCD (mean 739 g/kg DM) than the control (mean of 711 g/kg DM) An interaction (P<0.01) was recorded between DM and treatment for NCD with treatment U+ having the highest NCD (761 g/kg DM) at 800 g/kg DM whereas at 550 g/kg DM treatment PU had the highest NCD (763 g/kg DM). Additive had an effect (P<0.05, s.e.d. 1.194) on aerobic stability of forage. The lowest temperature increase above ambient temperature at 550 g/kg DM was observed for the forage treated with U+ (1.53^{0}C increase above ambient temperature) with temperature change equal between the Inoc and U+ treatments (1.58^{0}C increase above ambient temperature) at 800 g/kg DM.

Table 1. The effect of additive on the chemical composition of whole crop wheat harvested at two dry matters (g/kg DM unless otherwise stated)

	550 g/kg					800 g/kg						Significance		
	NC	Inoc	U+	LU	PU	NC	Inoc	U+	LU	PU	s.e.d.	A	DM	AxD
DM (g/kg)	558	562	574	567	547	833	812	816	796	821	0.8	ns	***	**
CP	109	106	204	200	218	105	112	183	158	196	1.0	***	**	*
NH_3-N (% total N)	2	1.5	25	5.3	5.3	1.3	1.0	31.5	12.7	22.8	1.39	***	***	***
pH	3.9	3.9	8.5	4.2	4.1	6.7	6.6	9.1	8.8	8.7	0.11	***	***	***
NDF	386	413	377	423	426	407	389	352	436	452	1.9	***	ns	ns
Starch	334	293	263	265	274	383	403	401	354	337	0.9	*	***	*
Sugars	18	18	11	17	11	12	10	10	10	12	0.39	ns	**	ns
NCD	732	703	718	758	763	690	719	761	698	738	1.8	*	ns	**

A = main effect of additive, DM = main effect of DM, AxDM = interaction between additive and DM

Experiment 2. Increasing DM at harvest decreased aerobic stability as indicated by an increased temperature increase (mean increase of 2.54, 2.85, 6.97 ^{o}C above ambient for material harvested at 600 g/kg DM, 700 g/kg DM and 800 g/kg DM respectively, P<0.05, s.e.d. 0.4202). Additive had no effect on aerobic stability (P>0.05). Yeast data is shown in Table 2. There was an effect of both additive and forage DM on yeast numbers. Forage treatment NC had the highest yeast numbers after 21 days of exposure to air at all DM contents (mean values of 449,544 yeasts/gram silage DM, P<0.001) with counts being highest for material harvested at 700 g/kg DM and lowest for material harvested at 800 g/kg DM. At 600 g/kg DM and 700 g/kg DM, treatment PU resulted in the lowest yeast count (2 and 354 yeasts/g forage DM respectively) whereas at 800 g/kg DM, treatment U+ resulted in the lowest yeast count (6 yeasts /g forage DM). There was an interaction between DM and additive (P<0.001) with PU resulting in the lowest yeast numbers at 600 g/kg DM followed by U+ and the highest level for NC (mean 2, 4736 and 68536 yeasts/g forage DM respectively. This pattern was repeated for material harvested at 700 g/kg DM but at 800 g/kg DM, U+ resulted in the lowest yeast numbers (6 yeasts/g forage DM).

Table 2. The effect of stage of maturity and additive on yeast number per gram of forage dry matter.

n=27	600 g/kg DM			700 g/kg DM			800 g/kg DM				Significance		
	NC	U+	PU	NC	U+	PU	NC	U+	PU	s.e.d.	A	DM	AxDM
Yeasts	68,536	4,736	2	1278,785	525	354	1,312	6	11	230,968.5	***	***	***

A = main effect of additive, DM = main effect of DM, DMxA = interaction between additive and DM

CONCLUSION

When harvested at 550 g/kg DM, whole crop wheat will ferment and the pH reduced unless a urea + urease additive is used whereupon an alkaline forage is produced. At 800 g/kg DM, ammonia was released from the liquid, prilled and urea + urease additives resulting in an increase in pH whilst neither the control or inoculant treatments fermented. However, there was little effect of additive type on aerobic stability at any DM. In terms of microbiological composition, the application of a urea + urease or prilled urea additive resulted in a significantly lower yeast level compared with no additive. The results from both experiments indicate that it may be necessary to apply a urea based additive at higher whole crop DM's, although there does not appear to be a major benefit from using a urea + urease combination.

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UTILISATION OF WHOLE-CROP PEA (*PISUM SATIVUM* L.) SILAGES BY FINISHING LAMBS; EFFECT ON GROWTH AND CARCASS CHARACTERISTICS

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INTRODUCTION

Supplying the protein requirements of ruminants constitutes a major proportion of production costs in UK agriculture. Since the ban of meat and bone meal and more recently fishmeal, the UK is heavily reliant on imports of soya-bean meal (Merry *et al.* 2001). Furthermore UK consumers are concerned about the inclusion of genetically modified feedstuffs both in their own feed and the feedstuffs of animals. Growing a home-grown (UK) source of protein could facilitate decreased production costs and increased eedstuff traceability. The presence of condensed tannin in coloured flowered varieties of legumes (Carbrera and Martin 1989) may increase the amount of rumen by-pass protein, thus replacing a portion of the protein supplied by soya-bean meal. Previous work by Mustafa *et al.* (2000), Fraser *et al.* (Fraser *et al.* 2001) and Hart *et al.* (2002) has shown that whole-crop pea silage has potential as a ruminant feedstuff when grown as a pure crop and not a bi-crop. This study was designed to evaluate the utilisation of whole-crop pea silage, differing in condensed tannin content, mixed with grass silage as a replacement for soya-bean meal in the diets of finishing lambs.

MATERIALS AND METHODS

Forage production Two varieties of spring sown semi leafless combinable peas cv. Racer (Cebeco, Netherlands) and Croma (Cebeco, Netherlands) were grown during the 2002 season. Peas were cut at growth stage (Knott 1987) 206 using a drum mower, allowed to wilt for 36hrs and processed using a self propelled forage harvester (Class Jaguar). Peas were ensiled with a bacterial inoculant (Wholecrop Legume; Biotal, Cardiff, UK) and were placed into covered concrete bunker silos.

Animals and diets Forty eight Suffolk cross wethers, average live-weight 30.0kg (s.d.=2.85), were housed individually in slated floor pens. All lambs had continual access to fresh clean drinking water. Lambs were fed either grass silage (GS) or GS & white flowered pea silage (WF) or GS & coloured flower pea silage (CF), silages were mixed 50:50 on a dry matter basis. Silage was fed every morning at 08:00hrs at 110% of previous days intake (*ad libitum*). Each forage mix was either supplemented with 400g/day barley (LoPro) or 400g/day + 200g/day hi-pro soya-bean meal (HiPro). The concentrate was pelleted to ease feeding and was fed in two meals per day at 08:00hrs and 16:00hrs. Diets were formulated according to AFRC (1993) to give a growth rate of 100g/day for GS + barley based diet and 200g/day for GS + barley/soya based diet. Silage and concentrate refusals were recorded twice weekly. Silage dry matter intake was expressed per kilogram metabolic live-weight ($W^{0.75}$). Lambs were weighed weekly. Lambs were sent to commercial slaughter after eight weeks on the trial diets. Carcasses were split prior to weighing. Hot carcass weight was recorded at the slaughter house within 30 minutes post mortem, with cold carcass weight being recorded after the carcasses had hung for 24hrs at 4°C. Carcass characteristics were determined on the right hand side of the carcass. The carcasses were assessed for chest depth, kidney weight, kidney knob and channel fat weight and hind leg circumference. The carcass was split between the 7th and 8th rib and the eye muscle area, fat depth and eye muscle length and width recorded as described by Brown and Williams (1979). Killing out proportion was calculated by dividing CCW by slaughter weight. Data was analysed as a 3 (forage mix) by 2 (concentrate) factorial design using ANOVA in Genstat (version 5). One lamb was withdrawn from the trial on health grounds.

RESULTS AND DISCUSSION

Results for SDMI, growth rate and carcass analysis are presented in Table 1. Lambs fed the HiPro concentrate had a heavier slaughter weight compared to those fed the LoPro diet (44kg vs. 39kg, n=47, s.e.d.= 0.77), forage type did not significantly (P>0.05) effect the slaughter weight but lambs fed the pea/grass mixtures tended to be heavier than those fed grass silage as the sole forage (40.5kg vs. 41.8kg vs. 41.9kg for GS, WF, and CF mixes respectively, n=47, s.e.d.=0.95). This trend was also apparent in both the hot and cold carcass weight. Forage dry matter intake (g/kg $W^{0.75}$) were found to be similar and was affected by concentrate type. The control diets i.e. the grass silage, performed better than predicted on the LoPro, 136g/day vs. 100g/day and HiPro, 208g/day vs. 200g/day. All lambs had the same KO proportion regardless of diet. Lambs had fed the HiPro concentrate had a larger leg circumference than those fed the LoPro diet (43cm vs. 41cm, n=47, s.e.d.=0.33), indicating an increase in muscle deposition. Lambs fed the pea mixes tended to have a larger leg circumference than those fed the grass silage diets (41.4cm vs. 41.9cm vs. 41.8cm, for GS, WF, and CF mixes respectively, n=47, s.e.d.=0.41). Chest depth was deeper on those lambs fed the pea mixes, this may have been due to the increased sub-cutaneous fat depth. The eye muscle area was not significantly different (P>0.05) across all of the treatments. There were no significant (P>0.05) forage times concentrate interactions.

Table 1. Effect of forage and concentrate on feed intake, growth rate and carcass characteristics of finishing lambs

	Grass silage		Grass:WF		Grass:CF		Significance		
	LoPro	HiPro	LoPro	HiPro	LoPro	HiPro	s.e.d.	Forage	Conc.
Slaughter weight (kg)	38.3	42.7	39.2	44.4	39.6	44.2	1.34	NS	***
Silage ry matter intake (g/kgW$^{0.75}$)	59.9	56.7	60.8	57.2	56.7	58.3	3.53	NS	NS
Average daily live-weight gain (g/day)	136.7	207.8	175.3	256.7	166.9	235.2	21.22	*	***
Hot carcass weight (kg)	17.6	19.5	18.5	21.1	18.7	20.5	0.80	NS	***
Cold carcass weight(kg)	17.7	19.3	18.3	20.9	18.6	20.3	0.77	NS	***
Killing out proportion (kg/kg)	0.46	0.46	0.47	0.47	0.47	0.46	0.018	NS	NS
Kidney weight (g)	48.7	55.5	50.3	59.4	57.4	56.5	3.45	NS	*
Kidney knob & channel fat weight (g)	150.7	150.1	145.9	177.9	153.9	160.5	24.15	NS	NS
Leg circumference (cm)	40.8	42.1	41.1	42.7	40.7	42.9	0.58	NS	***
Chest depth (cm)	27.4	28.6	28.3	29.1	27.9	27.7	0.51	*	NS
Eye muscle area (mm^2)	1297	1417	1428	1476	1381	1466	80.5	NS	NS
FD (mm)at depth	1.8	1.4	2.6	3.4	2.3	3.1	0.55	**	NS
Eye muscle length (cm)	6.2	6.2	6.3	6.6	5.9	6.4	0.19	*	*
Eye muscle wifth (cm)	2.7	2.9	2.8	3.0	2.9	3.1	0.15	NS	*

NS P>0.05, * P<0.05, ** P<0.01, *** P<0.001. conc = concentrate. N=47

CONCLUSIONS

At a ratio of 50:50 on a dry matter basis the pea mixes fed with the LoPro concentrate did not out perform the control diet of grass silage with the HiPro concentrate. When lambs were fed forage mixtures consisting of pea silage and grass silage or a sole grass silage diet, both supplemented with the same concentrate, lambs tended to perform better on diets containing the pea forages. There is a need for further work to be carried out to determine the optimum ratio of pea forage to grass silage so that lamb performance can be maximised.

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COMPARISON OF THE EFFECT OF TWO HARVESTING METHODS OF LEGUME-GRASS SILAGE ON RUMEN FUNCTION

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ABSTRACT

The silages were made from a first cut wilted red clover-grass (60%- red clover, 25% - thymothy, 10% - fescue and 5% - others) sward. Twelve fattening bulls assigned on the basis of initial weight into two groups were housed in individual pens and offered silages *ad libitum* during a period of 143 days. There were no significant effects of the type of silage on pH in the rumen (6.74 *vs* 6.66 for trench silage and big bale) on the infuzoria count (346 vs 377 thous/ml) on the total volatile fatty acids concentration (9.73 *vs* 10.30 mmol/100 ml^{-1}) and on these proportions (57.54 *vs* 57.52 for acetic acid, 21.76 *vs* 20.83 for propionic acid, 15.41 *vs* 16.31 for butyric acid). Feeding big bales silage was beneficial to rumen protein synthesis, i.e. the content of protein nitrogen and that of total nitrogen were, respectively, by 25.13 and 11.6 mg/l00 ml^{-1} higher and the content of ammonia nitrogen was by 2.5 mg/100ml^{-1} lower compared to trench silage.

INTRODUCTION

About two thirds of grass silage in Lithuania is ensiled into trench or clamps. Another never method of making silage is the wrapped bale and principally popular on smaller farms. One of the differences of these ensiling methods that grass for trench silage precision chopped and for big bale silage not chopped. Forages that are finely chopped are rapidly consumed and fermented in rumen, which reduces the animals chewing time, rumen fluid pH, the acetate-to-propionate ratio, decrease the number and activity of fiber-degrading bacteria (Muck and O'Kiely, 2002). However, big bales technology does not use chopped material and this means that the fermentation is not some as for other, more well researched structures (Slotner, 2002). The harvest and conservation methods have also on influence on the animals performance to a losser extent. Silage making in big bales reduces organic matter digestibility and often also voluntary intake, especially in conditions of bad weather (Andrieu et al., 1999). The aim of this study was to compare the rumen fluid characteristics of fattening bulls offered red clover-grass mixture ensiled in trench and in big bales.

MATERIALS AND METHODS

First cut grass (60 % to red clover, 25 % - thymothy, 10 % - fescue and 5 % - other) was harvested at the beginning of June, 2001 with the mower/conditioner and wilted one day. From the one half of the field, wilted grass was ensiled using a baler and wrapped with six layers of plastic (BB), while from the another half of the field wilted grass was collected and chopped with a chopper and ensiled in a ferro-concrete trench (T). Twelve fattening bulls assigned on the basis of initial weight into two groups were housed in individual pens and offered silages *ad libitum* during a period of 143 days. Compound feed in experimental periods was offered twice daily (Table 1).

Table 1. Experimental design

Group of bulls	No of bulls	Feeding pattern
Trench (T)	6	Silage made in trench, compound feed (barley meal – 89%, protein-vitamin-mineral premix – 11%)
Big bale (BB)	6	Silage made in big bales, compound feed (barley meal – 89%, protein-vitamin-mineral premix – 11%)

The rumen contents (fluid) was collected from three bulls of each group using the pharynx probe with a steel tip in 2 hours after a.m. feeding once in the pre-experimental period and three times in the experimental period. The rumen contents was analysed for infusoria count per 1 ml fluid in the Fux-Rozenthal chamber, total VFA by distillation with Markgham's apparatus and VFA ratio determined with the gas chromatograph Chrom-5, pH-value determined with the pH 526-meter, total nitrogen, protein nitrogen – according to the method of Kjeldal with apparatus Kjeltec System 1002, ammonia – by the method of Convey and Bright. Statistical analyses were carried out by means of procedures described by STATISTIKA for Windows (Sakalauskas, 1998).

RESULTS AND DISCUSSIONS

The rumen microbiological metabolism in the experiment are shown in Table 2. During experimental period infusoria count mount up in both groups, but at the end of the experiment infusoria count in BB group was by 9.1 % higher than that in the T group. VFA concentration in rumen bulls fed big bale silage was by 0.57 mmol/100ml^{-1} higher compare with that fed the trench silage. VFA concentration affected the pH values of the rumen content and in group

BB rumen pH value was by 0.08 unit lower compound with the T group. There were no significant effects of the type of silage volatile fatty acids proportions (57.54 *vs* 57.52 for acetic acid, 21.76 *vs* 20.83 for propionic acid, 15.41 *vs* 16.31 for butyric acid).

Feeding big bales silage was beneficial to rumen protein synthesis, i.e. the content of protein nitrogen and that of total nitrogen were, respectively, by 25.13 and 11.6 mg/100 ml^{-1} higher and the content of ammonia nitrogen was by 2.5 mg/100 ml^{-1} (P<0.05) lower compared to trench silage.

Table 2. Microbiological and biochemical indicators

	T		BB	
	At the end of pre-experimental period	At the end of experiment	At the end of pre-experimental period	At the end of experiment
pH	6.64±0.21	6.74±0.08	6.90±0.06	6.66±0.07
Infusoria count, thous. ml	215.2±21.0	346.1±12.3	244.2±8.1	377.5±10.3
Total VFA, mmol/100ml^{-1}	10.58±0.84	9.73±0.46	9.83±0.97	10.30±0.48
Molar proportions of VFA:				
acetic	59.71±0.30	57.54±1.31	64.15±0.38**	57.52±0.75
propionic	19.08±0.13	21.76±0.96	17.33±0.33*	20.83±0.55
butyric	15.82±0.27	15.41±0.73	14.78±0.49	16.31±0.43
Total nitrogen, mg/100 ml^{-1}	96.82±6.22	108.98±6.02	95.09±6.09	120.59±8.57
Protein nitrogen, mg/100 ml^{-1}	73.09±7.20	79.58±2.87	76.09±3.56	104.71±9.13
Non-protein nitrogen, mg/100 ml^{-1}	23.73±1.76	29.40±3.16	23.67±1.78	25.56±2.34
Ammonia nitrogen, mg/100 ml^{-1}	9.52±0.85	11.01±0.61	8.74±0.51	8.49±0.68*

*P<0.05; **P<0.025.

CONCLUSIONS

There were no significant differences between trench or big bale silages in terms of rumen pH infusoria count and total volatile acids concentration.

Feeding big bales silage was beneficial to rumen protein synthesis.

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NITROGENOUS FRACTIONS AND AMINO ACIDS PROFILES IN ALFALFA GREEN CROP AND ALFALFA SILAGES MADE WITH DIFFERENT ADDITIVES

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INTRODUCTION

In milk cows nutrition, basic components of rations, apart silages from maize are silages from legumes, grasses and theirs mixtures. Proteins from ensiled grasses and legumes are quickly degraded in rumen, slower degraded are proteins from hay prepared from this plants. So, it is possible, that in consequence of wilting legumes before ensiling, effective degradation nitrogenous fraction silages in rumen will get smaller. They exist researches, which confirm this hypothesis (Chamney and Veira, 1990; Nagel and Broderic, 1992; Brzóska et al., 1999), but works are also, in which profitable wilting green forage before ensilage onto slow protein degradation were not affirmed (Gąsior and Brzóska, 2000). It is impossible to preclude influence applied supplements on this protein's feature. But results of researches on this field are ambiguous too. Some authors bring, that addition of formic acid lowers degradation of nitrogenous compounds in rumen (Brzóska et al., 1999), however different did not affirm such (Gąsior and Brzóska, 1999).The research was carried out to estimate chemical composition especially nitrogenous compounds in green and ensiled alfalfa.

MATERIAL AND METHODS

Alfalfa from first cut in stage of budding, were wilted to content DM ca 30% and ensiled in micro silo at capacities 3 dm^3 in three repetitions without supplements as well as with three different additives: formic acid and mollases (applied 3 and 2 % respectively), Polmasil extra^{TM} and Feedech silage (applied in accordance with recommendations of manufacturer). Polmasil contains culture of lactic acid bacterium: *Enterococus faecium M 74, Lactobacillus casei, Lactobacillus plantarum, Pediococcus* spp and *Lactobacillus buchneri*, however Feedtech silage strain of bacterium *Pediococcus acidilactici* and *Lactobacillus plantarum* and enzymes decompose cellulose.

Chemical composition (with widen nitrogenous fraction by total nitrogen, protein nitrogen, non-protein nitrogen (NPN), soluble nitrogen and amino acid profile) of green forage and silages was qualified according to standard analysis. Quality of silage was estimated according to the Flieg-Zimmers scale.

The statistical analysis of results was conduct with Excels statistical packet, significance of differences with Duncans test.

RESULTS AND DISCUSSION

Use additives did not influence onto quality of silages, qualities all of them were very good. Lowest level of nitrogen-free extract was affirmed in silage without additives, significant more was this fraction in silage with formic acid and molasses (tab. 1) this was probably caused by addition of sugar (molasses) during ensilage.

Table 1. Chemical composition of green forage and silages

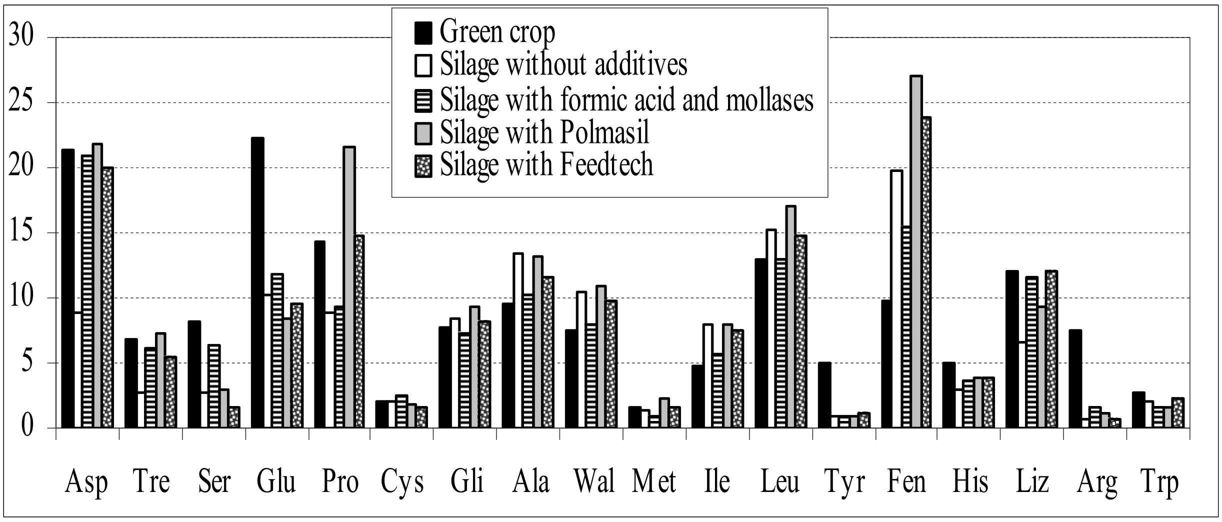
Item	Green crop	Way of ensile			
		Without additives	With formic acid and molasses	With Polmasil extra	With Feedtech silage
Dry mater [%]	31,2	31,36A	34,1B	36,29C	33,78B
Crude ash [% d.m]	11,6	13,3a	11,9a	12,24a	12,37a
Crude fat [% d.m]	4,0	4,7a	4,0b	4,1b	4,2 b
Crude fibre [% d.m]	27,5	29,1a	27,9a	29,0a	28,8a
NDF [% d.m]	48,3	32,9a	32,0a	31,7 a	31,5a
ADF [% d.m]	30,2	29,8b	27,7 a	27,6 a	27,8a
Hemicellulose [%d.m]	18,1	3,1a	4,3b	4,1b	3,7c
N-free extract [% d.m]	35,5	28,0a	33,9b	30,16a,b	30,5a,b
Total – N [% d.m]	3,42	3,98a	3,56b	3,92a	3,87b
Protein – N [% d.m]	2,98	1,48a	1,73b	1,72b	1,54a
NPN [% d.m]	0,44	2,50a	2,83b	2,2c	2,33c
Soluble – N [% d.m]	0,2	0,36a	0,31b	0,33a,b	0,34a
N-NH_3 [g/kg Tot-N]	-	9,39c	6,41a	8,49 b	8,30b

A,B,… - significant differences $P \leq 0,01$; a, b, … - significant differences $P \leq 0,05$

Silage without additives contained significant more fat than rest, but it did not influence onto her feeding value. Estimate of tested fodders as regard nitrogenous fraction showed, that in all silages quantity of soluble nitrogen and non–protein nitrogen grew up, and quantity of protein nitrogen decreased(tab. 1). Lowest level of protein nitrogen were observe in silage without additives (1,48 %) and silage with addition Feddtech (1,54%). These results are peaceable with researches Króliczek's at al. (1989) . During ensilage follow degradation proteins and grows up content of soluble nitrogen fraction. It is unfavorable from point of sight of ruminants, because causes fast degradation nitrogenous fraction in rumen and large losses of nitrogen, especially when we haven't sufficient supply easily fermenting carbohydrates. Raised level of ammoniac nitrogen (9,39 % of total nitrogen) were observed in silages prepared without additives, lowest (6,41 % of general white) in silage with and formic acid.

Differences in degradation of amino acids in dependence on way of ensilage were affirmed (fig. 1) Degradation of amino acids (in this lysine and metionine) in silage without additives was larger depression than in silages prepared with additives. From among amino acids most susceptible onto degradation was arginine and glutamic acid were.

Figure 1. Amino acid profile of proteins green forages and silages from alfalfa. (% total of proteins)



CONCLUSIONS

1. Used methods of ensilage did not have onto quality of silages
2. Independently from method of ensilage height of fraction of soluble nitrogen and non- protein nitrogen was affirmed.
3. Use formic acid with molasses as well as Polmasil and Feedtech reduced degree of degradation amino acids in comparison to silage without additives.

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THE EFFECT OF AEROBICALLY INSTABILE MAIZE SILAGE ON THE RUMEN FERMENTATION IN COWS

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INTRODUCTION

Silages of high quality can be prepared under anaerobic conditions only from feeds of good quality using a complex biological process, during which plant saccharids are changed by lactic acid bacteria into conserrving lactic acid, volatile fat acids (VFA), carbon dioxide, with parallel decline of the pH value and energy decrease. The success of this conserving method depends on a large number of intrinsic (feed sort, dry matter content and composition, amount of saccharids, etc.) and extrinsic (technical, technological, weather conditions and additiva) factors conditioned and affected mutually.

The maize ensilaged belongs, due to its favourable dry matter composition, to easily ensilaged feeds, and at observing all technological demands, mostly silages of very high quality are obtained. The quality of fermentation process is also related to the aerobic stability of maize silage, even when the content of fermenting acids itself, or only a low pH value does not still mean a good stability (FLACHOWSKY et al., 2000; PAHLOW, 2000; URIARTE et al., 2001). Laboratory tests indicate that the silage aerobic stability, of maize silages in particular, is affected, in addition by oxide concentration, by exposure time length, size of contact areas, by qualitative and quantitative epiphytous microflora, just at the crop itself (PAHLOW, 1982; WOOLFORD and COOK, 1978, and others). In general, the principle is true that with silage density decreasing, thus with the greater silage porosity, the potential of air penetration into the silo is increased resulting in a range of undesirable changes (HONIG et al. 1999). The maize silages, according to a number of authors (PAHLOW, 1999; MUCK and ÓKIELY, 1992) uses to be often more susceptible to aerobic degradation than silages from other plant products. Silages of good quality representing the dominant proportion in the feeding ration, are in such way important prerequisites for the rumen physiological function. In the rumen, a very intensive microbial digestion occurs, allowing to the animal to obtain daily 3-7 kg microbial protein (VRZGULA et al., 1990). The cattle rumen represents a very complex biological and biochemical system that responds very sensitively not only to all sudden feeding ration changes, but also to poor quality of certain feeds, silages not excluded (BÍREŠ et al., 2000). For protein production, numerous and physiologically functional microflora is inevitably necessary, which can fulfil its role only under stable conditions. Amount of biomass created can be, therefore not only by voluminous and core feeds and by their quality but also by their structure. In this connection BOLSEN a URIARTE (2001), but also ILLEK and MATĚJÍČEK (2001) report the negative impact of feeding with silages changed aerobically (thus instabile ones) or accepting feed dry matter by milk cows, on utility, rumen digestion, milk compossition and cows health.

The present study has been aimed at examination of the effect of maize silage aerobically changed, mixed within the feeding ration (TMR), and fed, on selected indices of the rumen fermentation in cows.

MATERIALS AND METHODS

In the present experiment, lactating cows in the first phase after calving were used, fed with mixed feeding ration (total mixed ration TMR*)* prepared on the basis of maize (12 kg), of silages from crushed Ears of Maize (6 kg), protein silages fedds, hay, and mixture. The nutritive value of feeding ration and fermentation process in individual silages were determined, including the microbial analysis. The rumen fluid was taken per os using a sond from the group of four lactating cows being in the first phase after calving in 3-4 hours after fed, durin the 6th -8th weeks, for analysis and assessments of the main bacterial indices.

RESSULTS AND DISCUSSION

From the results presented in the table, it is evident that, in the TMR with a higher occurrence of colonizing mycetes, a negative influence on the rumen fermentation occurs. Under influence of aerobically instabile maize silage (a temperature of silage 50 ^{o}C) with a higher proportion of mycetes mixed in TMR ($6*10^6$, or $2*10^7$ in 1g feed), a higher finding of ammonia and significant reduction in the total amount of volatile fat acids, in particular in the proportion of acetic acid, were diagnosed. Feeding with silages of poor quality also led to reduction of Protozoa, considered to be susceptible indicators of the rumen fermentation (DVOŘÁK, 1994). Their amount ranged below the reference limits (244 thousand/ml). From the above facts, it is evident that even when the microflora represents certain natural defensive filter against undesirable microorganisms and their toxins, as compared with monogastric animals, at higher concentrations, it can be the cause of disorders in the rumen metabolism. The impact of feeding with aerobically changed and damaged feeds corresponds to the previous findings by BOLSEN (2001), ILLEK and MATĚJÍČEK (2001), and WHITLOCK et al. (1999) who state that, at feeding with mouldy and aerobic instable maize silages in rations for cows, decreased acceptability, palatability, as well as the rumen fermentation and milk component changes occur.

SUMMARY

Examined was the effect of feeding with TMR containing aerobically changed or mouldy silages on the rumen fermentation in cows of the first phase after calving. The inclusion of changed feeds in TMR led to significant changes in the rumen fermentation itself, individual characteristics of which did not correspond to the reference range of the rumen physiological function. Aerobic changed silages caused the increased finding of ammonia, reduction in acetic acid proportion, increase of pH value and significant reduction of the rumen microfauna up to its disappearing from the rumen medium. It was revealed that the inclusion of aerobically changed silages, though mixed with TMR, bringsabout in animals alimentary disorders of the rumen digestion associated, moreover, with low feed acceptability, disorders in ruminantion and utility decrease.

Table 1. The effect of aerobic instable silages on the rumen characteristics

Indices	Dry matter	Fungi	pH	VFA	AA	PA	BA	NH_3	Infusoria
	g/kg	thousand cfu/g		mmol/l	%				thousand/ml
Mean	482.3 ± 28.3	4,190.6 ± 718.6	6.96 ± 0.24	96.3 ± 25.5	51.43 ± 3.87	28.86 ± 2.48	19.71 ±2.75	10.49 ±3.62	244.33 ±97.01
Reference values	550-550		6.2-6.8	80-120	55-56	15-25	10-17	6-15	300-450
Difference		**	*		*	*			*

CONCLUSION AND RECOMMENDATION

From the literature and partly also from the present experimental and practical examination, the following conclusion and recommendation can be inferred:

It was revealed and confirmed that the feeding with TMR containing mouldy and aerobically changed silages (maize silage, resp. silages from crushed ears of maize) with higher numbers of spores of 10^6 up 10^7 cfu/g feed bringsabout the rumen medium disorders, inhibits the rumen fermentation, increases the pH value, reduces acetic acid proportion and increases the ammonia finding. Aerobically changed feeds are the cause of inhibition up to disappearing of the microfauna. Inclusion in TMR of silages of hygienically inappropriate quality, including warmed silages, always causes nutritive deterioration of the entire TMR. Therefore, it is recommended to pay the maximum attention to techniques and technology to the production of silages as preventive and safety measures in order to prevent undesirable aerobic changes in silages, as well as to prevent the inclusion of such feeds in TMR.

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NUTRITIVE VALUE OF SILAGES FOR RUMINANTS

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INTRODUCTION

In this study, nutritive values of silages for ruminants were determined. The group of feeds included corn silage (2 samples), lucerne silage (2 samples), clover silage, bean silage, grass silage and ryegrass silage. We determined chemical composition, the nitrogen degradability using in sacco method, intestinal digestibility of rumen undegraded protein using the mobile bag technique and digestibility of organic matter using enzyme cellulase. The PDIN and PDIE values were calculated according to Sommer et al. (1994).

MATERIAL AND METHODS

Nitrogen degradability (DEG)

The nitrogen degradability experiments were performed using in sacco method in three dry cows or steers (Black Pied) with a large ruminal cannulas (120 mm internal diameter). A Retsch cutting grinder with 3 mm mesh was used to grind samples of silages. Feed was weighed at 2 g to 15 x 5 cm nylon bags of 42 μm pore size (Uhelon 130 T, Silk & Progress Moravská Chrastová). The bags with the feed were attached to a cylindrical carrier (Třináctý et al., 1995) and incubated in the rumen for 2, 4, 8, 16, 24 and 48 hours. For each time period, 6 bags with the feed tested were made, and each of the 3 cannulated cows or steers had two of them placed in the rumen. When removed from the rumen, the bags were washed immediately in cold water. To calculate the effective degradability, the method of Ørskov and McDonald (1979) was used at the rumen fractional outflow rate (k) of $5\%.h^{-1}$. No corrections for microbial contamination were made.

Intestinal digestibility of rumen undegraded protein (DSI)

The mobile bag technique (Frydrych 1992, Homolka et al., 1996) with dry cows fitted with the T-piece cannula in the proximal duodenum was used to ascertain the intestinal digestibility. It consists of three steps:

1) Feed incubation in the rumen of three cows to obtain undegraded feed residues. Samples of silages were ground on a 3 mm mesh Retsch cutting mill. The bags (15 x 5 cm, pore size 42 μm) with weighed feed were incubated in the rumen for 16 hours. The bags were then washed for 30 minutes in water and dried for 24 hours at 50° C.
2) The residues of each feed were weighed to 22 nylon bags (4 x 4.6 cm, pore size 42 μm). The bags were sealed and incubated in a pepsin and hydrochloric acid solution for 2.5 hours at 39°C.
3) The bags were placed into the duodenum of 3 cows with a simple duodenal T-cannula. The bags found within 24 hours in the faeces were washed in water and subsequently freeze-dried. The intestinal digestibility was calculated from the formula: (A-B)/A*100, where

A = amount of proteins (in dry matter) entering to the intestine
B = protein residues (in dry matter) after the passage through the intestine

Organic matter digestibility

Organic matter digestibility was determined by two-stage *in vitro* method pepsin-cellulase and the results were adjusted using regression equations for silages (Homolka, 1994).

Calculations of PDI

The PDIN and PDIE values were calculated according to Sommer et al. (1994).

RESULTS

Table 1. The chemical compositions of the silages

Feed	Dry matter	Crude protein	Crude fibre	Ether extract	Nitrogen-free extract	Organic matter
	g					
Clover silage (1370)	1000 259,60	179,83 46,68	268,86 69,80	17,54 4,55	439,39 114,07	905,62 235,10
Rye-grass silage (1372)	1000 214,40	192,77 41,33	255,75 54,83	26,39 5,66	332,93 71,38	807,84 173,20
Grass silage (1465)	1000 342,00	161,34 55,18	265,94 90,95	24,37 8,33	474,47 180,54	926,12 352,39
Maize silage (1371)	1000 421,40	69,46 29,46	210,29 89,18	28,06 11,90	647,41 274,57	955,22 405,11
Maize silage (1464)	1000 385,20	103,60 39,91	198,47 76,45	35,33 13,61	606,87 233,77	944,27 363,73
Lucerne silage (1470)	1000 522,7	172,29 90,06	333,12 174,12	20,57 10,75	364,08 190,30	890,06 465,23
Lucerne silage (1471)	1000 404,90	182,56 73,92	281,36 113,92	25,98 10,52	383,27 155,19	873,17 353,55
Broad bean silage (1473)	1000 353,8	191,23 67,66	258,82 91,57	23,41 8,28	413,30 146,23	886,76 313,74

Table 2. Protein degradability, intestinal digestibility, organic matter digestibility and contents of PDIN, PDIE in absolute dry matter.

Feed	DEG	DSI	Digestibility coefficient of organic matter	PDIN	PDIE
	%	%	%	g	g
Clover silage	75,80	69,86	69,62	109,50	82,43
Rye-grass silage	86,30	50,50	72,68	108,95	60,41
Grass silage	78,45	62,66	68,32	94,88	73,34
Maize silage	54,10	81,09	66,94	48,32	77,50
Maize silage	79,30	58,72	69,43	59,94	64,69
Lucerne silage	85,57	75,29	66,09	104,12	66,26
Lucerne silage	84,40	64,97	66,87	107,48	64,73
Broad bean silage	88,29	60,90	67,49	110,97	61,56

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EFFECT OF WHOLE-CROP GRAIN SILAGE ON FERMENTATION PROCESSES AND MICRO FLORA STATUS IN THE RUMEN

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INTRODUCTION

Maize silage is the basic ingredient of cattle fodder. In regions, where cultivate of this plant is disappointed takes meanings cultivate of breads' cereals for silage (GPS). Production of silages from barley, oat, wheat, and even triticale found acknowledgement in many countries. Results of research show, that silage from this plants (GPS) with best result can be applied in basal ration for cattle. (Petkov et al.., 1997; Gabel, 1994; Michna and Poloczek, 1993). Often as supplement for this fodders animals get silage or hay from grasses or legumes. Sometimes it is necessity of connection GPS with silage from maize. It comes question whether this connection of fodders can affect onto population microorganisms and processes occur in rumen.

MATERIAL AND METHODS

Research was done on four young bulls with permanent fistulas into the rumen. Animals were distributed randomly in arrangement of Latin square and were placed in separate individuals boxing, with solid access to water. Basis fodder for experimental animals was maize silage, which was applied in equal quantities, covering in 65% or 75% daily requirement of animals. In control group with maize silages hay was applied (dose A), and in experimental groups meadow hay was replaced from barley (dose II), silage from wheat (dose III), as well as silage from oat (dose IV) (tab. 1)

Table 1. Arrangement of experience

Control ration	Experimental rations		
I	II	III	IV
Maize silage 75% Hay 25%	Maize silage 65% GPS silage from barley 35%	Maize silage 65% GPS silage from wheat 35%	Maize silage 65% GPS silage from oats 35%

After three weeks of preliminary period, biological material was taken through rumen's fistulas right before feeding and 1.5 and 3 hours after the beginning of feeding. Basic parameters of rumen fodder processing were established: pH, VFA, NH_3-N , protozoa and bacteria were counted and protozoa were recognized too

RESULTS AND DISCUSSION

Quality hay and silages was very good. Feeding value of fodders was similar to values announced by different authors (Micek et al., 2001; Bielak et al., 1997). Reaction of rumen fluid did not depend from basal rations, pH was on level 6,82 to 7,13 (tab. 2).

Applied fodders influenced significant into ammonium nitrogen in rumen fluid. This coefficient was highest in case of ration with share wheat silage (11,93 mg/dl), however lowest in rumen of animals feeding maize silage and meadow hay (10,06 mg/dl).

Sum volatile fatty acids at animals feeding only silages was higher (group II, III, IV) in comparison to feeding maize silage and hay.

Number of protozoa in bull's rumen fluid was diverse. Most this micro-organisms were affirmed in rumen of animals with share hay, lowest in case of ration with share GPS silage from wheat.

Similarly number of bacteria rumen fluid changes in dependence from applied experimental rations. Turns attention, high number of bacterium especially at animals, feeding with silages from maize and wheat as well as with silages from maize and oat (tab. 2).

Table 2. Effect of the rations on fermentation indices and micro-organisms

Parameters	RATION			
	I	II	III	IV
PH	6,99[a]	7,08[a]	6,82[a]	7,13[a]
$N-NH_3$ mg/dl	10,06[a]	10,72[b]	11,93[c]	10,58[b]
Sum VFA	4,98[a]	7,02[b]	7,17[b]	6,93[b]
Numbers of protozoa in 1 ml of rumen fluid x 10^5	2,68[c]	2,01[b]	1,81[a]	1,84[a]
Numbers of bacteria in 1 ml of rumen fluid x 10^9	8,86[a]	9,51[b]	9,80[c]	9,75[c]

a,b,c,d $P \leq 0{,}05$

CONCLUSION

1. Rumen fluid of animals feeding only silages without share hay were marked higher coefficients rumen's transformations as well as higher number of protozoa.
2. Number of bacterium rumen fluid was higher for animals feeding only silages

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ESTIMATION OF DIGESTIBILITY AND ENERGY IN SILAGE BASED ON GREEN GRASS ANALYSIS

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INTRODUCTION

There are some advantages to analyse the green forage (GF, samples of wilted grass taken during ensiling) instead of the corresponding silage. Thus, the results are available before the silo is opened and the information can be used in feed ration formulation. In this paper the methode of the estimation of digestibilities of crude nutrients and of the content of ME of grass silage at the basis of the green forage is presented.

MATERIALS AND METHODS

The metabolisable energy (ME) in feeds for ruminants is defined as the sum of digestible nutrients (DN) weigthed by the energy factors of the nutrients. DN are the crude nutrients (CN) multiplied by their digestibility coefficient (DC). Whereas crude nutrients are measured analytically, the DC must be estimated with equations, because normally a digestibility trial has not been carried out.

By calculating the ME, we use the DC estimated at the basis of the crude nutrients. In order to calculate the ME in silage at the basis of the CN of the green forage, a set of equations is necessary (relation between CN in the green forage and the DC respectivly the DN in the silage).
To arrive at this set of equations, the following 5 steps have to be carried out:
1. Calculation of CN in the silage with equations based on CN in the green forage
2. Calculation of DC in the silage with equations based on CN in the silage
3. Calculation of DN in the silage using CN and DC
4. Calculation of DC in the silage based on CN in the GF by relating CN in the GF and the DN in the silage
5. Developing equations of DC in silage on CN in green forage by regression analysis

The steps are applicable for a data set of existing samples (like used in Rutzmoser et al. 2001a, 2001b) or for a simulated data set with a real range of CN.

For the first step of calculating the crude nutrient contents in grass silage out of analysis of green forage (GF), the equations presented at the 10^{th} symposium (Rutzmoser et al. 2001a) will be used :

Dry matter (DM) in silage = 48 + 0.85 * dry matter content in GF (g/kg) (1)
Crude ash in silage (CA) = 1.087 * crude content ash in GF (g/kg DM)
Crude protein in silage (CP) = 11 + 0.95 * crude protein content in GF (g/kg DM)
Crude fiber in silage(CF) = 12 + 1.0 * crude fiber content in GF (g/kg DM)

A crude fat (lipide, CL) value of 40 g/kg DM in silage is generally used, the N-free extract or NfE (CX) is defined as the rest of dry matter and calculated as difference.
With this set of equations, in a first step the expected crude nutrient contents in silage from the analysed values in green forage (forage before ensiling) are calculated.

In the second step, digestibility data of crude nutrients are estimated with another set of equations. These have been developed out of digestibility data of the German Agricultural Society (DLG 1991, 1997).

The equations are based on crude protein in organic matter (CPOM) or crude fiber in organic matter (CFOM), defined as follows:

CPOM = CP / (1000 – CA) *1000 (g/kg DM) (2)
CFOM = CF / (1000 – CA) *1000 (g/kg DM)

The digesibility of the crude nutrients (as percentage) of the grass silages has been calulated – separately for the first and the following cuts – with the following equations:
Grass silage, first cut:

DC crude protein = 47.40 + 0.12033 * CPOM (3)
DC crude fiber = 96.20 - 0.06713 * CFOM
DC crude fat = 62.56 + 0.01518 * CFOM
DC NfE = 102.96 - 0.10110* CFOM

Grass silage, following cuts:

DC crude protein = 24.02 + 0.23375 * CPOM (4)
DC crude fiber = 101.70 - 0.10209 * CFOM
DC crude fat = 57.14 + 0.00768 * CFOM
DC NfE = 97.09 - 0.09661 * CFOM

In the third step, the digestible nutrients (DN) are calculated by multiplying CN (1) by DC (3) respectively (4).

In the forth step, to get the DC, the DN in the silage are related to the crude nutrients in the green forage.

RESULTS AND DISCUSSION

In the fifth step, the resulting equations are obtained by a regression analysis of DC of the forth step on crude nutrients in GF. The equations are as follows:
Grass silage, first cut:

DC crude protein = 54.42 + 0.09221 * CPOM (GF) (3)
DC crude fiber = 103.90 - 0.08520 * CFOM (GF)
DC crude fat = 62.77 + 0.01530 * CFOM (GF)
DC NfE = 98.49 - 0.10380* CFOM (GF)

Grass silage, following cuts:

DC crude protein = 31.93 + 0.20330 * CPOM (GF) (4)
DC crude fiber = 109.30 - 0.12310 * CFOM (GF)
DC crude fat = 57.27 - 0.00764 * CFOM (GF)
DC NfE = 90.87 - 0.09207 * CFOM (GF)

Table 1. An example of the computations step by step is given for a sample of first cut grass forage taking into account only the crude fiber (CF) - per kg DM, if not otherwise stated:

Step	Green forage	Equations	Silage
1	CF 240 g, CA 95 g CFOM 265 g	CF in silage = 12 + 1.0 * CF in GF (g/kg DM) = 12 + 1.0 * 240	CF 252 g, CA 103 g CFOM 281 g
2		DC of CF in silage = 96.2 – 0.06713 * CFOM in silage = 96.2 – 0.06713 * 281	DC 77.34 %
3		DN of CF in silage = CF * DC in silage = 252* 77.34 / 100	DN 195 g
4	CF 240 g	DC of CF in GF = DN in silage / CF in GF = 195 / 240	DC 81.25 %
5	CFOM 265 g	resulting equation DC of CF in silage = 103.9 – 0.0852 * CFOM in GF = 103.9 – 0.0852 * 265	DC 81.31 %

The resulting DC of the crude nutrients are used in the formula for calculation of ME:
ME (MJ) = CP * DC(CP) / 100 * 0.0147 + CF * DC(CF) / 100 * 0.0136 + CL * DC(CL) / 100 * 0.0312
+ CX * DC(CX) / 100 * 0.0147 + CP * 0.00234
For example: ME (MJ) = 160 * 70.7 / 100 * 0.0147 + 240 * 81.3 / 100 * 0.0136 + 40 * 66.8 / 100 * 0.0312
+ 465 * 71.0 * 0.0147 + 160 * 0.00234 = 10.38

CONCLUSIONS

Using the above mentionned equations, it is possible to estimate the digestibilities of the crude nutrients in silage, out of the crude nutrients analysed in the green forage. Thereafter the ME is calculated. The average deviations of these estimations were 0.18 MJ ME for the first-cut grass silages and 0.16 for MJ ME for the following cuts (data Rutzmoser et al. 2001b). The equations of set (1) – crude nutrients in silage out of the green forage crude nutrients – are based on an average fermatation quality with a recovery rate of 92 % of DM. In comparison to the advantages, especially the earlier results, the deviations from results gained from the corresponding silage seem acceptable.

SUMMARY

A system is presented how to estimate the digestibility of crude nutrients and the ME in grass silage at the basis of analytical data of the green forage. The errors of the estimated values seem to be in an acceptable range.

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NUTRITIVE VALUE OF LEGUME SILAGES

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INTRODUCTION

In recent years more legumes have been cultivated. As legumes absorb nitrogen from the air, they spare the costs on mineral N fertilisers but their ensiling is more risky. Low ensiling ability of legumes is related to their low suger content, high buffering ability and high humity content (Pahlow et al., 2002). To improve the ensiling of legumes, chemical conservants are used (Lättemäe, 2000).

Legumes are characterised as plants with high protein and lignin content, and with relatively low cell wall matter content. Although they contain alkaloids, tannins and estrogenic compounds, these factors are considered to be of secondary importance. Van Soest (1994) has reported that moderate tannin content may even improve the protein utilisation in the rumen of the ruminants. In the growing period, the digestibility of legumes decreases more slowly than that of grasses, and the optimum time for silage preparation is longer. The digestibility of red clover decreased by 0.15% per day, whereas that of rye grass decreased by 0.5% per day (Kaldmäe et al.; 2000).

The nutritive value of silages is mostly affected by the chemical composition of the material, and the digestibility of nutritives, which may be highly variable (from 35 % to 80 %), depending on different conditions (Lopez et al., 2000).

In the present study the effect of legume species on the chemical composition and nutritive value of silage was observed, also the ruminal degradability of legume silage protein and assimilation of nutrients were investigated.

MATERIALS AND METHODS

Legumes were sampled from trial fields in 2000 and 2001. The chemical composition, nutritive value and digestibility of silage prepared from early maturing red clover (*Trifolium pratence* L. *subvar. praecox* Witte) varieties ‘Jõgeva 433’ and hybrid lucerne (*Medicago varia* Mart) varieties ‘Karlu’ at early flowering stage were studied. For this purpose test silages were prepared. Raw material for silages was cut at the height of 5 cm, chopped into 2 cm pieces, supplemented with additive AIV 2000, and conserved into jars. In 90 days the jars were opened. The chemical composition of the test silages was determined according to the generally accepted methods and their nutritive value was calculated. The silage samples were analysed in the Institute of Animal Science of the Estonian Agricultural University. The protein degradability was determinated by *in sacco* method using fistulated cows. The organic matter digestibility of silages were determined *in vitro* by filter bag method using DAISY II and ANKOM analysers and ashing in a muffle furnace.

RESULTS AND DISCUSSION

As the dry matter content of the early maturing red clover variety “Jõgeva 433“ and hybrid lucerne variety “Karlu“ was low during the creation of bud formation (160 g/kg), silage was prepared at the beginning of flowering. At early flowering stage the dry matter content of raw material for the silage of red clover was 171 g/kg and and that of hybrid lucerne 199 g/kg.

The chemical composition and nutritive value of silage of red clover and lucerne are presented in Table 1.

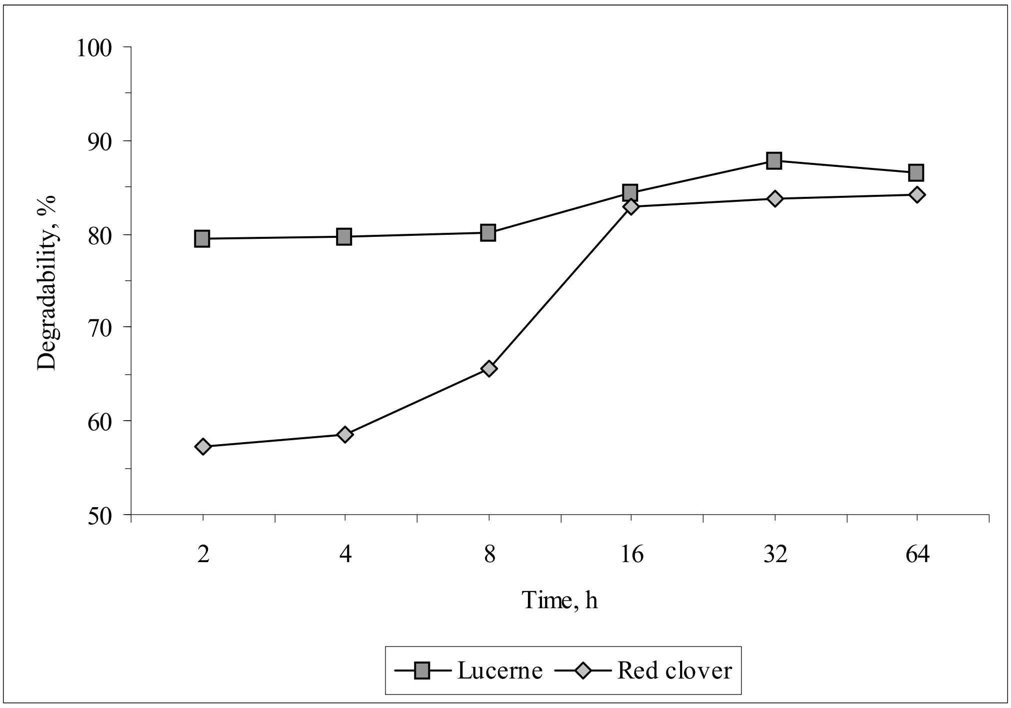
Table 1. The chemical composition and nutritive values of the studied silages

Intems	Lucerne ,n=6		Red clover, n=5	
	$\bar{x}$	s	$\bar{x}$	s
Dry matter, g/kg	193	4.2	188	17.7
In dry matter:				
crude protein, g/kg	184	7.4	164	10.5
crude fibre, g/kg	329	39.9	243	42.6
NDF, g/kg	472	41.3	394	55.6
ADF, g/kg	321	36.6	279	51.3
N-free extractives, g/kg	381	37.8	464	38.6
Ca, g/kg	21.1	2.20	16.2	0.67
P, g/kg	2.7	2.3	2.5	0.41
ME, MJ/kg	9.25	0.5	9.32	0.09
met.protein, g/kg	75.2	18.0	75.9	1.85
OMD, in vitro %	71	18.5	77	2.93

The nutritive value of lucerne and red clover silages was high, their content of metabolisable energy was 9.25 to 9.32 MJ/kg and *in vitro* digestibility of organic matter 71 to 77 % (Table 1). At early flowering the dry matter content was proper for ensiling and the crude protein content was still quite high (188 to 193 g/kg).

The investigation of ruminal protein degradability of different legume silages revealed that the degradation of lucerne protein is very fast already during the first hours of ruminal incubation but is lower in the case of red clover silage (Figure 1). The protein degradability of lucerne and red clover became equal after 16 hours of ruminal incubation. *In sacco* effective degradability of lucerne silage was 84.8 % and that of red clover was 74.3 %.

Figure 1. The ruminal protein degradability of red clover and lucerne silages



CONCLUSIONS

The nutritive value of legume silage depends on the species used.

The dry matter content of legume silage that is not prewilted is low, ranging from 188 to 193 g/kg.

The crude protein content of lucerne silage is higher (184 g/kg in DM) than that of red clover (164 g/kg in DM) but the content of metabolisable protein is almost equal (75.1 and 75.9 g/kg, respectively).

Lucerne silage protein is ruminally very fast degradable compared to red clover protein, which is an important fact to consider in feeding.

The digestibility of lucerne silage is lower than that of red clover as its fibre content is considerably higher.

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NUTRITIVE VALUE AND DIGESTIBILITY OF GRASS AND GRASS/LUCERNE SILAGE PRESERVED IN BIG BALES

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INTRODUCTION

Technology of forage preservation in " big bales " system is based on a wrapping of fresh or more often wilted forage into the stretch film, each bale representing a small silo. Steinwender (1993) recommends 40-60 % DM content in bales. In this trials when comparing a grass silage from clamp silo and big bales, he found better silage quality, higher OM (organic matter) digestibility and also a higher energy concentration in perserved big bales. Hunke et. al. (1997) compared ryegrass silage with silage of grass/clover mixture pressed into round bales at 25-65 % DM. Silage in the bales of 50 % DM was of higher quality, with higher nutrients digestibility and nutritive value.

MATERIALS AND METHODS

During 1999-2001 herbage from seminatural (permanent) grassland (PG) and grass/lucerne mixture (GLM) was harvested in the first cut by a dise mower equipped with MD 5-K conditioner. The swath moisture content was measured continually by the digital hygrometer. According to measured moisture the round bales were pressed at the DM content 370 g/kg (PG 1), 558 g/kg (PG 2), 373 g/kg (GLM 1) and 594 g/kg (GLM 2). After fermentation process silage was analysed in compliance with the Slovak Technical Standard STN 46 7093. The following parameters were determined from the water leach of silage : pH and acidity by electrometer, the content of carboxylic acids by isotachophoresis, ethanol and free ammonia by Conway′s method of acidimetry. Each silage sample was assessed visually (colour, odour, structure) and classified according to the modified Flieg-Zimmer′s scale. Nutrient digestibility of the preserved forage was determined by *in vivo* method with five wethers of Tzigaya breed. Transition and experimental period lasted 10 and 6 days, respectively. Balance trials were done in compliance with the trial methodology establishment, digestibility of DM, crude protein and organic matter were assessed by classical balance method. On the basis of nutrient content and their digestibility the basic parameters of nutritive value of preserved forage PDIE, PDIN, NEL, NEV and ME according to equation in Sommer et al. (1994) publication were calculated. Results were treated by analysis of variance ANOVA.

RESULTS AND DISCUSSION

Presumably, the exelent quality of silage (Tab. 1) resulted from higher DM content which suppressed the development of *Clostridia* in all experimental bales which is proved by a minimum of butyric acid in silage. Favourable effect of higher DM content on quality of preserved forage was also confirmed by Škultéty (1998).

Table 1. Quality of herbage preserved in bales (g/kg DM)

Treatment	Fresh Herbage DM	Acid content			pH	NH_3	Alcohol	Proteol.	Quality points	Quality class
		Lactic	Acetic	Butyric						
PG 1	361.07	18.72	6.42	0.15	5.10	0.94	8.07	4.42	86	I
PG 2	558.86	9.02	5.53	0.12	5.28	0.48	4.67	2.70	69	II
GLM 1	366.10	21.76	8.34	0.00	5.13	1.06	6.56	4.13	87	I
GLM 2	585.58	9.38	3.52	0.12	5.56	0.37	2.76	2.10	83	I
Treatment Tukey (P < 0.05)	++	++	++	+	+	++	++	++	++	++

Jonsson (1990) reported that wilting reduced proteolysis, buturic acid content and *Clostridia* spores. We found that with increasing DM content the production of carboxylic acids ($r = -0.8040^{++}$), ammonia content ($r = -0.7533^{++}$), alcohol content ($r = -0.7779^{++}$) and proteolysis ($r = -0.6455^{++}$) decreased which is in agreement with results of Doležal (1998) that the fermentation process and amount of fermentation products in silages with high DM content is restrained. Comparison of silage quality shows the more ′ successful ′ process of fermentation in GLM than in PG. This silage was characteristic not only by its significant lactic acid content, lower content of acetic acid and alcohol but also by lower proteolysis.

Silage degestibility in our trials can be evaluated as good (Tab. 2), the highest coefficients of DM, CF and OM digestibility were found in balance trials with PG of lower DM content. With increasing DM content in baled silage its coefficients of digestibility of DM ($r = -0.7166^{++}$), CP ($r = -0.3156^{+}$) and OM ($r = -0.7440^{++}$) decreased, which is in agreement with our previous experimental results. Also Doležal (1998) showed the decrease of nutrient′s digestibility of silage of higher DM content which is in lucerne/grass mixtures caused by lucerne faster maturing in comparison with other legumes. Crude fibre content in the sward DM affected the decrease of OM digestibility (r = - 0.6820 ++). According to Biro (2000) the increase of crude fibre in DM from 250 $g.kg^{-1}$ to 330 $g.kg^{-1}$ decreases OM digestibility by 6-8 %.

Table 2. Digestibility coefficients of herbage preserved (%) and nutritive value of silage in the bales (/kg DM)

Treatment	DM	CP	Fibre	OM	PDIN (g)	PDIE (g)	NEL (MJ)	NEV (MJ)	ME (MJ)
PG 1	68.5	69.1	72.4	71.2	71.49	69.64	5.52	5.37	9.38
PG 2	63.6	62.9	67.8	66.4	65.75	66.71	5.17	4.96	8.95
GLM 1	67.5	72.9	69.3	69.3	86.23	80.03	5.54	5.43	9.43
GLM 2	65.9	66.0	66.4	67.6	78.10	66.85	5.39	5.24	9.19
Treatment Tukey ($P < 0.05$)	++	++	++	++	++	++	++	++	++

Significantly higher parameters of nutritive value of baled silage were assessed at LG mixtures when preserved at lower DM content. The higher CP content in LG mixtures influenced positively the increase of protein component of nutritive value (r = 0.8399 ++) and also CP digestibility (r = 0.5155 ++). The lowest nutritive value was achieved at PG silage of higher DM content.

CONSLUSIONS AND RECOMMENDATIONS

With increasing DM content the nutrients′ digestibility of baled silage decreased. The highest values of digestible DM, crude fibre and OM were found at PG 1 silage and the highest values of CP digestibility were assessed in LG 1 silage. The highest level of nutritive value parameters were found in LG 1 silage. Significantly lowest nutritive value was determined in PG 2 silage.

To achieve good quality, nutritive value and nutrients′ digestibility in baled silage it is necessary to work with optimum DM content 350-400 g/kg and 370-450 g/kg of permanent grassland and lucerne/grass mixtures, respectively.

SUMMARY

During 1999 – 2001, quality, nutritive value and digestibility were studied in baled silage made from permanent grassland herbage (PG) as well as from grass/lucerne mixture (GLM), both of which were harvested at the 1st cut. The bales were pressed at mean dry matter (DM) content of 370 g/kg in PG 1, 558 g/kg in PG 2, 373 g/kg in GLM 1 and 594 g/kg in GLM 2, respectively. The assessment of quality showed better fermentation in the GLM silage than in the silage made from PG herbage. Significantly higher content of lactic acid, lower content of butyric acid and lower proteolysis were found in the GLM silage than in the PG one. The highest coefficients of crude protein (CP) digestibility (65.9 – 72.9 %) and the best nutritive value parameters were recorded at GLM 1 treatment with the lower DM content. Significantly lower nutritive value and digestibility were found in both the types of silage when ensiled at the higher DM content.

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EFFECT OF STARCH AND PROTEIN SOURCE ON THE MICROBIAL PROTEIN SUPPLY IN DAIRY COWS FED RED CLOVER RICH SILAGE

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INTRODUCTION

Traditionally in Estonia legumes, especially red clover, have played an important role in the production of grass feeds. Most frequently red clover is grown in mixture with timothy. With the spread of sustainable agricultural production the importance of legumes in crop rotation is increasing. In feeding legume-rich silages the major problems are extensive protein degradation that occurs already during ensiling, rapid hydrolysis of plant protein and the low efficiency of microbial protein synthesis in the rumen (Hatfield and Muck 1999; Messman et al., 1994). The objective of this experiment was to evaluate the effect of dietary starch and protein source on the efficiency of microbial N supply, feeding red clover rich silage to dairy cows.

MATERIALS AND METHODS

For cows entering their first lactation 4 x 4 Latin square design was used with a 2 x 2 factorial arrangement. Each cow received one of the four diets (Table 1) during each 14-day experimental period (8-day adaptation period and 6-daymeasurement period). All rations contained 40 per cent red clover rich silage (C) and 60 per cent concentrate on the basis of metabolizable energy. Concentrate was composed either from barley meal (B), corn meal (M), rapeseed cake (R) or soybean meal (S) so that crude protein content in DM was 18 per cent. Additionally all cows were fed 220 g vitamin-mineral premix and 100 g common salt per day.

Table 1. Composition of diets (MJ/d)

Ingredient	Diet			
	CBR	CBS	CMR	CMS
Red clover rich silage	99.2	99.2	99.2	99.2
Barley meal	114.1	125.8	-	-
Maize meal	-	-	96.5	112.3
Rapeseed cake	34.7	-	52.3	-
Soybean meal	-	23.0	-	36.5
Total	248	248	248	248

Cows were fed in two equal portions at 0600 and 1700 h. The first one provided concentrate, vitamin and mineral premix, salt, and after 1 h the silage. Orts were removed before each feeding time, weighed, subsampled, and retained for chemical analysis. Cows were housed in tie stalls bedded with peat, and milked in their stalls at 0500 and 1500 h. Mean milk production was recorded on the last 6 days of each period. Weighed means for milk fat, protein, lactose, and urea content were determined from milk that was sampled during the morning and evening milking on the 9^{th}, 11^{th} and 13^{th} day of each period.

Collection of total urine was made during two last days with the aid of harnesses. Total urine was weighed, and unit weight was measured daily. After each urination 100 ml per 10 kg urine was sampled into a glass jar in which there was 100 ml 10 % sulfuric acid to keep the pH below 3 and to prevent purine derivative degradation. Immediately after each trial period each sample was analysed for total N, urea, allantoin and uric acid content. Urine allantoin and uric acid were analysed and microbial protein supply was calculated according to Chen and Gomes (1992).

Data were analysed using the fit model procedure of MIXED (SAS Institute) according to the following model: $Y_{ijkl} = m + T_i + P_j + T_i \times P_j + L_k + e_{ijkl}$,where Y_{ijkl} = investigated characteristic, m = overall mean, T_i = fixed effect of starch, P_j = fixed effect of protein, L_k = random effect of cow, e_{ijkl} = residual, assumed to be normally distributed.

RESULTS AND DISCUSSION

The starch and protein source had no effect on milk production but they affected milk composition. In that experiment the starch source affected milk fat content and the protein source affected milk protein content, milk protein production and milk urea content. When the cows were fed barley meal, their milk fat content was lower than when fed with maize meal. Milk protein content was higher and urea content lower with rapeseed oil meal feeding in comparison with soybean oil meal feeding.

Table 2. Milk production and composition

Item	Diet				P value		
	SBR	SBS	SCR	SCS	Starch	Protein	INT[2]
Yield in kg/d							
Milk	32.0	31.7	31.6	31.5	0.4098	0.6384	0.7472
Milk fat	0.97	0.99	1.08	1.11	0.0738	0.6460	0.8788
Milk protein	0.97	0.95	0.97	0.91	0.3254	**0.0394**	0.2591
ECM	27.3	27.3	28.5	28.4	0.1398	0.7331	0.9061
Milk composition in %							
Fat	3.06	3.14	3.43	3.58	**0.0320**	0.6198	0.7950
Protein	3.05	3.01	3.10	2.92	0.6686	**0.0097**	0.0979
Urea[1]	272	313	286	327	0.1738	**0.0005**	0.9330

[1]Urea in mg/l,
[2]INT – Interaction of dietary starch and protein in the diet.

The starch source also affected the excretion of allantoin and uric acid, the amount of ruminally synthesised microbial protein N and the efficiency of microbial protein N synthesis. The protein source affected the amount of urinary N excreted and the efficiency of microbial protein N synthesis.

Table 3. Excretion of nitrogen and purine derivatives via urine and microbial protein supply of cows.

Item	Diet				P value		
	SBR	SBS	SCR	SCS	Starch	Protein	INT[1]
Excretion in g/d:							
Nitrogen	169.6	188.4	162.5	191.8	0.8613	**0.0266**	0.6100
Urea-N	94.9	102.1	98.8	122.2	0.1505	0.0696	0.3237
Allantoin	66.6	64.3	51.2	48.6	**0.0000**	0.0901	0.9198
Uric acid	6.8	6.9	5.1	5.6	**0.0004**	0.4322	0.6320
Supply:							
Microbial N in g/d	356.2	343.9	264.4	252.2	**0.0000**	0.1680	0.9993
Microbial N/DOMR[2] in g/kg	42.2	40.1	32.3	29.2	**0.0000**	**0.0293**	0.6424

[1]INT – Interaction of dietary starch and protein in the diet.
[2]DOMR – Digestible organic matter in the rumen, calculated as 0.65 x digestible organic matter intake.

CONCLUSIONS

In the rations based on red clover rich silage, it is proper to use barley meal as the starch source but its excessive amounts may decrease milk fat content. The microbial protein synthesis in the rumen is less affected by protein source than by starch source. In our experiment the cows used the protein of rapeseed oil meal more efficiently that that of the soybean oil meal.

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EFFECT OF STAGES OF MATURITY ON CRUDE PROTEIN, Ca, Mg AND P CONTENT IN LEAVES AND STEMS OF LUCERNE AND THEIR RELEASE DETERMINED BY IN SACCO METHOD

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INTRODUCTION

Lucerne is avowed as quality crop in the nutrition of beef-cattle and it is characterized by high content of crude protein and cell walls. Lucerne has higher nutrition value thanks to its anatomic microstructure in comparison to grass. Lucerne leaves contain a little of cell walls and lignin, therefore lucerne is characterized by high degradability or digestibility especially of crude protein (Čerešňáková et al., 1997). Utilization of minerals depends on solubility and release of the element from the feed and from its absorption from digestive tract. Level of utilization of minerals depends on several factors as variety of feed, its mineral composition, intake and digestibility of minerals and its form and availability for animals (Flachowsky et al., 1994).

The aim of our work was to determine crude protein degradability and disappearance of Ca, Mg and P from lucerne in the rumen by *in sacco* method.

MATERIAL AND METHOD

We made experiment with lucerne (Medicago sativa) during the vegetation within 1. mowing.

We harvested green mass in Drážovce area (Nitra district) in weekly periods from 2.5.2001 – 1. sampling (9.5 – 2. sampling, 16.5. –3. sampling, 23.5. – 4. sampling, 30.5. – 5. sampling) until the start of the flowerage. We dried leaves (L) and stems (S) separately from each sampling at room temperature.

We determined crude protein degradability in lucerne by in sacco method after 0, 6, 9, 16, 24, 48, 72 and 96 hours and the disappearance of minerals Ca, Mg and P after 16 hours incubation in the rumen.

In sacco experiments were carried out in two Black –White Pied oxes with big rumen cannulas (an average 10 cm) of live weight approx. 590 kg . The oxes were fed twice daily. Bags made from Uhelon T 130 contained 15 mg sample per 1 cm^2 of bags´s surface. These were inserted to the rumen immediately before morning feeding. Nondegraded content was weighted after washing and drying (24 hours, 55 ^oC) then milled and analysed. We determined crude protein content in original samples and residues of lucerne (MP SK 1497/4/1997-100), Ca, Mg by AAS method and P colorimetrically by molybdo-vanadate method. Crude protein effective degradability at passage rate of 0.06 and 0.08 h^{-1} was calculated by the program Neway according to Orskov and McDonald (1979).

RESULTS AND DICUSSION

Table 1. The content of crude protein, P, Mg and Ca ($g.kg^{-1}$)

Sampling	Plant	Crude protein	P	Mg	Ca
1. (2.5)	Leaves	315.2	3.51	1.97	12.6
	Stems	184.9	3.29	2.5	7.75
2. (9.5.)	Leaves	309.5	3.05	2.83	17.45
	Stems	170.4	2.99	1.59	5.64
3. (16.5.)	Leaves	336.0	2.29	3.57	18.89
	Stems	171.6	2.92	1.58	5.53
4. (23.5.)	Leaves	281.0	2.62	3.13	20.7
	Stems	124.0	2.39	1.41	5.28
5. (30.5.)	Leaves	283.9	3.45	3.18	23.39
	Stems	120.6	2.21	1.55	4.8

The content of crude protein in leaves has increasing tendency , later its fraction decreases by growing older of stand. In stems there is crude protein content markedly lower as in leaves and it decreased by growing older of stand (Table 1). Svetlanská et al. (1999) reported similar results. The content of crude protein was 248.0 $g.kg^{-1}$DM in the whole plant. The content of minerals is different and depends on the element and vegetation stage of the stand. Ca achieves the highest level in leaves (in the last samling 23.39 $g.kg^{-1}$). Emanuelle and Staples (1991) found out the content of Ca 14.6 %, Mg 3.9% and P 2.2 % in the whole plant. Crude protein degradability is different in leaves and stems and it depends on the stage of maturity, too. Janicky and Stalings (1988) presented crude protein degradability 71.1 %, Alvir et al. (1988) 73.6 % and Třináctý et al. (1996) 75.3%. Leaves show markedly higher effective crude protein degradability as stems on average (Table. 2).

Table 2. Charakteristics of crude protein degradability and disappearance of minerals P, Mg, and Ca from leaves and stems of lucerne

Sampling	Plant part	Fraction			Edg (%)		Disappearance of minerals after 16 h incubation in rumen		
		a %	b %	c %.h-1	Passage rate (%.h-1)				
					0.06	0.08	P	Mg	Ca
1. (2.5.)	L	58.3	112.2	0.026	89.7	83.2	73.9	93.1	80.3
	S	71.1	99.5	0.009	84.6	81.7	87.2	92.6	89.6
2. (9.5.)	L	50.0	42.1	0.230	83.2	81.0	68.3	96.3	84.9
	S	64.9	25.9	0.069	79.1	77.3	81.1	83.9	70.1
3. (16.5.)	L	57.7	38.0	0.183	85.7	83.5	68.3	949	65.2
	S	79.5	60.0	0.002	72.4	72.0	787	86.3	66.1
4. (23.5.)	L	38.1	56.0	0.159	78.9	75.7	87,4	94.0	85.1
	S	57.3	22.3	0.138	70.0	68.6	90.5	82.2	69.4
5. (30.5.)	L	22.1	72.5	0.259	82.8	79.8	81.7	94.0	79.8
	S	40.3	38.5	0.288	73.0	71.6	77.7	83.7	54.4

The disappearance of Ca, Mg and P in leaves and stems after 16 hours incubation is presented in Table. 2. Emanuele et al. (1991) reported release of minerals from six feeds and at 0 incubation disappearance of Ca was 46.7 %, Mg 71.8 %, and P 75.9% from lucerne. The disappearance of elements in our experiment depended on the stage of maturity of harvested lucerne and was observed different disappearance of elements from leaves and different one from stems. The disappearance of individual elements is decreasing gradually by growing older of the stand.

CONCLUSION

Our results of crude protein content in leaves and stems indicate its changes with stage of growing of lucerne.

The crude protein content is decreasing and also the ratio of monitored elements is changing with growing stage of maturity. Crude protein degradability decreases at passage rate 0.06 h^{-1}, the highest degradability achieved in leaves and stems was in the first sampling and the lowest in the fourth sampling The highest content of P was from the first sampling in leaves and stems, Mg from the third sampling in leaves and from the second sampling in stems. Calcium achieved the highest content in leaves from the fifth sampling and in stems from first sampling

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DETERMINATION OF THE *IN SACCO* DEGRADATION CHARACTERISTICS OF WHOLE-CROP PEA (*PISUM SATIVUM* L.) SILAGES

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IINTRODUCTION

The use of peas in ruminant diets has historically been as a protein concentrate. However work carried out by Mustafa *et al* (Mustafa *et al.* 2000; Fraser *et al.* 2001; Hart *et al.* 2002) has shown potential for the use of whole-crop pea silage as a ruminant feedstuff. The presence of condensed tannin in feedstuffs can have both positive and negative effects on protein degradation (Min *et al.* 2003). High levels of tannin can affect protein breakdown mechanisms within the rumen by complexing with the proteins rendering them unavailable to the rumen mucrobes, but low levels of tannin can protect protein n the same fashion, but not disrupt over all rumen function. The use of coloured flowered peas (tannin containing) may lead to an increase in rumen by-pass protein. To date there is a lack of data regarding the degradation characteristics of pea silages. This study was designed to determine the rumen degradation of pea silages in order to help facilitate formulation of ruminant diets that contain pea silage.

MATERIALS AND METHODS

Forage production Two varieties of spring sown semi leafless combinable peas *cv*. Racer (Cebeco, Netherlands) and Croma (Cebeco) were grown during the 2002 season according to standard agricultural practise. Peas were cut at growth stage 206 (Knott 1987) using a drum mower, allowed to wilt for 36hrs and processed using a self propelled forage harvester (Class Jaguar). Peas were ensiled with a bacterial inoculant (Wholecrop Legume; Biotal, Cardiff, UK) and were placed into covered concrete bunker silos. After 60 days of ensiling core samples (approximately depth 40cm) were taken from five points across the clamp, mixed and stored chilled at +4°C for the duration of the experiment.

Animals and diet Four Suffolk cross ruminally cannulated wethers (average live weight 105kg) were housed in individual slatted floor pens. Animals were housed in a controlled environment room maintained at 15°C and constantly lit. Animals had continuous access to water. Animals were fed a diet, formulated to be 105% of daily requirements (AFRC 1993), of hay and a standard concentrate at a ratio of 70:30 (dry matter basis) for the duration of the experiment. The concentrate consisted of barley (48.5%), sugar beet pulp (22%), hi-pro soya bean meal (11%), molasses (3.5%) and rapeseed meal (15%).

***In sacco* procedure** Approximately eight grams of fresh silage was weighed into a mono-filamentous precision woven polyester bag with internal dimensions of 23x9cm and an aperture of 43µm. Bags were sealed by passing the neck of the bag through a brass curtain ring (18mm diameter) and folding the neck back on itself and securing with a coloured elastic band to indicate the contents. Bags were connected to an anchor weight (stainless steel clip) which was attached to the cannula cap by a length on nylon cord (length 30cm). Triplicate bags were incubated in each sheep for either, 2, 4, 8, 16, 24, 36, 48 and 72 hrs in a continuous changeover design (Huntington and Givens 1995). Upon removal bags were washed in a washing machine (Electra, AWM1100B) on a standard cold cycle (cycle 7, with spin cancelled) and oven dried at 65°C for 48hrs. Zero time point bags were analysed by washing un-incubated bags of silage on a standard cold cycle in the washing machine. Dried samples were then combined within each time point within each sheep and milled to pass through a 1mm screen. Bag residues were analysed for dry matter, nitrogen (Kjeldahl method) and organic matter. Data was fitted to the first order model described by Ørskov and McDonald (1979), $P=a+b(1-e^{-ct})$, where P=potential degradability, a=immediately soluble fraction, b=the degradable part of the insoluble fraction, c=fractional rate (hr^{-1}) of degradation of b and t=incubation time. Data was fitted using Sigmaplot (version 8.2) and statistically analysed using Genstat (version 5)

RESUTS AND DISCUSSION

The results for dry matter degradation can be seen in Figure 1. The goodness of fit values (r^2) were 0.93 and 0.92 for white and coloured flowered peas respectively. All of the fitted coefficients differed statistically ($P<0.001$) between varieties.. The white flowered pea had a higher ‘a’ term 0.44 vs. 0.42 (n=8, s.e.d.=0.009), higher ‘b’ term 0.41 vs. 0.40 (n=8, s.e.d.=0.008) and a higher ‘c’ term 0.09 vs. 0.08 (n=8, s.e.d.=0.006). Results show that more of the dry matter is potentially degradable in the white flowered variety of pea compared to the coloured flowered variety, 0.85 vs. 0.82 (a+b; n=8, s.e.d.=0.007) of pea silage. Results for nitrogen and organic matter degradability can be seen in Table 1.

Table 1. Nitrogen and organic matter degradability coefficients

	Nitrogen degradation			Organic matter degradation		
	White flowered	Coloured flowered	s.e.d.	White flowered	Coloured flowerd	s.e.d.
a	0.78	0.74	0.011	0.41	0.40	0.011
b	0.17	0.19	0.008	0.43	0.41	0.014
a+b	0.95	0.94	0.007	0.85	0.82	0.007
c	0.255	0.107	0.0801	0.092	0.085	0.006
r^2	0.85	0.96		0.98	0.98	

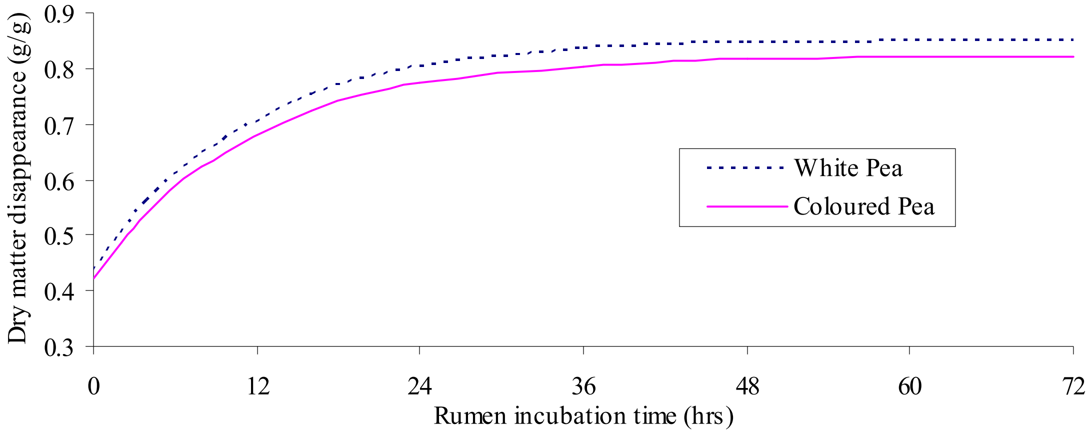

Figure 1. in situ dry matter degradation of pea silages over time

Results for both nitrogen and organic matter degradation show that the white flowered pea variety degrades to a greater extent than the coloured flowered variety. When degradation characteristics are applied to the UK metabolisable protein system as described by AFRC (1993) the rumen degradable protein (ERDP) was similar to the coloured flowered variety (138.6g/kgDM vs. 137.3g/kgDM), but the coloured flowered variety had a higher rumen by-pass fraction (DUP; 18.47g/kgDM vs. 9.48g/kgDM). Effective degradability of the pea silages was calculated for fractional rumen outflow rates of 0.02/hr (sheep at maintenance), 0.05l/hr (growing sheep/beef cattle/calves/cows <15l milk/day) and 0.08/hr (cows >15l milk/day) and were 0.94, 0.92 and 0.91 for white flowered pea silage and 0.91, 0.88 and 0.86 for the coloured flowered pea silage.

CONCLUSIONS

The lower degradation of dry matter and protein in the rumen of the coloured flowered variety of pea may have been due to the presence of condensed tannin. This may also explain the higher digestible undegradable protein (rumen by-pass protein) in this pea variety. Due to the high proportion of immediately degradable nitrogen peas would need to be fed in conjunction with a readily available source of carbohydrate such as fermented whole-crop wheat silage or maize silage.

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CALCIUM. SODIUM. POTASSIUM AND MAGNESIUM CONTENT IN THE SELECTED FORAGES AND IN SACCO DETERMINATION OF THEIR RELEASE IN THE RUMEN

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INTRODUCTION

There is a little information on the elution or solubilization of minerals from feed particles in the rumen. Utilization of minerals depends on their release from forages during passage through the digestive tract. The extent of minerals disappearance depends on ion- exchangeable groups in plant cell walls (van Soest et al.. 1991) and their location in the plant structure. The release of major elements (Na, K, Ca, Mg, P) from the nylon bags depends on mineral content and fibre source of incubated feed. incubation time and differences in diet mineral levels (Flachowsky et al. 1992). The aim of the present experiment was to determine disappearance of selected elements from forages in the rumen of yong bulls using *in sacco* method.

MATERIAL AND METHOD

In sacco method was used for determination of Ca, Mg, Na, K disappearance from two samples of lucerne hay with various content od NDF (1and 2**)**, grass (*Dactylis glomerata*) variety Rela (3)**,** grass silage (4**)**, clover silage treated with biological additive Feed Tech (5) resp. with chemical additive Kofasil (6). The samples of feeds were incubated in the rumen of two bulls (ϕ LW 450 kg) with large rumen fistula (i.d. 10 cm) for 0, 6, 9, 16, 24, 48 resp. 72 h. The minerals of feeds and of residues after washing. drying and grinding were analysed by AAS (UNICAM SOLAAR 939 Spectrometer, Cambridge, UK).

RESULTS AND DISCUSSION

There are differences in nutrients content in experimental feeds (Table 1). Mainly NDV and /or crude fibre content is higher in grass (*Dactylis glomerata*) and in grass silages than in lucerne from both cuts and clover silages.

Table 1. Content of nutrients in experimental forages (g/kg DM)

Nutrient	Feeds					
	Lucerne		*Dactylis glomerata*	Silage		
	1.cut 13.5.1998	2. cut 8.7.1998	Rela	Grass	Clover treated with Feedtech	Clover treated with Kofasil
Dry matter	218.6	307.6	171.1	212.8	299.1	314.2
CP (Nx6.25)	210.0	191.3	140.7	172.6	211.6	226.8
Crude fibre	281.9	285.5	348.8	331.9	234.2	244.8
NDF	351.7	383.7	597.7	545.5	325.5	361.7
Organic matter	873.7	905.6	899.8	920.7	874.8	867.5
Magnesium	3.3	1.7	1.5	1.9	3.6	3.7
Calcium	15.8	10.4	3.7	4.8	15.3	15.5
Sodium	0.28	0.31	1.8	0.50	0.20	0.39
Potassium	34.8	21.6	31.4	23.2	29.0	23.2

The content of individual minerals in the forages was inconsistent. The content of Mg and Ca was higher in lucerne and clover silages and lower in grass and grass silage. There were found out the differences in the content of Mg, Ca, Na and K in lucerne from 1. and 2. cut.

The percentage of mineral immediately (0 h) released varied with the forage species and the mineral. The range among these forages was 37.1 to 78.05 % for Mg. -22.5 to 53.6 % for Ca. 95.7 to 99.8 % for K. 32.3 to 85.82 % for Na (Fig. 1).

Release of Mg was extensive for all experimental forages and followed similar pattern to that of Ca release. Mg release was greater than Ca. Disappearance of Ca and Mg over time of incubation was much lower from forages with the highest NDV concentration (grass and/or grass silage) than from legumes. Grass Ca was released to a greater extent than other forages Ca ($P<0.05$). Mg release were significantly lower from grass and grass silage than from the others ($P<0.05$). The similar results echieved Emanuele et al. (1991) in experiment with six forages. McBurney et al. (1983) suggested that Ca is bonding to negatively charged functional groups of cell walls. In Na release from forages ranked in greater extent than other minerals over time of incubation and the differences between forages were significant ($P<0.05$). The release of potassium from all samples and all incubation times was higher than 97 % including washing loss (Fig. 1 and Table 2).

Figure 1. Elements release from tested forages in washing process

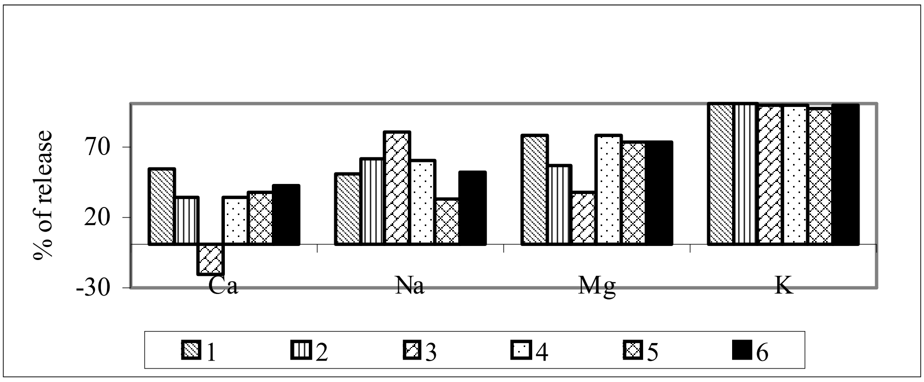

Table 2. Release of individual minerals (%) during incubation of farages in the rumen

Inc.	Ca						Mg						Na						K					
time	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
6	67	59	-24	16	50	52	89	84	51	76	80	79	62	76	86	46	41	74	99	99	98	99	97	99
9	73	66	-18	47	67	67	91	87	56	83	86	85	64	78	83	53	45	81	99	99	98	99	98	99
16	81	78	34	58	81	80	94	92	78	82	92	92	74	82	91	58	76	88	99	99	99	99	98	99
24	83	83	48	65	83	85	95	94	83	86	93	94	81	86	95	64	76	89	99	99	99	99	98	99
48	73	67	62	67	87	87	89	89	89	90	95	94	72	83	97	70	78	91	99	99	99	99	98	99
72	70	65	67	72	84	86	90	88	90	92	93	95	72	81	98	78	72	90	99	99	99	99	98	99

CONCLUSION

This study demonstrate that the rumen to be the major site of mineral release from these forages.The in situ method is suitable for detecting differences among forage species and among minerals disappearance. The minerals could be ranked based on maximal extent of release as follows: K> Mg > Na >Ca. Ca. Mg and Na release depends on stage of maturity of forage, NDF content and ruminal enviroment. Release Ca needs longer time because they are assotiated with the plant cell wall. With the exception of potassium, grasses released less of their minerals than legumes. The utilisation of minerals have to be evaluate from this point of view. The release of individual minerals can not be consider as a factor limiting the ability of the ruminant to absorb Ca,Mg, Na or K.

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DIGESTIBILITY OF FEEDING RATION IN RELATION TO THE TYPE OF SILAGE

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INTRODUCTION

Submontane and mountain regions are spread on a relatively large area of Slovakia and there is produced more than half of bulky feeding stuffs of the country. A sufficient production potencial of the country as well as favourable agri-climatic conditions support the polygastric animals rearing. Anyway, a long-term problem arising in these regions is a sufficient production of quality roughages. As the majority of area is covered by grassland, silage of grass and grass/clover mixture of higher DM content should form the basis of feeding rations, especially in winter period. To make dairy cows rearing economically effective in these regions, the roughages have to be of good quality for quality milk production provided the whole production is economical. The aim of this work is to concribute to the knowlede of the impact of feeding grass and grass/clover silage of higher DM content to dairy cows by means of comparison of nutrients′ digestibility depending on type of ensiled forage.

MATERIALS AND METHODS

Experimental works were done in semi-production conditions with dairy cows of Holstein-Friesian breed in second lactation of 6000 kg milk production per-lactation. The dairy cows were divided into two groups : first group was fed during the whole lactation by grass/clover silage with higher DM content (Trifolium pratense var. KVARTA 4n, intergeneric hybrid BEČVA-Lolium multiflorum x Festuca arundinacea, intergeneric hybrid ODRA-Lolium multiflorum x Hybridum Heausskn.) and second group was fed by silage of higher DM content, which was made of permanent grassland forage (*Lolium* perenne, *Festuca rubra*, *Festuca pratense*, *Dactylis glomerata*, *Phleum pratense*, *Poa pratense*, *Trifolium repens*, *Trifolium pratense*).

The swards were fertilised by 110 kg/ha N and 50 kg/ha P and harvested from the first cut at the beginning of flowering stage of the dominant grass species. When optimum DM content was achieved the wilted forage was preserved in big bales. After fermentation finished and then during the whole period of trial the silage samples were taken to determine nutrients′ concentrations and nutritive value in two weeks intervals.

The whole feeding ration consisted of silage of higher DM content as a main bulky feeding-stuff and of concentrate mixture : concentrate feeding mixture HD-12, crushed corn maize and soja grid. Four dairy cows of each group were in a balance trial to assess the digestibility of examined feeding rations. The investigation was done according to methodology of balance experiments by classical balance method. The feeding dose was analysed for digestibility of DM, crude protein (CP), crude fibre (CF) and nitrogen-free extract (NFE). On the basis of nutrients′ concentration and their digestibility the main parameters of nutritive value of the feeding ration (PDI,NEL and ME) were calculated. Results were statistically treated by analysis of variance ANOVA.

RESULTS AND DISCUSSION

The feeding ration digestibility is affected by many factors, of which the most important are a type of feed-stuff, nutrients concentration, growth stage of mowed forage, preservation method of ensiled biomass, composition of feeding ration and feeding technique. The most common reasons of reduced roughage quality and increased energy losses are late harvest date and also harvest technology which is not adjusted to forage requirements and actual weather conditions. A reduced potential production of biomass is caused by a harvest of grass and grass/clover mixtures in later phenological stages because with increasing DM content the nutrients′ digestibility decreases. Optimum parameters were found by Knotek, Žiláková (1983) at DM content 313.5 g/kg, while very rapid decrease of nutrients′ digestibility was found after 370 g/kg DM. Decrease of degradability and OM digestibility is seen in context with increasing crude fibre content and its individual components (Svetlanská et. al., 1999). According to Shoemaker (1991) the OH digestibility is the most negatively influenced by higher lignin concentration in forage. Lignim incrustation of structural carbohydrates and of other chemical components (e.g. proteins, pectins and hemicellulose) and making versilible construction with then prevents the enzymes′ penetrating into fibre structure and thus decreases its digestibility.

After treatment of results of balance trials the digestibility coefficients of experimental feeding rations above 70 % level were determined. Some authors (Demarquilly, Andrieu,1992, Petit et.al.,1993) consider as sufficient the OM digestibility higher than 65 %. The significantly higher digestibility of dry matter, crude fibre and organic matter was found at silage of grass/clover mixture (DM content of 320-360g/kg). It is assumed that this was caused not only by higher DM content of grass silage (380-430 g/kg) but also by a higher crude fibre content, which is in negative correlation with digestibility of other nutrients. A negative correlation between crude fibre content, OM digestibility and digestibility of individual nutrients is shown by Valihora (2000). In spite of this fact the digestibility of nutrients in both studied feeding rations was at a quite good level which was done by balancing of feeding rations with concentrate composition and its amount. At adjustment of digestibility it is necessary to take into consideration the nutrition level of animals because the higher nutrition level decreases OM digestibility in dependence on bulky and concentrate feed-stuffs ratio.

Table 1. Mean coefficients of nutrients digestibility in silage

group	feeding stuff		DM	CP	CF	NFE	OM
1.	GCM silage		63,13	57,43	78,14	60,29	66,43
	Whole feeding ration (WFR)		72,57	73,56	78,60	73,01	75,21
2.	PG silage		57,41	54,71	71,11	56,79	61,51
	Whole feeding ration (WFR)		70,92	76,17	72,12	72,36	73,45
Tukey ($P \leq 0,05$)	Group	GCM silage	+	+	+	+	+
		WFR	–	+	+	–	–

CONCLUSIONS AND RECOMMENDATIONS

Grass and grass/clover silage of high DM content which are made of swards with good combination of grasses and legumes can afford a high production efficiency of feeding rations with high nutrients′ digestibility for dairy cows. Suitably chosen somposition of concentrate feed, balancing the production need of dairy cows enables such silage to be used as a unique bulky feed in feeding ration, however taking into account the intraction of individual feeding-stuffs. Thus in mountain and submontane regions of Slovakia grass and grass/clover swards form a sufficient feed basis of high quality petential for the needs of animal production.

SUMMARY

Digestibility of silage with high dry matter (DM) content and that of full production feeding ration were investigated in relation to the type of silage. The research was performed with eight Holstein dairy cows at the end of the first third of their lactation period. The digestibility trials were carried out in compliance with the classical methodology. During the lactation, the feeding ration consisted of the concentrate and of the silages with high DM content made from grass/clover mixture (GCM) and from permanent grassland herbage (PG) with nearly identical nutritive value. The coefficients of digestibility determined in the feeding rations exceeded 70 % level. Significantly higher digestibility of DM, fibre and organic matter (OM) was found at GCM silage. Good results were recorded due to excellent silage quality, sufficient energy content, optimum composition of organic acids and the nutrient ratio in DM.

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CHARACTERISTICS MAIZE HYBRIDS FOR SILAGE SEMPOL HOLDING A.S. TRNAVA

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INTRODUCTION

Silage maize is a very well silageable crop. Low quality of produced silage is the evidence that not all technological principles are observed at production of maize silage.

Harvest of technologically ripe maize enables to produce feeds tuff from which is starch in the reticulum more slowly decomposed as starch of other crops and its passage into the round leads to a better usage and improvement of providing milk cows with glucose with the subsequent increase in milk yield. A lower velocity of decomposition of maize starch is connected with a higher percentage of maize grain dry matter. From this viewpoint, a choice of hybrids seems to be correct as one of the basic elements that can in the beginning of growing significantly effect the final success of growing. Its effect is usually admitted at 40 % of the total yield which shifts the value of field trials with maize hybrids to a pronouncedly other position as perceived. In case silage hybrids it is necessary to lay emphasis on the total yield of dry matter, energy and organic matter digestibility.

MATERIAL AND METODS

The aim of this work was to evaluate nutritive value and digestibility of organic matter and dry matter of eighteen hybrids for silage of SEMPOL Holding a. s. Trnava .

The hybrids were observed on the plots of the Animal Production Research Institute (VÚ□V) in Nitra . Hybrid samples for analysis were taken at stand cutting for theoretical height of 5 mm by a Class cutter. Parameters characterising hybrids were observed. Based upon the measured parameters, theoretical yields of fresh matter of whole plants and ears were calculated.

RESULTS AND DISCUSSION

Table 1. Nutritive value of dry matter of eighteen hybrids for silage of SEMPOL Holding a. s. Trnava.

Hybrid	NL	PDI	Fiber	NEL	NEV
	g.kg^{-1} dry matter			MJ.kg^{-1} dry matter	
Kysuca	74,90	47,1	306,11	6,58	6,70
Orava	65,10	40,9	266,01	669	6,83
Tereza	65,79	41,5	227,79	7,00	7,00
Torena	64,46	40,8	246,78	6,90	6,90
Tiara 260	68,20	43,3	221,46	7,01	7,01
Valentina	85,40	53,5	232,00	7,01	7,01
Markiza	78,31	49,3	259,38	6,63	6,69
Tantal	78,86	49,7	249,50	6,63	6,68
Helena	75,07	47,3	225,20	6,70	6,77
Karolina	84,94	53,3	220,64	6,74	6,82
Lucia	81,36	51,1	238,20	6,76	6,86
Toskana	77,02	48,3	234,83	6,64	6,70
Marusia	88,83	55,9	248,63	6,77	6,88
Mila	85,95	54,0	224,00	6,75	6,85
Acka	88,17	55,4	187,78	7,10	7,29
Anna	85,90	54,0	230,40	6,76	6,85
Valika	89,12	56,0	217,29	6,99	7,16
Erika	80,40	50,4	221,70	6,75	6,84

To ensure the optimal value between the volume production and content of digestible energy is necessary to reasonably correct the plant numbers dependent upon the thermal and humidity conditions of a plot and the corresponding hybrid earliness. To reach optimization, however is necessary to analyze in detail accumulation of energy and its digestibility in the individual maize organs.

Besides energy concentration in maize silage, the problem deals also with feed stuff usage since although the lignine part of biomass coming mainly from the basal part of the stalk is rich in energy. It can be used only in the minimal extent. Energy production in MJ NEL and NEV shows a very good energy production of the observed hybrids. A certain variability between hybrids in energy production is probably significantly effected by the course of climatic factors, factual location conditions, agronomic interventions, and it can be different with the same hybrid in various years.

RECOMMENDATIONS

The silage maize hybrids fy SEMPOL Holding a.s.

Potato area :
colder and moisture part: KYSUCA, ORAVA, TORENA, TEREZA
warmer and dryer part: TEREZA, VALENTINA, TATO 260 S, MARKIZA

Beet area:
colder and moisture part: VALENTINA, MARKIZA, FABIA, NOVA,TANTAL, HELENA
warmer and dryer part: VALENTINA, TATO 260 S, MARKIZA, FABIA, HELENA, KAROLINA, LUCIA

Maize area:
Moisture part: KAROLINA, LUCIA, TOSKANA, MARUSIA, MILA 400, ACKA, ANNA, ERIKA
Dry part: ACKA, ANNA, ERIKA

QUALITY AND AEROBIC STABILITY OF SILAGES MADE OF *ACREMONIUM* ENDOPHYTE-INFECTED TALL FESCUE GREEN FORAGE WITH DIFFERENT ADDITIVES

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INTRODUCTION

Permanent grasslands (*Festuca, Lolium*) are very often infected with endophytic fungi *Acremonium* (Naffa et al., 1998). Produced green forage can be dangerous to animals because of mycotoxines content (Auldist and Thom, 2000; Emile et al., 2000; Lewis, 1996). Acids produced during ensiling process have destructive action of fungal organisms. The objective of this study was to determine if the preservation of endophyte-infected green forage by ensiling effects quality and aerobic stability produced fodder.

MATERIALS AND METHODS

The study was conducted on tall fescue var. Pasja green forage. Seeds was derived from Experimental Station of Plants Breeding and Acclimatization in Bartążek (Poland). Endophyte non infected and endophyte infected seeds (about 45% of infection) were used. Green forage was cut in September 2002, chemical composition was analyzed. Forage samples was wilted to 50 % dry matter content and conserved in laboratory mini-silos in five variants (each variant in four repetitions):

- K – non infected green forage (control)
- E – infected green forage, without additive
- PR – infected green forage with propionic acid additive (3 liters per 1 ton)
- KE – infected green forage with organic acids mixture (3 liters per 1 ton)
- BP – infected green forage with probiotical preparation (28 g/ 30 liters/ 6 tons)

Probiotical preparation contained *Lactobacillus rhamnosus* > $1 * 10^{13}$ cfu/g and *Propionibacterium freudenreichii ssp. shermanii* > $0,5 * 10^{13}$ cfu/g, in KE variant mixture of formic (80%) and orthophosphoric acids.

After 3 months of experiment mini-silos were open and chemical composition and quality were evaluated.

Aerobic stability was determined in room with constant temperature $20^0C \pm 1,0$. To take temperature measurements Squirrel 2000 device was used.

RESULTS AND DISCUSSION

The least crude ash level was observed in non-infected tall fescue green forage (96.6 g in DM). Non-infected green forage contained also the least amounts of crude protein and ADL (106.4 g and 89.6 g in DM, respectively) and the highest levels of crude fiber and NFE (320.2 g and 459.8 g in DM, respectively). Crude fat, ADF and NDF levels were similar in all variants and were respectively 16 g; 453 g and 660 g in DM. Average crude protein content in tall fescue was approximately 120 g in DM (Collective works, 2001), so endophyte infection enhanced this constituent content in plants. Endophyte infection also enhanced crude ash content in green forages.

Table 1. Silage chemical composition

Item	*K*	*E*	*PR*	*KE*	*BP*	mean	Sd
Dry matter (g)	***532,9***^{b}	***491,0***^{ab}	***481,4***^{a}	***462,7***^{a}	***500,2***^{ab}	***493,65***	***29,66***
Crude ash (g/DM)	***112,9***^{a}	***207,9***^{b}	***134,7***^{ab}	***161,5***^{ab}	***160,0***^{ab}	***162,50***	***43,48***
Crude protein (g/DM)	***110,3***^{A}	***165,9***^{B}	***165,8***^{B}	***164,8***^{B}	***171,2***^{B}	155,61	23,28
Crude fat (g/DM)	***25,9***^{ABC}	***25,2***^{A}	***23,8***^{A}	***28,8***^{C}	***28,1***^{BC}	26,38	2,46
Crude fiber (g/DM)	***330,2***^{B}	***282,3***^{A}	***263,0***^{A}	***271,4***^{A}	***272,1***^{A}	283,79	29,70
NFE (g/DM)	$420,7^{b}$	$318,8^{a}$	$377,1^{ab}$	$373,6^{ab}$	$368,6^{ab}$	371,74	42,53
NDF (g/DM)	$612,2^{ab}$	$619,0^{b}$	$599,1^{a}$	$606,7^{ab}$	$594,7^{a}$	606,34	11,87
ADF (g/DM)	421,9	438,5	433,4	419,5	408,8	424,42	19,82
ADL (g/DM)	$79,0^{a}$	$161,3^{b}$	$150,9^{b}$	$143,1^{b}$	$134,4^{ab}$	133,74	37,20

Values marked with the same letters do not differ statistically significant with $p \geq 0.05$ (a, b,….) or with $p \geq 0.01$ (A, B,…)

Chemical composition of silages is shown in table 1. Control silage (K) contained the highest levels of dry matter, crude fiber and NFE. Silage made of infected green forage (E variant) consisted the highest levels of crude ash; detergent fiber fraction NDF, ADF, ADL determined with Van Soest method. Silage produced with microbiological preparation contained the highest amount of crude protein instead control silage contained the lowest amount of this constituent. Silage with propionic acid contained the lowest level of crude fiber. Crude fiber amount observed in this study was similar to amount contained in tall fescue green forage reported by Łyszczarz et al. (1998). Differences in crude protein, crude fat and crude fiber contents turned out to be statistically high significant. Differences between variants regarding to crude ash, NFE, NDF and ADL turned out to be statistically significant.

Quality of silages is shown in table 2. Follow from described results silage made without any additive of endophyte-infected green forage had the best quality (91 points) and control silage had the worst quality (74 points). The lowest pH was evaluated in silage produced with propionic acid – 4.7. Differences in pH, NH_3 and acetic acid contents were statistically significant.

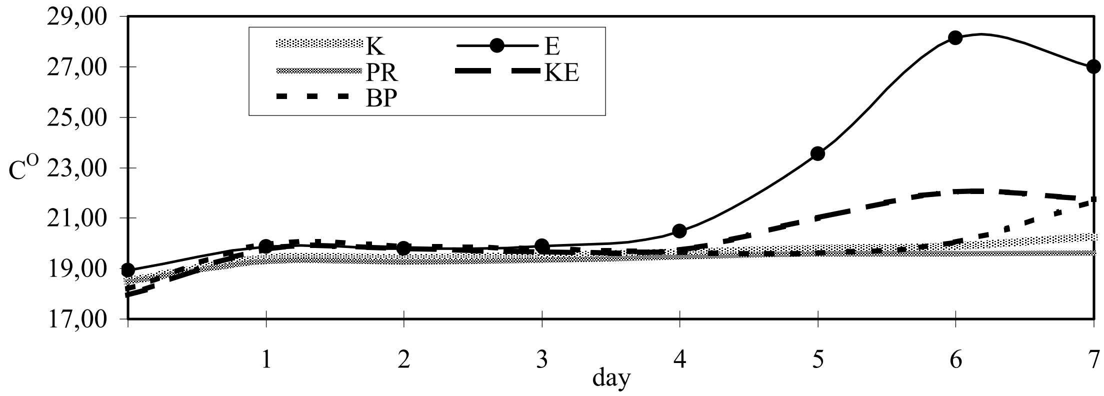
Table 2. Quality of produced silages

	K	E	PR	KE	BP	Mean	Sd
PH	***4,72^{a}***	***5,03^{b}***	***4,70^{a}***	***5,09^{b}***	***5,07^{b}***	***4,92***	***0,21***
NH_3	***0,0170^{a}***	***0,0296^{ab}***	***0,0275^{ab}***	***0,0578^{b}***	***0,0555^{ab}***	***0,04***	***0,02***
Lactic acid	***3,50***	***2,47***	***2,94***	***2,27***	***3,08***	***2,85***	***0,71***
Acetic acid	***1,11^{AB}***	***0,86^{AB}***	***1,44^{B}***	***0,90^{AB}***	***0,68^{A}***	***0,99***	***0,47***
Butyric acid	***0,11***	***0,00***	***0,02***	***0,02***	0,07	0,04	0,07
Points	74	91	81	88	78	83,25	15,62
Quality	good	very good	very good	very good	good	-	-

Values marked with the same letters do not differ statistically significant with $p \geq 0.05$ (a, b,….) or with $p \geq 0.01$ (A, B,…)

Silages aerobic stability is shown in figure 1. The worst aerobic stability was observed in endophyte-infected silage made without any additive (E), silage produced with organic acids mixture heated to small extent after 96 hours. The best aerobic stability was observed with silage made with propionic acid (PR), control silage (K) and silage produced with probiotic preparation (BP).

Figure 1. Aerobic stability of silages made with different additives



CONCLUSION

1. Silage made of endophytical fungi *Acremonium* infected green forage contains greater amount of crude protein and smaller amount of crude fiber than non infected green forage. ADL compounds quantity is higher in infected silages comparing to silages non infected while NDF and ADF fractions levels are similar.
2. Quality of *Acremonium* infected silage is high and lactic acid and acetic acid contents are in right proportion with no butyric acid.
3. Silage produced of endophyte-infected green forage is aerobically unstable, organic acids addition improves aerobic stability.

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IN VITRO RUMINAL STARCH DIGESTIBILITY OF MAIZE SILAGE

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INTRODUCTOIN

Starch is the primary energy component of corn and therefore is the primary nutrient in typical finishing diets used to promote high levels of production. Maize starch has specific characteristics that are not known in other grain. Maize grain, with its high nutrition value and low degradability of starch in the rumen, is ideal for feeding high-yield dairy cows. For this reason there is an increasing interest in more intensive using the feed rations composed of maize silage, LKS and CCM. These components are important sources of energy noted for middle degradability in rumen.

Most of the starch received in feed is degraded and digested in the rumen. Coordination between energy supply in the form of starch and protein supply into the rumen improves retention of starch as glucose and retention of nitrogen (Huntington, 1997). In theory, absorption of starch in the small intestine after degradation by enzymes is more efficient than its degradation in the rumen. Nevertheless, the amount of starch absorbed from the small intestine is likely to be limited by insufficient activity of pancreatic amylase, amounting to 1.5 kg/day, according to Sommer (2000). The starch escaping degradation in the rumen proceeds to the small intestine, where is decomposed by enzymes. The lower digestibility of starch in the rumen increases its amount to be indigested in the small intestine (Nocek and Tamminga, 1991). If the amount of starch is very high, part of it may escape both degradation in the rumen and enzymatic digestion in the small intestine, and proceed to the large intestine. There the starch is subject to microbial fermentation. Volatile products of hindgut fermentation are utilised by the animal.

The purpose of the present study was the application of in vitro enzymatic method to determine starch digestibility in the rumen for three samples maize silage.

MATERIALS AND METHODS

The fodder set included 1 sample of maize silage, 1 sample of LKS and 1 sample of CCM. Ruminal fluid was taken from two Black Pieb dry cows with permanent large ruminal cannulas.

Ruminal starch digestibility (IVRDS):

Samples were analysed for starch content and starch digestibility after 2, 4, 6, 16 and 24 hours fermentation of maize silage, as estimated by total α – linked glucosides using the method introduced by MacRae and Armstrong (1968). Each fodder was subject to triple analysis. Glucose was assayed enzymatically using Bio-la-test, (Lachema, Brno). The starch content was calculated as 90% of the total glucose content and recalculated for the sample dry matter.

Digestible starch content was determined via fermentation of the samples in a fermentation solution (buffer mixed with ruminal fluid). The buffer was prepared using the modified Goering and Van Soest (1970) method. The ruminal fluid was taken from two cannuled cows, mixed, filtered, tempered to 39°C and saturated with CO_2. The fermentation itself started with fodder supply (0.5g), addition of 50 ml of the fermentation solution and saturation of the soaked sample with CO_2. The trial included a blank for each time interval, a glucose standard and a standard sample for elimination of variability of the ruminal fluid. The fermentation was performed at 39°C and terminated after 2, 4, 6, 16 and 24 hours with addition of 1ml 6 N H_2SO_4. Followingly, the samples were autoclaved for 1 hour at 130°C and then incubated at 55°C during the period of 24 hours in acetate buffer with amyloglucosidase. The content of starch in the residues was estimated as total α-linked glucosides as described above.

RESULTS AND DISCUSSION

Table 1 shows the fermented qualities of tested maize silage, LKS and CCM.

Table 1. Characteristics of fermentation process in maize silage, LKS and CCM in fresh matter

	DM	CP	Fat	Fiber	Ash	BNLV	LA	AA	PA	pH	*AAL*
	g/kg						%				mg KOH/100g
Maize silage	385.20	39.90	13.60	76.40	21.5	233.8	2.24	0.62	0.07	3.74	1399.70
LKS	452.97	34.91	16.45	50.50	11.3	339.8	1.80	0.47	0.00	3.43	1410.73
CCM	647.63	57.95	29.95	18.35	11.9	529.5	1.53	0.22	0.09	3.64	1338.28

LKS – (Lieschen Kolben Schrott)
CCM – (Corn Cob Mix)
AAL – acidity of aqueous leach
LA - lactic acid
PA - propionic acid
AA - acetic acid

For total starch contents in the tested fodders see Fig. 1. The tested feeds differed in total starch content. Lowest value of the total starch was detected in maize silage (328.91 g/kg DM). The highest content of total starch was determined in

CCM silage (706.16 g/kg DM) and LKS contained 529.17 g/kg of total starch in DM.

The IVRDS values were measured in five time intervals of fermentation. Fig. 2 shows the course of IVRDS at five time intervals of fermentation.

Figure 1. Total starch content of maize silage, LKS and CCM

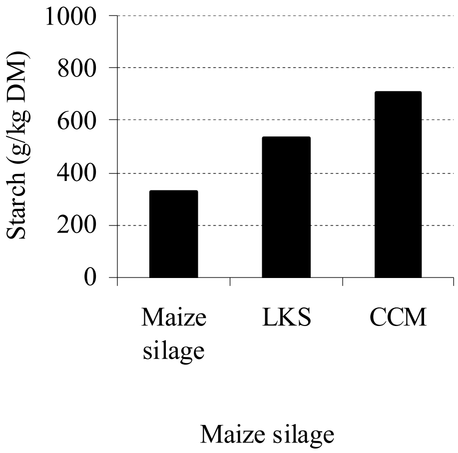
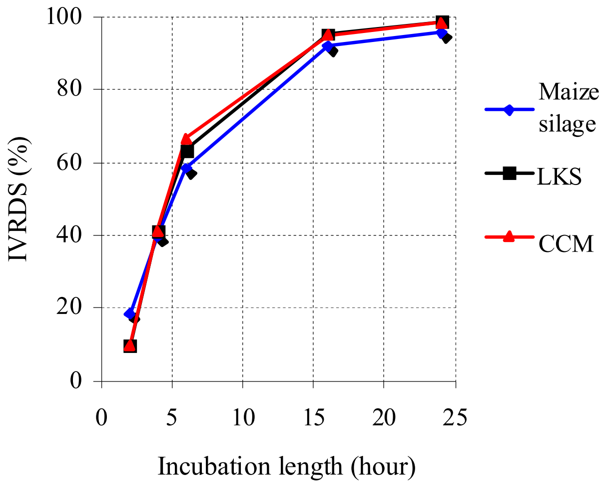


Figure 2. In vitro ruminal starch digestibility (IVRDS) of maize silage, LKS and CCM



It results from our experiment, that the process of rumen starch digestibility using in vitro method was approximately the same in maize silage, LKS and CCM. The IVRDS values varied from 9.5% to 18.5% in feeds fermented for 2 hours. In the case of 4 hour fermentation, the values were from 39.6% to 41.3%, and after the 6 hours of fermentation the values were from 58.5% to 66.6%. The IVRDS values of all feeds fermented for 16 and 24 hours were above 90%. The values were in interval of 91.9% to 95.4% in the case of 16 hours of fermentation, while for 24 hour fermentation the values reached the interval of 95.9 to 98.8%.

CONCLUSION

The advantages of the *in vitro* methods include higher reproducibility in comparison to the other methods. The IVRDS technique is rather demanding and time-consuming, but capable of accounting of differences in grain energy use by animals.

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CORN SILAGE SUPPLEMENTED WITH VARYING LEVELS OF COPPER (Cu) CHANGES IN PLASMA, Cu CONCENTRATION

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INTRODUCTION

Copper is essential to support biochemical reactions in animals (Davis and Mertz, 1987) and its requirement for various species is well documented (NRC). For cattle, a minimum dietary requirement is established at 10 ppm but may be higher depending upon other factors (NRC). Excessive amounts of copper can result in toxicity but maximum levels of copper intake are not well defined. Chronic Cu toxicity has been shown to occur in both lactating and dry cows fed 37.5 and 22.6 mg Cu/kg DM, respectively (Bradley, 1993). In addition, data suggest that Cu may influence lipid metabolism as well.

There is little information on the effects of providing supplemental Cu above the recommended NRC requirement on Cu status and performance in dairy cattle. The present study was conducted to determine the effects of dietary Cu on Cu status and lipid metabolism in lactating Holstein cows.

MATERIALS AND METHODS

Twenty four mature lactating Holstein cows were used in this study. Cows were housed in a covered free-stall barn. Cows were separated into three groups by age, days in milk (DIM), milk production, and parity. Each group was randomly assigned to one of the following three dietary treatments: 1) control (no supplemental Cu), 2) 10 mg Cu/kg DM, and 3) 40 mg Cu/kg DM; the source of Cu was copper proteinate. Diets were formulated to meet or exceed all nutrient requirements for high producing lactating dairy cows with the exception of Cu (NRC, 1989,2000). The basal diet contained 8.9 mg copper, 75.6 mg zinc, 238.9 mg iron, and 1.12 mg molybdenum per kg of DM, and .24% sulfur. Cows were fed twice daily in amounts adequate to allow ad libitum access to feed and to ensure 10% orts daily. Cows were milked twice daily and milk weights were recorded at each milking. On d 0 and 60 both a.m. and p.m. milk samples from individual cows were obtained and frozen at –80^{o}C until further blood samples were collected via jugular venipuncture, in heparinized and non-heparinized Vacutainer tubes

RESULTES AND DISCUSION

Plasma Cu concentrations were similar across treatments. Total serum cholesterol concentrations were higher in cows receiving supplemental Cu. Cows receiving 40 mg Cu/kg DM had higher serum cholesterol concentrations than cows receiving 10 mg Cu. Dry matter intake, average daily milk production, and milk lipid, protein, and somatic cell numbers were similar across treatments.

These results indicate that Cu supplementation alters lipid metabolism in high producing dairy cows.

ABSTRACT

For cattle , a minimum dietary requirement Cu is established at 10 mg/kg but may be higher depending upon other factors (NRC 2000).

There is little information on the effects of providing supplemental Cu above recommended NRC requirements on Cu status and lipid metabolism in lactating Holstein cows.

The present study was conducted to determine the effects of dietary Cu on Cu status and serum cholesterol level in lactating Holstein cows fed corn silage based diet. Twenty four lactating Holstein cows were used in this study. Cows were separated into three groups by age, days in milk, milk production, and parity. Each group was randomly assigned to one of the following three dietary treatments 1) control (no supplement Cu), 2) 10 mg Cu/kg DM, and 3) 40 mg Cu/kg DM. The source of Cu was copper proteinate. Plasma Cu concentration were higher in Cu supplemented cows at the end of the 61 d study.(control 1.07 mg Cu/l, group with supplement 40 mg Cu/kg DM 1.51 mg Cu/l). Cows receiving 40 mg Cu/kg DM had higher serum cholesterol concentration than control cows (control 165 mg/dl, 245 mg/dl) with supplemental 40 mg Cu/kg/DM). These resultes indicate that Cu supplementation alters lipid – cholesterol metabolism in high producing cows feeding corn silage based diets

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Table 1. Composition and chemical analysis of basal diet

Ingredient	% DM
Corn Silage	25.8
Whole soya seed	13.5
Alfalfa Silage	15.7
Concentrate mix	45.0
NEL, Mcal/kg	1.7
CP, %	18.7
ADF, %	17.6
NDF, %	28.4
EE, %	6.0

Table 2. Effect of supplemental copper on plasma copper and serum cholesterol concentrations in cows.

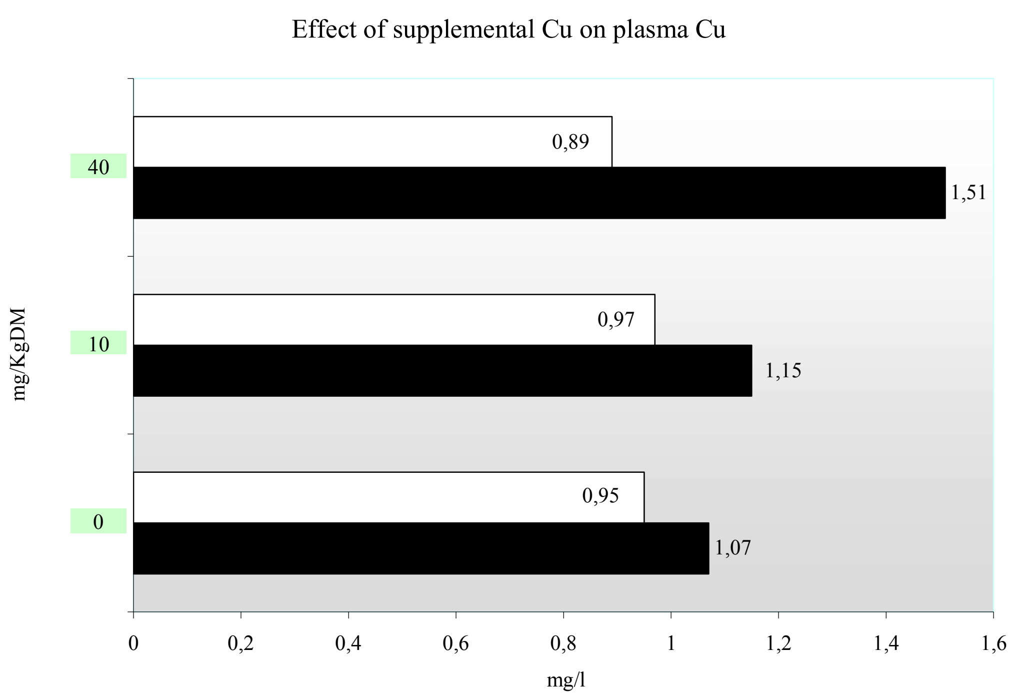
Item	Supplemental Cu, mg/kg DM			
	0	10	40	SEM
Plasma Cu, mg/l				
Initial	0.95	0.97	0.89	0.06
Final	1.07	1.15	1.51	0.05
Serum cholesterol, mg/dl[c,d]	165.90	192.50	245.00	15.70

[a]Control vs copper (P < .003)
[b]10 vs 40 mg Cu/kg DM (P < .001)
[c]Control vs copper (P < .05)
[d]10 vs 40 mg Cu/kg copper (P < .04)

Table 3. Effect of supplemental copper on dry matter intake (DMI), milk production, and milk composition in cows

Item	Supplemental Cu, mg/kg DM			
	0	10	40	SEM
DMI, kg	26.8	26.2	26.7	0.95
Milk yield, kg	40.0	36.7	40.3	2.2
Milk composition				
Fat, %	3.1	3.1	3.0	0.06
Protein, %	3.5	3.4	3.5	0.13

Figure 1.



THE INFLUENCE OF ENSILAGE SUPPLEMENTS FOR CHOICE QUALITATIVE PARAMETERS OF MAIZE ENSILAGES IN WORKING CONDITIONS

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ABSTRACT

We have observed the influence of ensilage supplements for choice qualitative parameters at 130 samples of maize ensilages.

We have evaluated total classification and categorization to quality classes according to fermentation process.

We have found out positive effect of the ensilage supplements for fermentation class and for total ensilage quality of maize ensilages. This positive effect has been more considerable at classification to the fermentation classes.

We have evaluated correlation coeficient between fermentation class and crude fibre content – weak dependence r = 0,10 (p<0,05), between fermentation class and acid acetic content - dependence r = 0,55 (p<0,05) and between total class and crude fibre content - dependence r = 0,48 (p<0,05). Optimum crude fibre content is 210 g/kg dry matter in maize ensilages.

INTRUDUCTION

Ideal fermetation process reduces fermentation losses and preserves good aerobe stability during animal feeding. Right ensiling and suitable ensilage supplements are the most important for ensilage quality. We know examples very bad ensilages but with good aerobe stability (high content of nonprotein nitrogen or high content of acid acetic or acid buttiric) and very good prepare ensilages can be aerobe unstability (Woolford, 1990).

They are known two reasons why to use ensilage supplements for better aerobe stability of ensilages. We must prevent to ensilage warming with following loss of dry matter. We must stop reducing of animal production in consequence of poor-quality ensilage (Bolsen et al., 1996). The effective ensilage supplements remove one or both problems (Kung, et al., 1998). The ensilage supplements improve fermentation process and reduce aerobe degradability (Jonsson, 1989). These supplements stimulate quick acidification of ensilage matter with help of higher production of acid lactic and obstruct growth and increasing of bad microorganisms.

MATERIALS AND METHODS

We evaluated the influence of ensilage supplements for quality parameters according to categorization to total classes and fermentation process in year 2001. We have evaluated 130 samples of maize ensilages in co-operation with Agriculture district laboratory in České Budějovice. The samples have been classification to quality classes according to acid contents in ensilage, pH, dry matter and crude proteins. The quality of ensilages has been evaluated according to fermentation procees too. The samples of maize ensilages have been evaluated by norm AgroKonzulta Žamberk s.r.o. and EKO-LAB Žamberk s.r.o.

RESULTS AND DISCUSSION

The categorization of maize ensilages to total classes in year 2001: class excelent 55,4 % of samples, class good 36,2 %, class worse 7,6 % and class bad 0,8 %. The maize ensilages with ensilage supplements have been classification to class excelent – 62,1 % of samples and to class good – 37,9 %. The maize ensilages without ensilage supplements have been classification to class excelent – 53,5 % of samples, class good – 35,6 %, class worse – 9,9 % and class bad – 1,0 %. The values in table No. 1. The ensilage supplements have positive influence for ensilage quality.

The categorization to class according to fermentation process: 80 % of samples in Ist class, 15,4 % in IInd class, 2,3 % in IIIrd class, 1,5 % in IVth and 0,8 % in Vth class of fermentation. The categorization of the maize ensilages with fermentation supplements to class according to fermentation process is better: 96,6 % of samples in Ist class and 3,4 % in IInd class of fermentation. The categorization of the maize ensilages without fermentation supplements to class according to fermentation process: 75,2 % of samples in Ist class, 18,8 % in IInd class, 3 % in IIIrd class, 2 % in IVth and 1 % in Vth class of fermentation. The fermentation supplements have very positive influence for fermentation process. . The values in table No. 2.

We have evaluated quality of ensilages according to dry matter, crude fibre and crude proteins. The dry matter was high at 38,5 % samples and low at 22,3 % samples. The crude proteins were high at 30,8 % samples and the crude fibre was high at 53,8 % samples. Optimum values (in norm): dry matter 300 - 350 g/kg, crude fibre to 210 g/kg of dry matter and crude protein to 90 g/kg of dry matter.

We have tested seven kinds of ensilage supplements in maize ensilages - MICROSIL, BACTOZYM, SIL-ALL, MAIZE-ALL, FEEDTECH SILAGE, SCHAUMASILL and SILLA-BAC.

Table 1. The percentage categorization of maize ensilages to total class in year 2001

Total class	Total	With ensilage supplements	Without ensilage supplements
I	55,4	62,1	53,5
II	36,2	37,9	35,6
III	7,6	-	9,9
IV	0,8	-	1

Table 2. The percentage categorization of maize ensilages to fermentation class in year 2001

Fermentation class	Total	With ensilage supplements	Without ensilage supplements
I	80	96,6	75,2
II	15,4	3,4	18,8
III	2,3	-	3
IV	1,5	-	2
V	0,8	-	1

The ensilage supplements are given to feedstuffs. The ensilage supplements have positive effect for acid milk fermentation, for aerobe stability and for feed value of ensilages. The ensilage supplements do not compensate mistakes in ensilage technology but they used for preparation of high quality ensilages (LOUČKA et al., 1998), Doležal et al. (2001). Třináctý at al. (2000) writes higher content of crude fibre in feed ration reduces dry matter consumption at dairy cows.

CONCLUSIONS

We have observed the positive influence of ensilage supplements for the fermentation process and quality of maize ensilages. This positive effect has been more considerable at classification to the fermentation class.

We have evaluated correlation coefficient between fermentation class and crude fibre content – weak dependence $r = 0,10$ ($p<0,05$), between fermentation class and acid acetic content - dependence $r = 0,55$ ($p<0,05$) and between total class and crude fibre content - dependence $r = 0,48$ ($p<0,05$). Optimum crude fibre content is 210 g/kg dry matter in maize ensilages.

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EFFECT OF DIVALENT IONS ON RUMINAL AMYLASE ACTIVITY

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INTRODUCTION

Quantitatively, carbohydrates are very important to the ruminant animal since plant tissues contain about 75% carbohydrates of one kind or another. Consequently, carbohydrates provide the primary source of energy for both the rumen organism and the host animal. The ability of the rumen population to ferment any specific carbohydrates is dependent upon the presence of the appropriate enzyme required to utilize any specific carbohydrate.

The degradation of starches (amylose and amylopectin) and the simple sugars (e.g., surcose, maltose) is performed by several species of primary amylolytic bacteria. Solubility and physical nature of carbohydrate can affect rate of utilization. In the recent past, factories producing copper and mercury have altered the agricultural environment.

Jenčík et al. (2001) reported that soil and plant biomass sample analyses from localities situated maximally 10 km from the copper and formerly mercury producing factories showed significant soil and biomass contamination by mercury, lead, cadmium, copper, and zinc ions. Magnesium-processing industry pollutes its surrounding by magnesium fly ash which may increase the risk of oversupply of this ion for exposed animals.

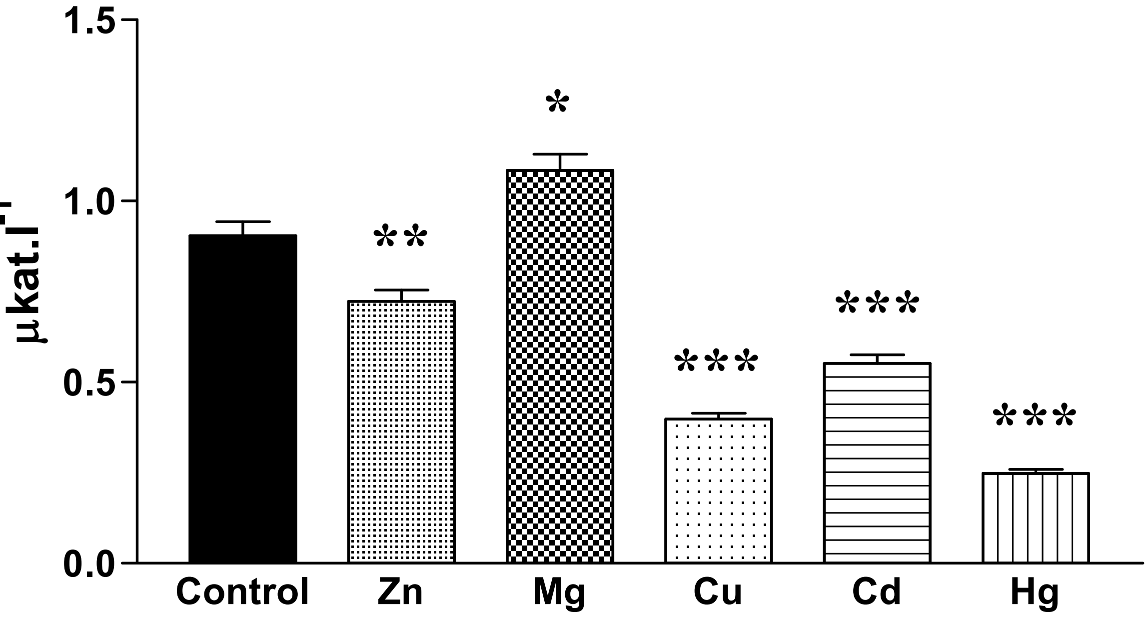
The objective of the present study was to determine effect of various ions on ruminal amylase activity of cow in vitro.

MATERIAL AND METHODS

Rumen fluid was obtained from six fistulated dairy cows. After being strained through cheesecloth, copper, zinc, mercury, cadmium and magnesium were separately added to 10ml of rumen fluid so that their final concentrations were 5 mmol/L. After the addition of each ion, mixture was shaken and incubated for 30 minute at 37 °C prior to enzyme activity assay in the rumen fluid with and without ions using spectrophotometric method. Statistic significance of the differences between values was determined by Student´s t-test.

RESULTS AND DISCUSSION

Figure 1. Effect of zinc, magnesium, copper, cadmium and mercury on amylase activity of rumen fluid.



Data from our study indicate that magnesium had stimulatory effect, while cadmium, zinc, mercury and copper inhibited enzyme activity. The distribution of amylase activity is different within the rumen. Most amylase activity was detected in the particle-associated fraction of the ruminal contents in comparison with the bacterial and extracellular fraction (Martinez et al., 2002)

The development of magnesium industry increases the risk of oversupply of magnesium from magnesium fly ash in farm and wild animals which result in depression of fertility and diarrhoe. Increased concentration of cadmium is toxic – it is able to bind to proteins by thiol groups. Faixová and Faix (2002) demonstrated that cadmium had both inhibitory as well as stimulatory effect on ruminal enzyme activities of sheep. Ingestion of quantities of copper slightly higher than required may cause haemolysis. Sheep are more sensitive to high copper supplementation than other farm animals. Several papers have dealt with the study of the effectiveness of various agents on the amylase activity of rumen.

Panda et al. (1999) found no significant effect of dietary inclusion of yeast cell suspension on amylase activity in six-day-old crossbred calves. In other study with adult fistulated buffaloes, bentonite supplementation had no significant effect on amylase activity (Chaudhary et al., 2000). And defaunation decreased amylase activity of the rumen in rumen-fistulated crossbred bullocks(Krishna et al., 1999).

CONCLUSION

The result of this experiment indicate that ions copper, cadmium, magnesium, zinc and mercury may effect amylase activty of the rumen, playing important role in metabolism of starches. They can further alter carbohydrate metabolism in the rumen mainly in industrially polluted areas.

SUMMARY

In vitro incubation experiments ware conducted to evaluate the effect of several ions on amylase acivity of rumen fluid of dairy cow. Copper, zinc, mercury, cadmium and magnesium were each added to 10 ml of rumen fluid to abtain final concentration of 5 mmol/L. After the addition of each ion, the mixture was shaken and incubated for 30 minute at 37 C prior to enzyme activity assay in the rumen fluid with and without ions using spectrophotometric method. The results of experiment indicate that magnesium had stimulatory effect, while cadmium, zinc, mercury and copper inhibited enzyme activity.

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EFFECT OF OESTRADIOL ON SCFA ABSORPTION ACROSS THE RUMEN EPITHELIUM IN SHEEP

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SUMMARY

Oestradiol is a steroid female sexual hormone derived from acetate and related also to some fatty acids.The effect of oestradiol on the absorption of acetate(A) and propionate(P) across the rumen epithelium was investigated. In the experiment the rumen walls obtained from adult Merino sheep have been used. Absorption was observed on an apparatus constructed in our laboratory. Determination of the acids was carried out by gas chromatography. The absorption rate of both acids was affected by the administration of oestradiol from the serous side of the rumen epithelium.

Key words: rumen epithelium, acetate, propionate, absorption, oestradiol

INTRODUCTION

Acetic and propionic acid belong to the short-chain fatty acids (SCFA) which are a natural part of the rumen content. They are produced from the fermentation of plant materials. In the rumen epithelium they are metabolized and absorbed into the blood stream. Acetic acid is utilized as the major source of energy. Propionic acid is quantitatively the most important precursor of glucose (Bergman 1982, 1983).

Oestradiol or 17-ß oestradiol is a female sexual hormone belonging to the group of oestrogens. Biosynthesis of sexual steroid hormones is derived from acetate and is also related to some fatty acids. It is for that reason that oestradiol has been used to investigate the effect of SCFA absorption across the rumen epithelium in sheep.

MATERIAL AND METHODS

In the experiment the rumen walls of 8 adult 2-4 year old Merino sheep were used. The animals were individually housed in sheds and given a diet consisting of meadow hay ad libitum and 200 g of ground barley per animal and day. The animals had free access to water and lick salt. Immediately after slaughter and bleeding the entire gastrointestinal tract was removed from the abdominal cavity and brought to the laboratory. There the rumen was separated, its content removed and washed with lukewarm water. Acetate and propionate absorption was observed on an apparatus (Fig.4) constructed in our laboratory. Each combination of acids and oestradiol was repeated six times (n=6). The solutions on both side of rumen epithelium was bubbled through with oxygen containing 5% CO_2. After one hour 5 ml samples were transferred from the individual vessels and syringes into plugged test tubes and after the addition of 1 ml standard solution the fatty acids were determined by gas chromatography (Perkin – Elmer 8500).

Statistical analysis

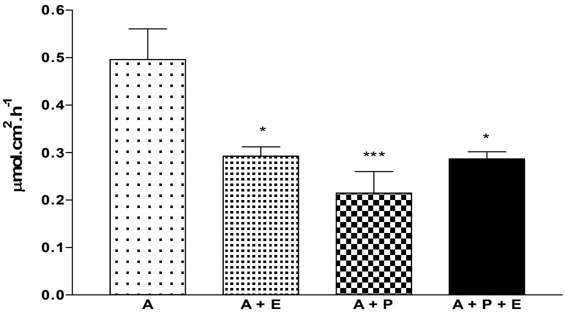
The means of the individual parameters were compared using the Tukey-Kramer multiple comparison test (GrapPad Instat Software, Inc., San Diego, USA).

RESULTS AND DISCUSSION

The acetate absorption rate across the rumen epithelium (Fig. 1) was significantly higher when applied separately in comparison to the application of acetate in combination with propionate (A+P) but no support has been found for this finding in so far known experimental work. However, we do not suggest that acetate absorption could be so profoundly suppressed by the presence of the propionate in the solution used. We rather endorse the opinion that this phenomenon could have been caused by some other factors which with the techniques used in the investigation of the SCFA absorption rate could not be taken into account. Addition of oestradiol to separate acetate decreased its absorption rate but addition of oestradiol to A+P did not affect acetate absorption. There are practically no data in literature on similar effects and thus their reasons can only by assumed. As mentioned in the survey of literature the SCFA absorption rate is the larger the longer the carbon chain of the corresponding acid is (Pfander and Phillipson 1953, Stevens and Stettler 1966). In that case the absorption rate is greater for acetate than for propionate. However, the amount of acid transported from the digestive tract into the blood stream is in reverse proportion (Bergman et al. 1966), i.e. it is greater for propionate than for acetate. In addition, propionate is to a considerable extent metabolized in the epithelium (Weeks and Webster 1975). These facts supported by the possibility that oestradiol might have affected also the morphological properties of the epithelium could well have been the reason for our finding.

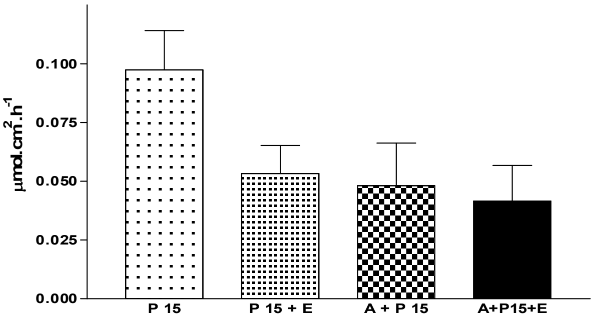
The effect of oestradiol on the propionate absorption rate across the rumen epithelium was not entirely identical. A 15 mmol concentration of propionate in the transport solution did not effect its absorption rate (Fig.2). The absorption rate of propionate across the rumen epithelium proved to be increased ($P < 0.01$) at a concentration of 30 mmol when separate propionate was used (Fig. 3). It can thus be stated that oestradiol partly increased the propionate absorption rate across the rumen epithelium, but only at the concentration of 30 mmol in the transport solution. A 15 mmol concentration appeared to be too low for an effect of oestradiol to become evident. This is probably related to the already mentioned fact according to which the absorption rate of the individual acids proportionally increases with their increasing concentration (Titus and Ahearn1992)

Fig. 1 Acetate absorption across the rumen epithelium after administration of oestradiol



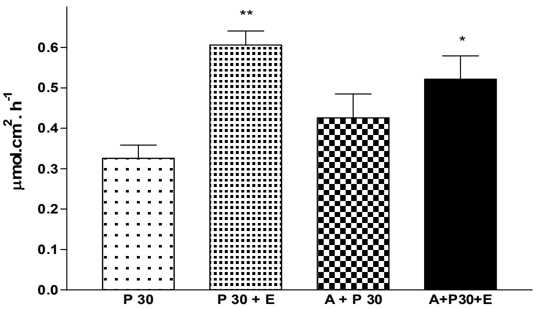
* P<0.05; *** P<0.001
A – acetate, 50mmol.l^{-1}
P – propionate, 30mmol.l^{-1}
E – estradiol, 150pg.ml^{-1}

Fig. 2 Propionate absorption at 15 mmol level across the rumen epithelium after administration of oestradiol



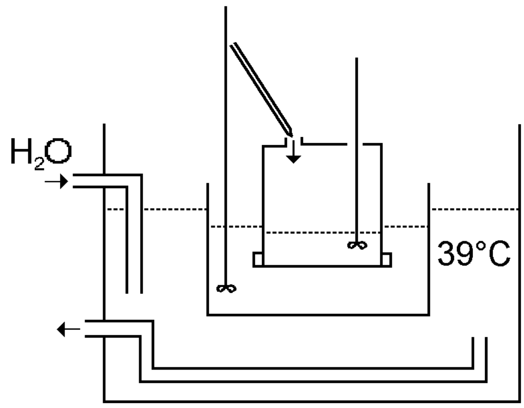
A- acetate, 50 mmol.l^{-1}
P-propionate, 15mmol.l^{-1}
E- estradiol, 150pg.ml^{-1}

Fig. 3 Propionate absorption at 30 mmol level across the rumen epithelium after administration of oestradiol



* P<0.05; ** P<0.01
A – acetate, 50mmol.l^{-1}
P – propionate, 30mmol.l^{-}
E – estradiol, 150 pg.ml^{-1}

Fig. 4 Apparatus for observation of fatty acids absorption



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CONCLUSION

Oestradiol effected the acetate and propionate absorption. However it will be necessary to verify this finding by means of some more progressive techniques which are counted with in the future in the investigation of absorptional relations.

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