Investigations on the replacement of maize products in rations for dairy cows and fattening bulls

Untersuchungen zum Ersatz von Maisprodukten in Rationen für Milchkühe und Mastbullen

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DOI 10.5073/jka.2014.444.044

Summary

For different reasons as for example the occurrence of pests like *Diabrotica virgifera* there may be a shortage in availability of maize products for ruminant feeding. Therefore, different feeding studies on replacement of maize products in rations for dairy cows and fattening bulls were conducted as a part of the "Diabrotica research programme" set up by the federal government of Germany and the federal state of Bavaria. The main focus was set to on suitability of alfalfa as well as grass silage as a roughage source for dairy cows and fattening bulls. It is shown that partial replacement of maize silage by these products allows producing at high production level in Simmental cows and fattening bulls. A decisive advantage is the possibility to reduce the portion of protein concentrates like soybean or rape meal in the diets. Moreover, other beneficial aspects for ruminant feeding such as the high structural value of alfalfa silage are discussed. In ruminant feeding, corn is used as an energy rich dietary component. As a part of the programme a dairy cow feeding trial was conducted to evaluate whether replacement of corn by wheat is a promising possibility to reduce portion of maize products in ruminant diets. Results of the study demonstrate the limits of these feeding strategies, especially in maize silage based diets high in energy concentration and in the concentration of soluble carbohydrates. In these diets, concentrations of degradable starch and sugar are often near or above the maximum recommended amounts. For these reasons use of corn as a source of undegradable starch is preferable to the use of other cereals to prevent conditions that promote rumen acidosis.

Key words: dairy cows, fattening bulls, roughage source, starch source

Zusammenfassung

Aus unterschiedlichen Gründen, wie zum Beispiel dem Auftreten von Schadorganismen wie *Diabrotica virgifera*, könnte Mais als Rinderfutter knapp werden. Deshalb wurden verschiedene Fütterungsversuche zum Ersatz von Maiserzeugnissen in Futterrationen für Milchkühe und Mastbullen im Rahmen des „*Diabrotica*-Forschungsprogramms" des Bundes und des Bundeslandes Bayern durchgeführt. Das Hauptaugenmerk lag auf Luzerne- und Grassilage als Raufutter für Milchkühe und Mastbullen. Es wurde festgestellt, dass ein teilweiser Ersatz von Silomais durch diese Erzeugnisse ein hohes Produktionsniveau bei Simmentalkühen und Mastbullen ermöglicht. Ein entscheidender Vorteil besteht darin, dass der Anteil an Proteinkonzentraten wie Soja- oder Rapsextraktionsschrot am Futter verringert werden kann. Außerdem werden weitere positive Aspekte bei der Rinderfütterung hohe Strukturwert von Luzernesilage diskutiert. Bei der Rinderfütterung wird Mais als energiereiche Nahrungsquelle verwendet. Im Rahmen eines Milchkuhfütterungsversuchs sollte festgestellt werden, ob der Ersatz von Mais durch Weizen eine aussichtsreiche Möglichkeit für die Verringerung des Maisanteils am Rinderfutter ist. Die Ergebnisse der Studie zeigen die Grenzen solcher Fütterungsstrategien, insbesondere bei maissilagebasierten Rationen mit hohem Energiegehalt und hohen Gehalten an löslichen Kohlenhydraten. In solchen Futtermitteln liegt die Konzentration abbaubarer Stärke und Zucker oft nahe an oder über den maximal empfohlenen Mengen. Aus diesem Grund wird Mais als Quelle nicht abbaubarer Stärke anderen Getreiden vorgezogen werden, um die Förderung von Azidose zu vermeiden.

Stichwörter: Milchvieh, Mastbulle, Grobfutter, Stärkequellen

1. Introduction

For several reasons maize silage became a more and more important roughage source for ruminant feeding over the past years. Maize normally shows high dry matter (DM) and energy yields. Preservation of maize is quite low in risk for deterioration of silage and easy to handle for the farmer. Moreover, compared to other roughage sources there is a large time frame for optimum harvest date in maize. Fibre concentration increases with time comparable to other field crops, resulting in a decrease of digestibility and energy concentration, mainly in stalks. In maize, however, this decrease is widely compensated by the increase of portion of the maize cob and the increase in starch concentration of the corn (Schwarz and Ettle, 2000). Thus, among the most common field crops, maize shows not only the highest energy yields per ha but is also suitable to give roughage with a very high energy concentration, which is more important from the perspective of animal nutrition. High milk yield in dairy cows and high daily gains in fattening bulls can only be obtained at a high level of feed intake. This, in turn, is largely determined by the energy concentration of the basal diet (Dlg, 2006). Another reason for the high value of maize or corn in ruminant nutrition is the low ruminal degradability of corn starch. Starch of wheat or barley has a degradability of about 85% whereas degradability of corn starch is assumed to be only 58% (Dlg, 2001, 2008). Ensiling, however, seems to modify structure of starch and therefore starch degradability of good maize silages seems to be comparable to that of wheat. A high proportion of ruminally undegradable starch is important in ruminant feeding for different reasons. Firstly, starch directly delivered and digested in the duodenum is used energetically more efficiently than starch fermented in the rumen. Thereby, maximum amount of starch used efficiently in the duodenum of dairy cows seems to be about 1.0 to 1.5 kg/day (Flachowsky *et al.*, 2000). A second reason for the need of undegradable starch in ruminant diets is that high amounts of ruminally fermentable starch increase the risk for ruminal acidosis (Steingass and Zebeli, 2008). As shown above, current diets for high yielding ruminants need to have a high energy density and this is mostly linked to low fibre concentrations of total rations as well as high starch concentration. Risk for rumen acidosis, however, is not only determined by the level of intake of (rumen degradable) starch but also by the intake of fibre compounds (Steingass and Zebeli, 2008) and therefore by the relation of starch to fibre of the diet. This high starch and low fibre concentration, however, is typical for current high energy maize based ruminant diets and therefore a well directed substitution with concentrates is needed, one option is corn starch of low degradability.

Despite of the high feeding value of maize silage and corn for ruminants, increased need of maize silage for biogas production or occurrence of pests such as *Diabrotica virgifera virgifera* may result in a shortage of availability of maize (silage) for animal feeding. Therefore, feeding studies in dairy cows and fattening bulls evaluating alternative roughage and concentrate sources were conducted as a part of the "Diabrotica research programme" set up by the federal government of Germany and the federal state of Bavaria. The results of these trials are presented below.

2. Feeding studies on partial replacement of maize silage by grass or alfalfa silage in fattening bulls

Studies on the use of grass silage, which may be considered as an alternative roughage source in fattening bulls, mainly resulted in depressed performance due to inclusion of grass silage in diets. In these studies, diets were corrected for low protein concentration of maize silage, but not for lower energy concentration of grass silage (e.g. Juniper *et al.*, 2005). For this reason, two feeding studies were conducted to evaluate the effects of partial replacement of maize silage by grass (trial 1) or alfalfa (trial 2) silage in isoenergetic diets for fattening bulls. Each trial involved a total of 72 Simmental bulls (trial 1: 250 ± 18 kg, 197±7 days old; trial 2: 222 ± 19 kg, 180±5 days old). Within each trial, animals were equally assigned to three feeding groups according to body weight and ancestry. Group 1 (group 0% grass and group 0% alfalfa silage) was fed a Total Mixed Ration (TMR) based on maize silage, straw and concentrates. In the diets for groups 2 and 3, about 30% and 60% of maize silage and straw (based on DM) were substituted by grass silage (trial 1; groups 30% and 60% grass silage) or alfalfa silage (trial 2; groups 30% and 60% alfalfa silage). Crude protein concentration was partially equalized by reducing portion of protein concentrates (extracted soybean meal or rape meal, respectively) in groups fed grass or alfalfa silage. To obtain comparable energy concentration between feeding groups within each trial, portion of corn and rape cake was increased in these feeding groups. In trial 2, portion of concentrates in the TMR was also slightly increased. Animals were housed in group boxes (12 bulls/box) equipped with a slatted floor. In each box, four animals of each feeding group were kept. TMR and water were provided *ad libitum*. Individual feed intake was automatically recorded daily using automatic feeding troughs with sensors for animal identification. Live weight was recorded every 4 weeks and back fat depth every 12 weeks. More details on diet composition and materials and methods are given in Ettle *et al.* (2010, 2012a).

Tab. 1 Feed intake, nutrient and energy intake, growth and slaughter performance and selected meat characteristics (mean±SD) in fattening bulls fed with varying amounts of grass silage.

Tab. 1 *Futter-, Nährstoff- und Energieaufnahme, Wachstum und Schlachtleistung und ausgewählte Fleischmerkmale (Durchschnitt±SD) von Mastbullen bei unterschiedlichen Anteilen an Grassilage in der Ration.*

	Group 1, 0% grass silage			**Group 2, 30% grass silage**			**Group 3, 60% grass silage**		
Feed intake (kg DM/day)	9.3	±	1.1	9.6	±	0.8	9.3	±	1.1
CP intake, g/day	1215	±	151	1322	±	125	1285	±	153
ME intake, MJ/day	110	±	13	113	±	10	109	±	13
Initial weight, kg	248	±	19	252	±	15	252	±	17
End weight, kg	748	±	13	747	±	12	744	±	28
Average daily gain, g	1595	±	158	1615	±	122	1550	±	196
Dressing proportion, %	58.7	±	1.1	58.8	±	1.4	59.0	±	1.1
Carcass classification (EUROP)*	2.48	±	0.51	2.63	±	0.50	2.57	±	0.51
Fat classification**	2.57	±	0.51	2.84	±	0.50	2.76	±	0.54
Back fat depth at slaughter (cm)	1.74	±	0.26[c]	1.90	±	0.37[b]	2.12	±	0.31[a]
Intramuscular fat (%)	2.49	±	0.72	2.59	±	0.5	2.54	±	0.72
Fat colour (b*; haunch)	5.29	±	1.81[b]	7.07	±	2.16[a]	8.12	±	2.59[a]
ω-6/ω-3 – ratio of m. l. dorsi	11.96	±	1.39[a]	6.81	±	0.74[b]	5.14	±	0.84[c]

[a,b] Values differ at P< 0.05; *E=1,…, P=5;** 1=lean, …, 5=fat

In trial 1, feed, CP and energy intake in group 30% grass silage was slightly higher than in other groups (Tab. 1). Time to reach end weight of 750 kg was 316, 308, and 321 days for groups 0%, 30% and 60% grass silage, respectively. Average daily gain was not affected by treatment. Moreover, there was no influence on hot carcass weight, dressing or carcass conformation. Carcass fatness classification was slightly higher in animals fed diets with grass silage, and back fat depth in the middle of the fattening period and at slaughter increased significantly (P<0.05). Intramuscular fat content and pH value, share force, drip losses and grilling time of meat were not influenced by treatment. ω-6/ω-3 – ratio of meat of m. l. dorsi decreased (P<0.05) when higher proportions of grass silage were fed. In a comparable manner, pasture feeding increased ω-3 fatty acids in meat of German Holstein steers compared to concentrate feeding (Ender *et al*., 2000). Lower ω-6 and higher ω-3 fatty acid intake is discussed to positively affect consumer's health (Hollo *et al*., 2005). There was no influence on meat colour, but subcutaneous fat was more yellow (P<0.05) in grass silage fed bulls. No effect on serum GLDH-activity and concentration of urea, total protein and glucose could be observed. In summary, inclusion of grass silage in diets for fattening bulls had only minor influence on growth performance or carcass characteristics of fattening bulls. Therefore, partial replacement of maize silage by grass silage may be a valid alternative in situations where availability of maize products is limited, but lower energy concentration of grass silage has to be accounted for in diet formulation.

In the second feeding trial with fattening bulls, feed intake in group 0% alfalfa silage was slightly lower than in other groups (Tab. 2). Despite of low energy concentration of alfalfa silage (9.0 MJ ME/kg DM) and some differences in energy concentration of TMR (calculated from diet composition and energy concentration of different components: 11.6, 11.5, and 11.3 MJ ME/kg DM for groups 0%, 30%, and 60% alfalfa silage, respectively), mean daily ME intake was comparable between groups. CP intake in group 0% alfalfa silage was lower (p<0.05) compared to other groups. Time to reach end weight of 750 kg was 335, 321, and 338 days for groups 0%, 30%, and 60% alfalfa silage, respectively. There were no major differences in growth and slaughter performance and meat characteristics between groups. On the contrary to the grass silage trial, there were no differences in colour of adipose fat. Comparable to trial 1, ω-6/ω-3 – ratio of meat of m. l. dorsi decreased (P<0.05) when higher proportions of alfalfa silage were fed. Serum GLDH activity was higher (p<0.05) but serum urea concentration was lower (P<0.05) in group 0% alfalfa silage compared to other groups. GLDH is a liver specific enzyme that is only released when some liver cells are damaged. Therefore, one may speculate that the alfalfa silage with its high fibre content and structural value had positive effects on animal health. These specific properties of alfalfa may be of particular importance in fattening bulls fed maize silage based diets with high concentrations of soluble carbohydrates. Blood urea concentration is correlated to dietary crude protein concentration and to ruminal N-balance. Thus, higher values in groups fed alfalfa silage may be discussed in the context of an inefficient use of dietary N.

Tab. 2 Feed intake, nutrient and energy intake, growth and slaughter performance and selected meat characteristics (mean±SD) in fattening bulls fed varying amounts of alfalfa silage.

Tab. 2 *Futter-, Nährstoff- und Energieaufnahme, Wachstum und Schlachtleistung und ausgewählte Fleischmerkmale (Durchschnitt±SD) von Mastbullen bei unterschiedlichen Anteilen an Luzernesilage in der Ration.*

	Group 1, 0% alfalfa silage			**Group 2, 30% alfalfa silage**			**Group 3, 60% alfalfa silage**		
Feed intake (kg DM/day)	9.1	±	1.3	9.4	±	0.8	9.3	±	0.6
CP intake, g/day	1266	±	176[b]	1454	±	118[a]	1461	±	84[a]
ME intake, MJ/day	105	±	15	108	±	9	105	±	6
Initial weight, kg	223	±	23	224	±	18	223	±	19
End weight, kg	755	±	35	751	±	30	755	±	28
Average daily gain, g	1599	±	168	1652	±	197	1580	±	144
Dressing proportion, %	59.1	±	1.3	59.6	±	1.5	59.2	±	1.4
Carcass classification (EUROP)*	2.67	±	0.48	2.45	±	0,51	2.41	±	0.5
Fat classification**	2.86	±	0.57	3.00	±	0.44	2.73	±	0.63
Back fat depth at slaughter (cm)	2.00	±	0.45	2.03	±	0,37	1.93	±	0.43
Intramuscular fat (%)	2.96	±	0.79	3.32	±	1.11	3.23	±	1.03
Fat colour (b*; haunch)	6.31	±	1.65	7.43	±	2.3	6.39	±	2.57
ω-6/ω-3 – ratio of m. l. dorsi	9.2	±	1.2[a]	5.9	±	1.3[b]	4.6	±	0.7[c]

[a,b] Values differ at P< 0.05; *E=1,…, P=5;** 1=lean, …, 5=fat

In conclusion, inclusion of alfalfa silage in diets for fattening bulls tended to positively affect feed intake and had no negative effects on growth performance, which was at a high level in all groups. Therefore, inclusion of alfalfa silage in rations for fattening bulls allows reducing consumption of maize silage where availability is limited, and also helps to reduce portion of protein rich concentrates in the rations. However, as in grass silage based diets, sufficient energy supply has to be considered.

3. Feeding studies in dairy cows

In a first feeding study in dairy cows, effects of replacement of maize and grass silage by alfalfa silage were investigated. The feeding trial involved a total of 40 Simmental cows and lasted 10 weeks. Cows were divided into two groups (treatment (treat) 1: maize silage; treat 2: alfalfa silage) according to milk yield, stage of lactation, and feed intake. The cows had *ad libitum* access to partial mixed rations (PMR). PMR of treat 1 contained maize silage (47% of DM), grass silage (16% of DM) and hay/straw (4.8/4.3% of DM). In treat 2, grass silage and hay/straw were completely replaced by alfalfa silage, and maize silage by about 50%. Considering an intake of 18 kg DM of PMR/day that is equal to an amount of 7.5 kg DM alfalfa silage daily. Lower energy concentration of alfalfa silage was partly compensated by variation of type of concentrates as well as a slightly higher portion of concentrates in the PMR, respectively. However, as determined in digestibility trials in rams there was still a difference in energy concentration of PMR of 0.4 MJ NEL/kg DM. The utilizable crude protein concentration was partly equalized by a reduced portion of rape products in PMR of treat 2. In the present example, the sparing effect for protein concentrates was 1.2 kg DM/cow and day. Calculated concentration of utilizable crude protein (uCP), starch and sugar, and ruminally undegradable starch were comparable between feeding groups. More details on composition of diets are given in Ettle *et al*. (2012b).

Tab. 3 Feed intake, milk yield, milk composition, and net acid-base excretion (NABE) of cows fed maize or alfalfa silage based diets (mean±SD).

Tab. 3 *Futteraufnahme, Milchleistung, Milchzusammensetzung und Netto-Säuren-Basen-Ausscheidung (NSBA) bei mit mais- oder luzernesilagebasierten Rationen gefütterten Kühen (Durchschnitt±SD).*

	Feeding group					
	Maize silage			Alfalfa silage		
DM intake, kg/day	21.8	±	2.5	21.8	±	2.7
CP intake, g/day	3503	±	412	3791	±	517
uCP intake, g/day	3502	±	401	3438	±	448
Energy intake, MJ NEL/day	156	±	18	150	±	19
Milk yield, kg/day	34.0	±	5.7	32.7	±	6.4
Milk fat, %	3.78	±	0.39	3.98	±	0.55
Milk protein, %	3.45	±	0.22	3.44	±	0.19
Milk urea, mg/l	236	±	28[b]	311	±	35[a]
ECM, kg/day	33.2	±	5.3	32.5	±	5.2
NABE 1 (4. week), mmol/l	111	±	49[b]	151	±	22[a]
NABE 2 (8. week), mmol/l	155	±	48[b]	202	±	23[a]

Mean daily feed intake was 21.8 kg DM in both groups (Tab. 3). Given that alfalfa is characterized by a high DM degradability per time unit (Flachowsky *et al*., 1992) and a high ruminal transition rate (Hoffmann *et al*., 1998) one can generally expect positive effects of alfalfa silage on feed intake. Such positive effects have been demonstrated in dairy cow trials comparing grass silage based diets and alfalfa based diets (Bulang *et al*., 2006; Ettle *et al*., 2011). Positive effects of alfalfa silage on feed intake compared to maize silage were demonstrated in dairy cows which were more than 60 days in milk (Bulang *et al*., 2006). Such additional effects on feed intake were not seen in the present study, but as feed intake is largely determined by energy concentration of basal diet (Dlg, 2006) it is of interest that feed intake in the alfalfa group was not decreased. Daily milk yield in the alfalfa group was numerically lower than in the maize silage group and that is in accordance with differences in energy intake. Nevertheless, the present data demonstrate that also diets very high in portion of alfalfa silage allow a high production level in Simmental cows and the role of alfalfa as a stabilizing diet component is underlined. There were only minor differences in milk fat concentration between groups. Because of the high fiber concentration in diets of both groups a milk fat depression may not be expected. The increased ($P<0.05$) milk urea concentration in the alfalfa silage group is a consequence of the higher ruminal N-balance.

In week 4 and week 8 of the trial urine samples were taken to determine net acid-base excretion (NABE). Higher values ($p<0.05$) were obtained for group alfalfa silage at both sampling dates. Moreover, values below reference values were seen more often in cows of the maize silage group than in other groups. There is a correlation between NABE and the fibre intake in dairy cows (Scholz *et al*., 2010) and therefore the differences may be discussed as a benefit of supply of dietary structure due to feeding of alfalfa. However, at given high dietary fibre concentrations differences may also be a consequence of differences in dietary cation-anion balance, which is also known to influence NABE (Scholz *et al*., 2010). From the result of the present trial it can be concluded that alfafa silage is suitable as a roughage source in high yielding dairy cows, even if proportion of alfalfa in the total diet is high. Benefits of supply of structural fibre may be seen in diets with a high starch concentration. Characterisation of influence of alfalfa on feed intake in relation to its energy concentration should be further investigated.

A second dairy cow feeding trial within the Diabrotica research programme was conducted to determine the effects of replacement of corn by wheat. The study involved 34 dairy cows each having more than 34 days in milk. Conditions of the study were comparable to the first dairy cow feeding trial and are described in more detail in Ettle *et al.* (2012c). PMR was based on maize silage (29% of DM), alfalfa silage (31% of DM), hay and straw (2.4% of DM each), and concentrates. In the concentrates portion, corn was replaced by wheat in a 1:1 ratio. Considering a daily intake of 19 kg DM of PMR this corresponds to 4.6 kg DM corn or wheat, respectively. According to diet calculation, PMR of the two feeding groups were comparable with energy and concentration of most nutrients, but there were considerable differences in concentration of rumen undegradable starch. Digestibility trials with rams, however, resulted in a slightly increased energy concentration (0.2 MJ NEL/kg DM) in PMR of cows fed corn. DM intake in corn fed animals was about 1 kg/day higher than in the other group (Tab. 4). These differences were not significant but resulted in a slightly increased intake of energy and utilizable crude protein in the corn fed group. In a study of Gozho and Mutsvangwa (2008) feed intake in corn fed cows was increased by 2 kg DM/day compared to wheat fed cows, whereas in a comparable study of Daenicke (2000) there was no effect on feed intake. Reasons for different effects on feed intake in studies on different starch sources fed to dairy cows may be the composition of total diet, dietary concentration of starch and total soluble carbohydrates, as well as other factors like conditioning of starch sources. Concentration of readily available carbohydrates in PMR wheat was 253 g/kg DM and therefore slightly above the critical concentration of 250 g/kg DM given by Dlg (2001). The additionally given concentrates were also based on wheat and barley and therefore a further source of soluble carbohydrates, thus supporting conditions for rumen acidosis. On the other hand one can speculate on some beneficial effects of structural fibre of the alfalfa silage preventing cows of the wheat group from a significant decrease of feed intake.

Mean milk yield was 28.4 and 26.9 kg/day for corn and wheat fed cows, respectively. A literature overview on several comparable studies (Daenicke, 2000) resulted in a mean increase of milk yield of about 1.1 kg/day when barley or wheat was replaced by corn. The present results are fairly within this range. Former tables on feed composition for ruminants (Dlg, 1997) indicated a slightly lower energy concentration of maize (8.39 MJ NEL/kg DM) than of wheat (8.51 MJ NEL/kg DM). On the other hand, respiration trials indicated higher energy concentration of corn compared to wheat (Gädeken *et al.*, 1995; Daenicke, 2000), and this is in accordance with digestibility studies conducted with the PMR, wheat and corn used in the present study. Therefore, energetic value of wheat and corn needs to be further investigated.

In accordance with other studies (Daenicke, 2000) there were no differences in milk fat or protein concentration. Milk fat concentrations of 4.1% in both feeding groups do not support any incidence acidosis. Milk urea concentration in the wheat group was significantly increased which may be a result of differences of ruminal N-balance. Blood urea concentration, which is closely correlated to milk urea concentration (Burgos *et al.*, 2007) was, however, not influenced in the present study. Serum GLDH activity, total protein, and glucose concentration were not influenced by treatment and within reference limits in both groups. Therefore, these data do not support differences in health status or energy supply between the feeding groups.

In summary, replacement of corn by wheat resulted in a slightly depressed feed intake, a decreased energy intake and a reduction of milk yield of about 1.5 kg/day. These data are in good agreement with data from literature. There is no evidence that in alfalfa and maize silage based diets corn, a provider of undegradable starch, should be replaced by wheat or other cereals. Combination of maize silage and wheat results in high dietary levels of soluble carbohydrates. Therefore there is an increased risk to exceed the current reference value of 250 g starch and sugar/kg DM (Dlg, 2001) and in consequence an increased risk for rumen acidosis.

Tab. 4 Feed intake, milk yield, and milk composition of cows fed corn or wheat (mean±SD).

Tab. 4 *Futteraufnahme, Milchleistung und Milchzusammensetzung bei mit Körnermais oder Weizen gefütterten Milchkühen (Durchschnitt±SD).*

	Feeding group					
	Corn			Wheat		
DM intake, kg/day	22.2	±	2.6	21.1	±	2.2
CP intake, g/day	3565	±	496	3431	±	418
uCP intake, g/day	3458	±	443	3249	±	367
Energy intake, MJ NEL/day	157	±	19	146	±	16
Milk yield, kg/day	28.4	±	9.8	26.9	±	7.4
Milk fat, %	4.09	±	0.47	4.06	±	0.40
Milk protein, %	3.60	±	0.23	3.71	±	0.23
Milk urea, mg/l	249	±	25[b]	298	±	38[a]
ECM, kg/day	28.8	±	9.0	27.4	±	6.9

4. Conclusions

Feeding studies in fattening bulls and dairy cows were conducted to investigate the potential of replacement of maize silage and corn by grass or alfalfa silage and wheat, respectively. In both, bulls and dairy cows, partial replacement of maize silage by alfalfa silage had only minor influence on performance, which was at a high level in all trials. Moreover, there are some indications that alfalfa silage may positively affect feed intake and health, especially when diets high in energy and soluble carbohydrates and low in fibre concentration are fed. The use of alfalfa and grass silage moreover allows reducing the portion of protein concentrates as soybean or rape meal in the rations, but there is the risk of a surplus of protein which is not effectively used by the animal. The relatively low energy concentration grass and alfalfa silage has to be considered and corrected for in diet formulation. Besides maize silage, corn is used in ruminant nutrition. The main advantage over other cereals is its high concentration of ruminally undegradable starch. The present results do not indicate any advantage for the animal, when corn in diets for dairy cows is replaced by wheat.

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