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EFFECT OF SILAGE FROM MAIZE AND STRIP-CROPPED SORGHUM AND MAIZE ON DAIRY COW'S YIELD AND MILK COMPOSITION*

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Abstract

In an experiment conducted on 34 mid-lactation dairy cows of the Red-and-White and Black-and-White breed, in a random square design, the effect of maize or sorghum-maize silage present in partly mixed ration (PMR) on milk yield, milk composition and blood serum parameters was investigated. The PMR diet contained maize silage, which compared with PMR diet contained sorghum-maize silage made from strip-cropped plants. Both fodder plants were harvested with a 4-row precision chopper, which cut 2 rows of maize and 2 rows of sorghum, giving mixed maize/sorghum forage. The feeding experiment lasted 84 days and consisted of four sub-periods, each 21 days in length to record milk yield, feed and milk chemical composition, and blood parameters. In addition to PMR diets containing part of ration compound feedingstuffs, the cows received part of compound feedingstuffs given at feed stations to meet their nutritional requirement. The compound feedingstuffs in station were controlled by an electronic system related to actual cow's milk yield. Chemical composition of both silages and milk production efficiency were compared. The average dry matter intake in both groups was 18.80 vs 20.4±1.95 kg/day, but compound feedingstuff intake from station was 3.61 vs 4.56 (P>0.01). Milk yield was 21.8 and 20.5±0.51 kg/day, respectively (P>0.01). The amount of standardized fat and protein content of milk (FPCM) was 21.0 and 20.2 kg/g ±0.48 kg/day (P≥0.01). No significant differences were found in the fat, protein, casein, lactose, urea, total solids and solids not fat percentage of milk or in milk traits (acidity, renneting time, density) among groups (P≥0.01). Feeding cows PMR ration with maize silage significantly elevated total cholesterol (P<0.05), but decreased urea levels in blood plasma (P<0.01). It is concluded that strip cropping of sorghum and maize could be an alternative to maize grown as a pure stand in maize high-risk areas for dairy cows in mid-lactation.

Key words: sorghum, maize, mixed cropping, silage, cow's yield, milk composition

Groundwater shortages in some regions of Poland are becoming the main factor to limit the productivity of the main fodder crops for dairy cattle including permanent

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grasslands, grasses and legumes on arable land, as well as maize. These factors may considerably limit the production of milk and the development of dairy farming. In a hot summer with no rain, most fodder crops, including maize dry out, thus giving a low yield of both green matter and dry matter, while cob percentage in plant matter does not exceed 25% and is considerably lower than the yield obtainable under optimum weather conditions. The incidence of common smut is an additional factor that lowers the energy value of maize plants because of the lack of kernels on the cob and their infection by *Fusarium* disease. A search is underway for fodder plants to replace, partly or completely, maize silage in the nutrition of cattle, including dairy cows, in maize high-risk areas. Earlier research showed that one such plant is sorghum (*Sorghum saccharatum*), which has for a long time been successfully used to feed animals in arid regions of the United States and southern Europe. Compared to maize, the resistance of sorghum to drought consists in a different structure of the root system which extends to deeper soil layers. Sorghum is best suited for warm and fertile soils and has excellent drought tolerance (Undersander et al., 2000). In dry soils unsuitable for maize cultivation, sorghum gives a higher dry matter and energy yield per hectare compared to maize (Cole et al., 1996). The prospects for sorghum cultivation in Europe were discussed at length by Berenji and Dahlberg (2004). In the United States, research is underway to develop hybrids with increased tolerance to cold (Tiryaki and Andrews, 2001; Yu and Tuinstra, 2001), which would enable the yield potential of sorghum to be better used in the future in Europe's temperate climate.

Sorghum × Sudan grass hybrids have been shown to exhibit very large variation in Poland (Mucha and Brzóska, 1983). An additional factor influencing the quality of sorghum crops and silage is the date of harvest, which is directly related to the stage of maturity (Bolsen, 2004) that affects the level of digestible energy in plants (Gul et al., 2008), as well as grain content (Young et al., 1996). The optimum harvest date is determined by the interaction between maximum yield of digestible nutrients and the dry matter content favourable for proper ensilage (Sonon et al., 1991; Grant and Stock, 1996; Bolsen, 2004). The observations made to date show that in Poland, fodder sorghum yield is equal to that of maize during the years of average atmospheric precipitation, or exceeds it during extremely dry years, when maize yield decreases by as much as 30–40%. During the growth period, the chemical composition and nutritive value of fodder sorghum plants undergo the same changes as for earless maize plants. Because unlike maize, sorghum plants retain green leaves to the end of growth that lasts until first frosts, the plant dry matter levels are lower than in maize due to the lack of cobs and kernels. Research findings show that the energy value of sorghum silages is lower compared to maize (NRDC, 2001; Śliwiński, 2007). Because when maize is sown it is not possible to predict weather conditions and soil moisture during its growth, a technology for strip cropping of maize with sorghum was developed. In dry years, sorghum surpasses maize in dry matter yield, which alleviates possible roughage shortages where maize is grown as a pure stand. The lower energy value of sorghum silages may result in lower milk yield of the cows or higher intake of feeds by lactating cows, with the decrease in the level of milk production depending on the composition of PMR diet and the proportion of sorghum silage in this diet (Śliwiński, 2007). Strip cropping of maize alternating with sorghum should reduce differences between maize and sorghum in the nutritive value of silages and their suitability for milk production, in contrast to when both plants are grown in monoculture. In tropical climate, the milk yield of cows receiving diets containing sorghum silage was comparable with that of cows receiving dietary maize silage (Nichols et al., 1998), but in temperate climate the cows' yield was significantly lower (Oliver et al., 2004). Planting strip-cropped sorghum and maize may also reduce losses in maize plantations caused by the European corn borer and by game animals, especially in areas with considerable forest cover. There was no information in Poland about strip-cropped sorghum and maize cultivation, silage composition and dairy cow productivity.

The aim of the study was to determine the fermentation quality and nutritive value of silages made from sorghum strip-cropped with maize in the large silos and to compare them with silage made from maize grown in monoculture, as well as to determine the efficiency of using both silages in PMR rations for dairy cows in mid-lactation.

Material and methods

Plant cultivation and harvesting

The feeding trial was performed in a curtain-sided loose barn for dairy cows in Kostkowice farm, belonging to the Experimental Station Grodziec Śląski of the National Research Institute of Animal Production in Kraków. Maize cultivar Magister was sown on a 3-ha area (95 000 seeds/ha) over the last ten days of April. Sowing date of sorghum seeds was delayed by about 10 days to allow soil to warm up and to ensure better germination of sorghum. Mixed cropping system was used in the same field, with the same amount of a single maize cultivar being sown in 4 rows alternating with sorghum plants. The following fertilization doses were applied: N – 160 kg, P – 80 kg and K – 170 kg per ha. Sucrosorgo 506 sorghum variety was sown at a density of 200 000 seeds/ha. Both plants were sown at an interrow spacing of 75 cm, with an intrarow spacing of 20–25 cm for maize and 6.5 cm for sorghum. Sowing was performed using a Monosem pneumatic single-seed drill. Maize and sorghum were cultivated in accordance with the recommendation from the Institute of Soil Science and Plant Cultivation No. 90/2002 and cultivation guidelines of Syngenta Company. Both plantations were cut and ensiled over the first ten days of October. Cutting was done with a self-propelled, 4-row precision chopper. The harvester was set up to cut 2 rows of sorghum and 2 rows of maize at the same time, thus providing well mixed material for silage. Plants were chopped into 0.5–3.0 cm long pieces and ensiled in polyethylene bags as sleeves. Both silages were used in the feeding trial 60 days after the commencement of fermentation.

Animals, feeding trial and sampling

The experiment used 14 Black-and-White and 20 Red-and-White cows, 120–140 days after calving, assigned proportionally according to breed to two groups: control, which received partly mixed ration (PMR) with maize silage and experimental, which received PMR ration with sorghum and maize silage, with the same number of breeds in each group. The ration for cows was formulated according to the IZ PIB-INRA allowances and feed tables (Strzetelski, 2009). The 84-day feeding trial was subdivided into 4 periods of 21 days each. Animals were selected from a herd of 175 cows according to milk yield, body weight, stage of lactation and average milking level ±0.5 kg/day. The animals were divided into two equal groups based on test-day yields. The average milk yield before the experiment was 24.0±0.48 kg milk/day. PMR diets contained maize silage for the control group and maize and sorghum-maize silage for the experimental group. The PMR diets, apart from the tested silages, contained wilted lucerne silage, ensiled moist maize grain, meadow hay, pelleted compound feedingstuffs (the same as in feed stations) and protein supplement Promilk for dairy cows. According to the current daily milk yield, the cows received an additional ration of compound feedingstuffs, which was given from an electronically controlled feed station. Before and after the experiment all cows were weighed. Cows were milked twice a day. Feed and milk samples were taken at the end of each period, twice during the morning and afternoon milking time. The milk yield was recorded throughout the experiment, but representative samples of milk were collected on the last two days of each of the four experimental periods to determine milk yield, composition and physico-chemical traits. These samples were divided into two parts: fresh and preserved with 0.2 mg/ml of Bromopol (2–bromo–2–nitro–1,3 propanediol), and frozen. Fresh milk was analysed for physical properties including density, acidity and renneting time. Frozen milk samples were transported to the Central Laboratory of the National Research Institute of Animal Production in Kraków to assay the nutrient content of feeds and milk. To determine the metabolic status of the cows at the end of each experimental period, blood samples were drawn from the jugular vein of animals before the morning feeding. Blood was supplemented with heparin and centrifuged, and the plasma obtained was divided into 2 samples. A sample of non-frozen blood was analysed for glucose, and both frozen serum and serum thawed several days later were used for analysis of total protein, triglycerides, total cholesterol and urea.

Chemical analyses

The chemical composition of silage and the nutrient content of feeds, including PMR diet were determined using AOAC procedures (1998) and feed nutritive value was expressed according to the IZ PIB-INRA allowances and feed tables (Strzetelski, 2009) and calculated using Winwar 1.3 software. Feed dry matter was determined at 105°C and its content in silages was adjusted for volatile substances (Dulphy and Demarquilly, 1981). Short chain fatty acids in silages were determined by gas chromatography using a Varian Star 3400 CX apparatus. Milk fat, protein, casein, lactose contents, urea, total solids and solids not fat were determined following the Polish Standard (PN-68-A-86122) with MilkoScan FT 120 (Foss Electric A/S). Milk yield was converted into milk production adjusted for fat (4%) and protein (3.2%) content in milk according to a formula proposed by Subnel et al. (1994). Milk density, acidity and specific gravity were determined according to the Polish Standard (PN-68/A-86122). Analyses of total glucose, protein, urea, triglycerides and total cholesterol in blood plasma were performed using the enzyme-linked test from Cormay Diagnostyka S.A. (Lublin, Poland). The laboratory has an accreditation certificate No. 512, issued by the Polish Centre for Accreditation on 14 August 2008 and prolonged during next year visits.

Statistical analysis

The results of the experiment were subjected to statistical analysis of variance using the Statgraphics 6.0 software package and Student's t-test to determine the influence of type of silage in PMR diet on the parameters of silage chemical composition and cows' yield. The effects were considered to be significant at $P<0.05$ and $P<0.01$. Trends between both levels of probability are also discussed.

Results

The level of dry matter in silages from strip-cropped sorghum with maize was almost identical to that in silages from maize grown in monoculture. Both silages had very low pH (Table 1). Control silages contained much more lactic acid and less acetic acid, which resulted in a higher LA/TA × 100 index. The level of ammonium nitrogen in silages was low and did not exceed 3% of total nitrogen. Crude protein and crude fat content of sorghum-maize silage was lower than for maize silage. The sorghum-maize silage had higher NDF and ADF levels than the maize silage. The proportion of compound feedingstuffs, ensiled moist maize grain and Promilk additive in PMR diet in both groups was 35.1 and 38.5%, and the proportion of roughages was 64.9 and 61.5%, respectively (Table 2). The mean dry matter content of PMR diet containing the analysed silages was 36.8 (maize) and 40.3% (sorghum--maize).

The cows' body weight averaged 595 kg before the experiment, but was an average of 625 kg at the end of the experiment (Table 3). No significant differences were found in PMR intake in both groups of cows, with a 1.6 kg DM higher intake of the PMR containing sorghum-maize silage ($P\geq0.01$). There were also no significant differences in the intake of compound feedingstuffs from the feed stations and in the total intake of compound feedingstuffs in the basic diets and feed stations ($P\geq0.01$).

No statistically significant differences were found in the milk yield of the cows and in the milk yield corrected for the protein and fat content (FPCM) ($P\geq0.01$) (Table 3). Also no significant differences were observed in the milk composition and in the amount of milk nutrients obtained daily, with a tendency towards lower milk production and milk nutrient content in experimental cows ($P\geq0.01$). There were also no statistically significant differences in the physico-chemical properties of milk or in the plasma levels of glucose, protein, triglycerides, total cholesterol and urea ($P\geq0.01$).

Table 1. Nutrient and chemical composition of PMR ration components (g/kg DM)

Item	PMR ration components					Compound feeding-stuffs
	maize	sorghum + maize	wilted lucerne silage	meadow hay	ensiled maize grain	
Dry matter (%)	32.2	32.3	46.6	89.0	63.6	90.3
Nutrients (% of DM):						
organic matter	962	945	897	816	985	895
crude protein	81	60	154	168	93	229
crude fat	30	19	39	29	41	26
crude fibre	196	298	239	243	27	40
N-free extractives	655	568	465	376	824	600
NDF	388	554	442	459	138	114
ADF	214	340	258	311	37	59
crude ash	38	55	103	84	15	105
Fatty acids of silage (g of DM):						
pH	3.58	3.87	5.30	-	5.04	-
lactic	136	145	89	-	71	-
acetic	85	78	30	-	19	-
propionic	0.0	0.0	0.0	-	-	-
isobutyric	10	20	10	-	-	-
butyric	0.0	0.0	0.0	-	-	-
isovaleric	0.0	0.0	0.0	-	-	-
valeric	0.0	0.0	0.0	-	-	-
LA/TA × 100	58.9	59.7	89.9	-	78.9	-
AA/LA × 100	62.5	53.8	33.7	-	26.8	-
ammonia nitrogen (mg N/100 g)	36	-	42	-	22	-
ammonia nitrogen (% total-N)	2.8	1.9	1.7	-	3.8	-

LA/TA × 100 lactic acid/total acids × 100.
AA/LA × 100 acetic acid/lactic acid × 100.

Table 2. PMR ration components in fresh matter (in kg)

Feed	PMR ration with maize silage	PMR ration with sorghum/maize silage
Maize silage	29.5	-
Sorghum/Maize silage	-	30.3
Wilted lucerne silage	10.2	10.2
Meadow hay	0.5	0.5
Compound feedingstuffs	4.0	4.0
Ensiled moist maize grain	1.0	1.0
Promilk protein supplement	1.0	1.0
Total PMR ration	46.2	47.0
PMR dry matter estimated (%)	36.8	37.5

Table 3. Feed intake, cows' yield and blood parameters

Item	PMR ration*		SEM
	control with maize	experimental with sorghum + maize	
Cows' body weight (kg):			
initial	582	607	26
final	623	628	9
PMR fresh matter intake (kg/day)	46.2	47.0	3.28
PMR dry matter intake (kg/day)	17.00	17.63	2.11
incl. silage	9.50	9.46	1.70
incl. compound feedingstuffs	3.89	3.61	0.29
from feed station (kg DM/d)	3.61	4.56	0.16
Total compound feedingstuff intake	7.50	8.17	2.53
Total DM intake (kg/d)	20.61	22.19	1.95
Yield and milk parameters:			
milk (kg/day)	21.8	20.5	0.51
FPCM[1] (kg/day)	22.9	21.2	0.48
fat (%)	4.29	4.26	0.10
fat (g/day)	935	873	65
protein (%)	3.66	3.69	0.03
protein (g/day)	798	756	45
casein (%)	2.97	2.98	0.02
casein (g/day)	647	611	40
lactose (%)	4.75	4.74	0.01
lactose (g/day)	1036	972	76
urea (mg/1000 ml)	120	140	25
density (g/cm^3)	1.030	1.040	0.003
acidity (° SH)	6.95	6.83	0.07
renneting time (sec)	269	236	7
Blood parameters:			
glucose (mmol/l)	4.37	4.41	0.07
triglycerols (mg/dl)	10.6	11.2	0.21
total cholesterol (mg/dl)	172.0	171.0	2.65
total protein (g/dl)	7.89	8.02	0.04
urea (mg/dl)	25.8	25.4	0.42

*No significant differences were found between the groups.
[1]Values estimated with Subnel et al. (1994) formula.

Discussion

Under optimal soil humidity conditions, the same amount of silage is usually made from sorghum as from maize. In the Polish climate, sorghum plants only produce inflorescences or grain primordials rather than fully developed grain, as a result of shorter vegetation period and relatively lower temperature than in hotter climate. Because sorghum plants contain more detergent fibre than maize plants and do not produce the cobs, they can be grown at a higher density per hectare. This is the main reason for the higher yielding of sorghum compared to maize plants under the same cultivation conditions. The second important factor is the root system of sorghum plants, which allows them to get water from deeper soil layers compared to maize. The quality of both silages was good, but maize silage had better chemical composition. This problem should be resolved in a more accurate fermentation study. Both silages had a dry matter content exceeding 30%, which means that no silage juice is generated during fermentation. Undersander et al. (2000) showed that sorghum-maize silage has more protein than maize silage, but is less digestible. We failed to obtain the same effect. Sorghum plants grown for silage in the USA were found to have more NDF, less starch and 10–20% less energy in kg dry matter than maize silage (NRDC, 2001). This is due to the lack of cobs, kernels and starch as well as the relatively higher content of neutral detergent fibre (NDF) and acid detergent fibre (ADF), which makes sorghum silage less digestible (Grant and Stock, 1996). This agrees with the results obtained by Kozłowski et al. (2009), who showed a higher level of sugars and NDF of raw material sorghum for ensiling.

Growing maize for silage at the back end of a cattle farm in periodically dry regions is a threat to the feed balance. Strip cropping of maize and sorghum mainly results from the fact that by sowing both plants in late April/early May, the risk of lower maize yields is compensated by higher sorghum yields. Where the growing season is moist, sorghum yield matches that of maize, with slightly lower energy value of the silage. Earlier research showed that sorghum silages could be an alternative to maize silages when both plants are grown in monoculture, ensiled separately and then fed to dairy cows (Śliwiński, 2007). Sorghum is a tropical short-day plant, which under Polish conditions can be grown for use as feed or bioenergy feedstock because of high biomass production, but the seeds it produces are not developed enough. The origin of sorghum and the history of its cultivation were reviewed in detail by Śliwiński and Brzóska (2006). While the cob may constitute approx. 43% of the maize plant, the proportion of sorghum inflorescence averages 14% and the nutritive value of sorghum feeds depends primarily on the chemical composition of leaves and stalks (Kozłowski et al., 2009). In the case of strip intercropping of sorghum with maize, the nutritive value of the material obtained should be in between both species, or possibly higher for that species which predominates in the crop. The yield of individual plants is substantially affected by the weather. The use of the mix cropping system where sorghum-maize are grown in separate rows within the same field has both its supporters and opponents. This system offers the advantage of simultaneous harvesting and very good mixing of the plant material intended for ensiling. Research results demonstrated that maize silages as well as silages from sorghum strip-cropped with maize are characterized by excessive acidity. This could be due to the high content of easily fermentable sugars in both plants (Mucha and Brzóska, 1983; Kozłowski et al., 2009). It might be well to consider using fermentation inhibitors that limit the extent of bacterial fermentation, thus reducing high acidity of the silage, especially the acetic acid of silage.

No research on the feeding of cattle with sorghum or sorghum-maize silage in Poland has been conducted to date. Most research results on the use of sorghum in cattle nutrition concern North American conditions. The NRDC (2001) Nutrient Requirements of Dairy Cows and Feed Tables show that digestible energy content in sorghum silage is approximately 25% lower than that of maize silage, due to no cobs in the sorghum plant containing starch. In the early feeding trials, cows which received maize silage produced significantly more milk and consumed more dry matter compared to those fed sorghum silage, with sorghum silage being 92 and 85% as efficient as maize silage for milk production in the first and second experiment, respectively (Lance et al., 1964). Different results were reported for a mutation of sorghum obtained by selection, characterized by low lignin content and higher digestibility and energy value. Grant et al. (1995) gave mid-lactation cows a TMR diet composed of 65% roughages and 35% concentrates. The roughages were silage from hybrid sorghum with low lignin content (BMR mutation), maize silage, lucerne silage, and traditional sorghum without the mutation. Brown mid-rib (BMR) sorghum has less lignin in stalks and leaves, as a result of which the feed made from it is more palatable and better digested. However, these plants are more fragile and brittle, which may cause the crop to lodge. BMR hybrids have been shown in *in situ* and *in vitro* analyses to have a higher digestibility and NDF content. The intake of sorghum and maize silages by the cows was similar (Grant et al., 1995). Daily production of fat-corrected milk (FCM) was similar for BMR sorghum, maize silage and lucerne silage, and lower for silage made from traditional sorghum. When using diets containing 65% BMR sorghum, standard sorghum, lucerne or maize as well as 35% compound feedingstuffs, Aydin et al. (1999) observed a significant increase in the milk yield of cows receiving BMR sorghum compared to standard sorghum. By decreasing the proportion of silages to 35% in a long-term experiment with early-lactation cows, the authors cited above observed that with the same feed intake, the cows fed BMR sorghum silage had the same milk yield as the cows receiving maize silage, and better milk yield than the cows receiving traditional sorghum silage. When giving dairy cows *ad libitum* silage from grain sorghum or maize silage, Ortega et al. (1972) found a higher intake of sorghum silage and the lack of significant differences in milk composition and milk yield. Cows receiving BMR sorghum silage had the same milk yield as those fed maize silage (Lusk et al., 1984; Wedig et al., 1987). In a comparative study, Oliver et al. (2004) obtained similar milk yield when feeding cows with BMR-6 sorghum silage and maize silage, and lower milk yield when cows received silage from conventional sorghum. These authors attributed the increased milk yield to both improved rumen digestibility and higher total NDF digestibility, which is in agreement with the findings of Miller and Stroup (2003). Similar tendencies as in our experiment were observed for feed intake and milk production by Emile et al. (2006).

In our study, silage from strip-cropped sorghum and maize mixture did not significantly modify the mean milk yield of the cows or the mean amount of protein and fat obtained in 24-hour periods, and the observed differences were only numerical. We obtained similar results in a previous experiment using silage from sorghum grown as a pure stand (Śliwiński, 2007), in which the mean daily milk production decreased non-significantly by 1 litre in relation to the group receiving maize silage. The slightly lower energy content of the experimental silage was compensated by the 1 kg DM higher intake of PMR diet including sorghum and maize silage and compound feedingstuffs. This allowed for well-balanced energy to protein ratio, as evidenced by the similar levels of urea in milk and blood from both control and experimental cows. In the previous experiment (Śliwiński, 2007) we observed elevated urea levels in both milk and blood in the experimental group, which received silage from sorghum grown in monoculture. It therefore seems that the mixture of PMR diets given on the feed table to experimental cows was properly formulated. It can be speculated that under dry conditions, when maize is unable to produce full cobs, starch deficiency may increase the energy deficit in cow nutrition. Then additional supplementation of compound feedingstuffs from the feed station will be necessary.

When feeding sorghum and maize silage, antinutritional substances should not be an issue. Sorghum plants, especially in the early stages of development and under stress conditions such as mechanical damage or low temperature, contain the cyanogenic alkaloid dhurrin, which after hydrolization releases hydrogen cyanide (HCN), also known as prussian acid (Marsalis, 2006; Roth and Harper, 1995). This substance may be dangerous when sorghum is used on pasture, or possibly when it is given to cows as fresh green forage. Young plants, shoots on leaf sheaths as well as damaged plants and new stem shoots at the soil surface contain over twice as much prussian acid as mature leaves in normal, healthy plants. These substances are completely broken down during ensilage by bacteria and their concentration decreases as plants become older (Ouda et al., 2001). The situation is similar for nitrate nitrogen, the level of which in dry matter should not exceed 0.2% (Marsalis, 2006; Roth and Harper, 1995). Nitrate can be a threat to animal health when fresh sorghum plants are fed in the early stages of development. Where the concentration of nitrates is high, such feed should be ensiled or administered together with another feed that is low in these compounds (Guorley and Lusk, 1978).

In conclusion, sorghum strip-cropped with maize gives silages of good quality but excessive acidity. It might be well to use fermentation inhibitors to limit excessive fermentation. Giving cows silages from mixed and stripped-cropped sorghum and maize in PMR diets in the mid-lactation has no significant effect on feed intake. Nor does it significantly affect the milk production level compared to PMR diet containing silage from maize grown in monoculture. It causes no differences in the content and yield of fat, protein and lactose in milk, and in physicochemical parameters of milk such as density, acidity and renneting time. It has no significant effect on the cows' plasma metabolic parameters.

We concluded that silages from strip-cropped sorghum and maize that are ensiled together could be a substitute for silages made exclusively from maize for cows in the mid-lactation, in maize high-risk areas affected by periodical and recurrent soil droughts, which considerably reduce the yield of maize for ensilage.

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Wpływ kiszonki z kukurydzy i uprawianego pasowo sorga i kukurydzy na wydajność krów mlecznych i skład mleka

STRESZCZENIE

Doświadczenie żywieniowe wykonano na 34 krowach w środkowym okresie laktacji, podzielonych na dwie grupy dwurasowe (nczb, ncb) po równo w każdej z grup. Badano wpływ dawek pokarmowych PMR zawierających kiszonkę z kukurydzy lub kukurydzę z sorgiem na wydajność mleczną, pobranie paszy, składniki mleka i wskaźniki metaboliczne krwi. Dawki PMR zawierały ponadto kiszonkę podsuszoną z lucerny, kiszone wilgotne ziarno kukurydzy, siano łąkowe i białkowy suplement diety Promilk. Obie rośliny uprawiano na tym samym polu w układzie pasowym 4 + 4 rzędy siane naprzemiennie. Zielonkę obu roślin zbierano sieczkarnią samojezdną, 4-rzędową kosząc 2 rzędy kukurydzy i 2 rzędy sorgo. Zielonkę zakiszano w plastikowych rękawach, bez dodatków kiszonkarskich. Doświadczenie żywieniowe trwające 84 dni podzielono na 4 okresy, każdy po 21 dni. Kontrolowano masę ciała krów na początku i na końcu doświadczenia. Krowy dojono dwukrotnie w ciągu dnia. W czasie dwóch ostatnich dni każdego okresu mierzono ilość udojonego mleka. Ostatniego dnia doświadczenia z żyły jarzmowej pobierano próbki krwi do analiz. W boksach paszowych podawano dodatkowo elektronicznie normowaną mieszankę granulowaną, zależnie od wydajności mleka, taką samą jaka znajdowała się w dawce PMR. Porównywano skład chemiczny obu kiszonek i efektywność produkcji mleka w obu grupach krów. Nie stwierdzono istotnych różnic w pobraniu suchej masy dawki PMR, a także w pobraniu mieszanki paszowej ze stacji (P≥0,01). Nie stwierdzono istotnych różnic w wydajności mleka, w tym mleka standaryzowanego na zawartość tłuszczu i białka (FPCM) (P≥0,01). Zawartość składników w mleku była wyrównana. Nie stwierdzono pomiędzy grupami istotnych różnic w zawartości tłuszczu, białka, kazeiny, laktozy, a także w cechach mleka, jak kwasowość, krzepliwość i gęstość (P≥0,01). Zawartość metabolitów w surowicy krwi nie różniła się istotnie pomiędzy krupami krów (P≥0,01). Wnioskowano, że dla krów w drugim i trzecim okresie laktacji kiszonka z sorgo i kukurydzy uprawianymi pasowo może być alternatywą dla kiszonki z kukurydzy w rejonie ryzyka jej uprawy. Podawanie obu kiszonek krowom mlecznym w środkowym okresie laktacji daje zbliżoną wydajność mleczną i skład mleka oraz nie wpływa na parametry osocza krwi krów.