

The use of meadow-grass silage with formic acid in the nutrition of young calves

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ABSTRACT

Black-and-White bull calves aged 14 to 91 days were fed rations differing in the type of roughage offered to appetite: hay (group H) or meadow grass silage (group S) with 2 kg 80% formic acid/ton of fresh forage. Before weaning (days 14–42 of age), the average daily intake of roughage dry matter and gross energy per kg^{0.75} was higher ($P \leq 0.05$) in group H than in group S (45.0 g and 1.1 MJ, vs. 41.1 g and 1.0 MJ, respectively). However, the differences in daily weight gains (623 and 583 g in groups H and S) and feed utilization were not significant. After weaning (43 to 91 day of life), mean daily intake of nutrients and total energy was similar in both groups with daily weight gains reaching 478 and 502 g, respectively for group H and S. Mean body weight gains during the entire experimental period were the same in both groups and equalled 530 g.

The system of nutrition introduced in the present experiment may be useful for the rearing calves designed for future fattening based on roughages. However, due to the low level of Mg observed in blood plasma (0.38 mmol/l) of all the calves, the ration ought to be supplemented with a mineral mixture containing magnesium.

KEY WORDS: grass silage, calves, nutrition, performance

INTRODUCTION

Silage-based, hay-free rations have traditionally not been introduced into calf rations until weaning (Chapple, 1985; Leaver, 1973; McIlmoyle, 1976; Steen, 1985). However, it has been demonstrated that good quality grass silage can be included in hay-free diets for young calves even of the age of two weeks (Bartholomew et al., 1981; Marsh, 1975, 1976). According to Marsh (1975) when fattened calves were provided with limited amounts of concentrates and grass silage fed to appetite, satisfactory weight gains were achieved and 35% less concentrate was consumed in comparison with traditional feeding regimens. Similar experiments have been conducted in Poland using maize silage (Piotrowski et al., 1988), red clover silage (Baranowski et al., 1989) and a mixed

cereals x leguminous silage (Zduńczyk and Lewicki, 1989). Moreover, investigations have been conducted on the improvement of the value of grass silages for calves and included silages obtained from wilted herbage (Zduńczyk and Lewicki, 1988) and silages obtained from the second and third cut treated with Acidol (Bidwell-Porebska et al., 1987; Piotrowski et al., 1988). The present work aimed at determining the effects of feeding young calves on hay or silage obtained from the first cut of meadow grass treated with formic acid. As the feeding regimen may influence the mineral metabolism of calves (Bomba et al., 1993; Friedrich et al., 1996; Reece and Wahlstrom, 1972) on the last day of the experiment the level of macroelements was determined in the blood plasma of all the animals.

MATERIAL AND METHODS

Both, silage treated with 80% formic acid (2 kg/ton fresh grass) and hay used as the control feed (field-dried, followed by cold-air drying) were prepared from the first growth of meadow grass cut in flower (dominant species: *Dactylis glomerata*, *Phleum pratense*, *Poa pratensis*). Formic acid was added during harvesting with the aid of a Z-310 silos-combine and a HP-5 applicator from Ylö (Finland). The grass containing formic acid was placed in an experimental container made from concrete rings, protected against rain, snow and frost.

The experiment was conducted during late autumn on two groups of 12 Black-and-White bull calves, between 14 and 91 days of age. The animals were assigned to one of two groups differing in type of roughage offered to appetite. Group H received meadow hay, group S – grass silage. Until 42 days of age, each calf was given whole milk twice daily in an amount equivalent to 10% of its body weight, an average of 5.2 kg/day, and 300 g of concentrate CJ. After weaning on the 42nd day of life each calf received 1 kg concentrate per day until day 91. The CJ concentrate, supplemented with a mineral mixture Polfamix C at the rate of 10 g per calf, was offered once daily (at 7:30 AM). The roughages were offered to appetite at 7:30 AM and 4:30 PM. The calves were given water twice daily before hay or silage was offered. The intake of feeds was recorded daily. Samples of feeds were taken daily, pooled into weekly samples and subjected to chemical analysis. Blood was drawn from the zygomatic vein for determination of plasma Na, K, Ca, inorganic P, Mg and Cl contents.

The amount of basic nutrients in the feed samples was determined using conventional methods, gross energy in a KL-6 calorimeter. The organic acid content in silage was determined (Polish Standard, 1974), ammonia and pH according to Skulmowski (1974). The silage dry matter content was adjusted according to Fatianoff and Gouet (1969). Plasma Na, K, Ca and Mg levels were

assayed by atomic mass absorption spectrometry, chloride (Cl) and inorganic phosphorous (Png) by methods given by Pinkiewicz (1972).

The results were subjected to variance analysis using Harvey 1990 software.

RESULTS AND DISCUSSION

The silage (Table 1) had an optimal pH value (4.02) and a low protein degradation index, characteristic for well conserved grasses (N-NH₃:total N), equalling 6.75% (Voss, 1967). No butyric acid was found, while its low lactic and acetic acid levels (1.35 and 1.43% fresh matter) reflect the pattern of fermentation characteristic for formic acid (Jaakkola et al., 1991). In comparison with hay, the silage contained more crude protein (18.2 and 12.4%, respectively) and less crude fibre (24.9 and 30.3% of DM, respectively). The natural structure of the silaged grasses, their colour and smell indicated that the silage was of good quality.

During the first period of rearing (14-42 days of age) the calves in group H consumed on average more dry matter daily ($P \leq 0.05$) than the group S (45.0 g/kg W^{0.75} vs. 41.1 g/kg W^{0.75}; Table 2). Significant differences in favour of group H were also found in total organic matter intake (41.9 and 38.7 g/kg W^{0.75} in groups H and S, respectively) and in total gross energy intake (1.1 and 1.0 MJ/kg W^{0.75}, respectively). The group H calves consumed more nutrients from concentrate and roughages than those in group S, but these differences were insignificant because of high individual variability in both groups. Similar differences in respect to intake of concentrate, hay and silage before weaning were found by Zduńczyk and Lewicki (1989).

During the second period of rearing (43-91 days of age), the mean intake of dry matter, organic matter and gross energy were similar in both groups. The calves in group S did, however, intake more crude protein in their rations ($P \leq 0.05$) than group H, 12.6 vs 11.1 g/kg W^{0.75} because of the greater concentration of crude protein in the silage (Table 1).

No significant differences were observed between the groups in terms of feed intake and weight gains during the entire experiment. We found, in agreement with the results of other authors (Marsh, 1976; Zduńczyk and Lewicki, 1989), that limiting the ration of concentrate stimulates the intake of silage (the ratio of dry matter intake from concentrate to that from roughage in groups H and S was similar and equalled 1.3 and 1.4, respectively), and the silage, in spite of its low DM content (18.9%) was comparable to hay as a source of nutrients for the calves.

During the period of feeding with milk the daily weight gains of the calves in group S were about 580 g and did not differ from the values found in calves fed red clover silage under similar conditions (Baranowski et al., 1989) or

TABLE 1

Feeds	dry matter	In dry matter, %			gross energy MJ/kg	pH	In fresh material, %			N-NH ₃ total N %
		organic matter	crude protein	crude fibre			lactic acid	acetic acid	butyric acid	
Cows milk	12.3	94.3	24.7	0.0	25.2	—	—	—	—	—
Concentrate mixture CJ (for calves)	86.6	93.2	22.6	6.1	18.4	—	—	—	—	—
Meadow hay	86.9	89.4	12.4	30.3	18.1	—	—	—	—	—
Silage	18.9	90.4	18.2	24.9	18.2	4.02	1.35	1.43	0.00	6.75
SEM	0.77	0.59	0.55	0.58	0.16	0.031	0.081	0.075	0.00	0.419

TABLE 2

Item	Feeding period - age days					
	14-42			43-91		
	GROUPS					
	H	S	SEM	H	S	SEM
Dry matter, total	45.0 ^a	41.1 ^b	0.87	62.3	61.7	2.00
from: concentrate mixture CJ	6.8	5.7	0.47	32.9	32.8	0.71
hay or silage	6.0	4.6	0.62	29.7	28.8	2.21
Organic matter, total	41.9 ^a	38.7 ^b	0.75	58.1	56.7	1.80
from: concentrate mixture CJ	6.5	5.3	0.44	30.5	30.6	0.68
hay or silage	5.4	4.2	0.59	26.3	26.1	2.06
Crude protein, total	9.0	9.8	0.18	11.1 ^a	12.6 ^b	0.34
from: concentrate mixture CJ	1.5	1.3	0.15	7.4	7.3	0.17
hay or silage	0.7	0.8	0.09	3.7 ^a	5.2 ^b	0.36
Gross energy, total	1.1 ^a	1.0 ^b	0.02	1.1	1.2	0.04
from: concentrate mixture CJ	0.1	0.1	0.01	0.6	0.6	0.01
hay or silage	0.1	0.1	0.01	0.5	0.6	0.04
SEM	0.1	0.1	0.01	0.5	0.6	0.04

a, b - P ≤ 0.05p pp

Table 3

Mean liveweight, daily gains and feed utilization by calves

Indices	Age, days	G R O U P S		SEM
		H	S	
Live weight, kg	14	46.9	46.9	1.39
	42	64.3	63.1	1.74
	91	87.8	87.7	2.47
Daily gain, g	14-42	623	583	43.2
	43-91	478	502	22.8
	14-91	531	531	24.6
Feed utilization:				
dry matter, g/kg gain	14-42	1657	1764	193.1
	43-91	3392	3319	180.1
	14-91	2630	2535	99.8
organic matter, g/kg gain	14-42	1549	1651	182.0
	43-91	3103	3047	164.9
	14-91	2380	2341	88.9
crude protein, g/kg gain	14-42	372	419	47.1
	43-91	605	682	35.6
	14-91	501	542	19.1
gross energy, MJ/kg gain	14-42	38.5	41.8	4.85
	42-91	62.1	62.5	3.21
	14-91	51.6	49.7	1.91

cereal-leguminous silage (Zduńczyk and Lewicki, 1989). These gains were 40 g lower than those in group H, but this difference was not statistically significant (Table 3).

During the second period of the experiment, between days 43 and 91 of age, the daily gains of the calves in group S were somewhat greater (502 g) than in group H (478 g), but these differences were also found to be insignificant. Similar gains after weaning in calves fed limited amounts of concentrated feed (1 kg per animal per day) and hay or silage from the second cut of meadow grasses (476 and 519 g, respectively) were found in the calves studied by Piotrowski et al. (1988).

The dietary regimen used in this study did not, however, result in high daily gains, which overall averaged 530 g in both groups. The gains obtained in this experiment, as well as the feed utilization indices (no significant differences between the groups) confirm the conclusions reached in other studies (Bidwell-Porębska et al., 1987; Piotrowski et al., 1988; Zduńczyk and Lewicki, 1988; Zduńczyk and Lewicki, 1989; Buch, 1990) that these rations have a similar nutritional value, regardless of the roughages used, be it hay or silage.

The plasma Na, K, Ca, inorganic P, Mg and Cl levels (Table 4) did not differ significantly among the calves in both groups. The plasma mineral contents were

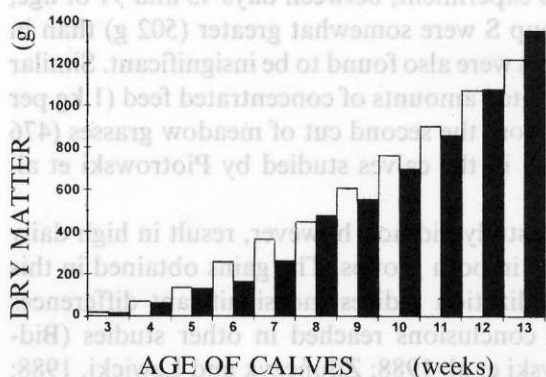
TABLE 4

Minerals content in blood plasma, mmol/l

Ingredient	GROUPS		GROUPS		SEM
	H	S	H	S	
Na	121	122			0.7
K	3.8	3.8			0.05
Ca	2.6	2.4			0.06
Inorganic P	2.4	2.5			0.05
Mg	0.38	0.38			0.017
Cl	122	124			1.1

within the normal ranges for three-month-old calves (Bouda and Jagoš, 1984; Dalton, 1967; Friedrich et al., 1986; Reece and Wahlstrom, 1972) with the exception of Mg, the level of which (0.38 mmol/l) indicated subclinical hypomagnesemia (Ivins and Alcroft, 1969; Smith, 1957). The probable cause was insufficient intake with the diet (the limited amount of concentrate in the ration) additionally influenced by natural factors (low constitutional Mg reserves, low utilization of Mg in the feed) that intensify hypomagnesemia in calves (Bomba et al., 1993).

This experiment showed that the type of roughages given, hay or silage, does not have a significant effect on the performance of calves during rearing or on feed utilization by them between 14 and 91 days of age. The daily weight gains of these bull calves were relatively low, but comparable with those of calves fed



Group H □ hay Group S ■ silage

Figure 1. Dry matter intake from roughages, g/calf/d

limited rations of concentrates with various types of silages (Bidwell-Porębska et al., 1987; Piotrowski et al., 1988, Zduńczyk and Lewicki, 1988, 1989; Baranowski et al., 1989). Limiting the ration of concentrate CJ stimulated the consumption of roughages, especially silage. During the last week of the experiment (Fig. 1) more silage than hay was consumed (by 1357 and 1220 g, respectively per calf per day). At the age of 3 months, the bull calves weighing about 88 kg ate about 7 kg silage daily and were well prepared for future fattening based on roughages. Because of the low plasma magnesium level in all of the calves, the rations should additionally be supplemented with a mineral mixture containing this element.

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STRESZCZENIE

Zastosowanie kiszonki z porostu łąkowego z dodatkiem kwasu mrówkowego w żywieniu cieląt

Cielęta-buhajki rasy ncb od 14 do 91 dnia życia żywiono dawkami różniącymi się rodzajem skarmianej do woli paszy objętościowej – siana (Grupa H) lub kiszonki z 1 pokosu runi łąkowej (Grupa S) z dodatkiem 80 % kwasu mrówkowego (2 kg na 1 tonę zielonki). W okresie żywienia mlecznego (14-42 dzień życia) średnie dzienne pobranie suchej masy i energii brutto na 1 kg metabolicznej masy ciała było większe ($P \leq 0.05$) w Grupie H (odpowiednio 45.0 g i 1.1 MJ) niż S (odpowiednio 41.1 g i 1.0 MJ), lecz nie stwierdzono istotnych różnic między grupami w wykorzystaniu paszy i przyrostach cieląt, które w grupie H i S wynosiły odpowiednio 623 g i 583 g na sztukę dziennie. W drugim okresie żywienia, w którym skarmiano wyłącznie pasze stałe (43-91 dzień życia), średnie dzienne pobranie składników pokarmowych i energii brutto w obydwóch grupach było podobne, a średnie dzienne przyrosty cieląt w grupie H i S wynosiły odpowiednio po 478 i 502 g (różnice nieistotne). Średnie przyrosty masy ciała cieląt w ciągu całego doświadczenia były w obydwóch grupach jednakowe i wynosiły po 530 g.

Przyjęty w doświadczeniu schemat żywienia buhajków, z ograniczonym udziałem paszy treściwej i kiszonki skarmianej do woli, może być przydatny w odchowieniu cieląt przeznaczonych do późniejszego opasania, opartego na paszach objętościowych. Ze względu na obserwowany u wszystkich buhajków niski poziom Mg w osoczu krwi (0.38 mmol/l) skarmiane dawki pokarmowe powinny być uzupełniane mieszanką mineralną zawierającą magnez.