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EFFECTS OF LIQUID DIET COMPOSITION AND FEEDING FREQUENCY ON SOLID FEED INTAKE AND RUMEN FERMENTATION *

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INTRODUCTION

The type of diet fed plays an important role in rumen development. When a ruminant animal suckles, the esophageal groove does not close completely, and some liquid feeds may leak in to the rumen and fermented to VFA (Lane et al., 2000). It seems that the liquid feed composition could influence a microbial fermentation in the rumen. On the other hand the changes in milk-replacer formulas led to the replacement of dried skim milk with plant products, which in nonruminant calves decrease nutrient utilization (Montagne et al., 2003). The negative effects on performance of calves are also exerted by the once daily feeding system (Strzetelski et al., 2001). The effects of liquid feed composition and of feeding frequency on the solid feed intake and rumen fermentation of calves are not really recognized.

The study was conducted to evaluate the effects of type of liquid feed and frequency of feeding on concentrate intake and rumen fermentation of calves.

MATERIAL AND METHODS

The experiment was carried out with 36 Black-and-White Lowland bull calves, divided at 7 days of age into 2 groups (18 animals per group). In Group M calves received milk and in Group MR isonitrogenous solution of milk replacer once (subgroups-1) or three times a day (subgroups-2). Milk replacer protein was composed of (%): soy protein concentrate, 60; and whey, 40. From each subgroup three calves aged 36, 60 and 90 days were slaughtered and rumen contents were removed for Volatile Fatty Acids (VFA) analysis. The calves were fed according to IZ-INRA (2001) recommendations and the individual intake of feed was monitored. All of the calves were given to appetite concentrate consisting of (%): rolled barley, 50; wheat bran, 6; soybean oilmeal, 17; rolled wheat, 25; and mineral mixture 2.

Proximate analysis of feeds was carried out according to AOAC (1990). VFA concentrations were determined as methyl esters using VARIAN 3400 equipment with CPWax-58 column. The results were analyzed statistically using the two-way (type of liquid feed and feeding frequency) analysis of variance procedure of STATISTICA (ver. 5.1). The differences were accepted to be non-significant at $P>0.05$.

RESULTS

Nutrient content and feed value are given in Table 1.

Table 1. Nutrient content and nutritive value of feed

Item	Dry matter	In 1 kg of DM							
		Crude protein	Ether extract	Crude fibre	Ash	UFL	PDIN	Digested Protein[1]	PDIE
Concentrate mixture	875.3	189.1	15.7	47.5	61.4	1.17	130		131
Hay meadow	821.5	85.7	18.1	331.7	108.1	0.58	57.2		74.2
Cow's milk	125.6	266.7	319.3	-	59.7	1.90	-	253.3	-
Milk replacer[2]	947.0	215.8	154.4	10.1	77.1	1.53	-	204.9	-

[1] Digested crude protein was estimated acc. INRA (1989); [2] Solution contains 166 g of milk replacer powder

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From 7 until 36 days of age calves of group M were characterized by the higher daily intakes of liquid feed (about 6,61 kg day^{-1}) compare with MR (5,49 kg day^{-1}), but the daily intake of concentrate mixture were similar in both groups (P>0.05; Table 2). The calve s fed once a day intake lower amount of liquid feed (near 5,73 kg day^{-1}) compared with those fed three times (6,39 kg day^{-1}). Calves fed three times a day intake the higher amount of concentrate mixture (P ≤0.02).

Table 2. The daily intake of concentrate mixture, kg

Item	Liquid feed			Frequency			Mean	SEM
	M	MR	P=[1]	1	2	P=		
During the period (days of life)[2]:								
7 – 36	0.07	0.08	0.72	0.11	0.04	0.02	0.08	0.02
7 – 60	0.24	0.11	0.01	0.18	0.15	0.21	0.17	0.02
7 – 90	1.19	1.33	0.20	1.24	1.29	0.60	1.26	0.07

[1] Means differed at significance level P=; [2] Age of calves (days): 36,75±2,2; 59,8±2,5 and 89,5±4,3

The higher concentration of butyric acid (P≤0.03) in the sum of VFA in the rumen fluid of calves fed milk in comparison with those receiving milk replacer were found (Table 3). At 36 day of life the rumen fluid of calves fed liquid feed three times a day was charact erized by the higher level of C_4 compare with those fed once a day (P≤0.03).

Table 3. VFA concentration in the rumen fluid

Item		Liquid feed			Frequency			Means	SEM
		M	MR	P=[1]	1	2	P=		
36 days of age:									
Rumen content [1]		2.74	2.89	0.51	2.99	2.62	0.05	2.81	0.51
Sum of VFA[2]		133.75	177.06	0.22	120.01	190.81	0.07	155.41	22.9
% mol[3]	C_2	56.43	61.62	0.06	57.28	60.76	0.10	59.02	1.80
	C_3	26.58	28.46	0.06	29.96	25.07	0.10	27.52	1.92
	C_4	12.45	6.2	0.01	8.58	10.07	0.03	9.33	1.08
pH	min	5.73	5.6	0.49	5.84	5.48	0.12	5.66	0.12
	max	5.9	5.9	0.91	5.99	5.79	0.39	5.90	0.12
60 days of age									
Rumen content		9.62	8.56	0.62	11.37	6.79	0.08	9.09	1.21
Sum of VFA		136.6	118.2	0.53	134.37	120.56	0.61	127.43	18.7
% mol	C_2	53.3	53.14	0.91	55.5	50.94	0.32	53.22	2.2
	C_3	30.2	35.9	0.03	32.18	33.92	0.41	33.05	1.87
	C_4	10.75	6.53	0.03	7.3	9.98	0.06	8.64	1.67
pH	min	6.24	5.93	0.31	6.24	5.94	0.21	6.09	0.18
	max	6.38	6.01	0.19	6.23	6.16	0.42	6.20	0.19
90 days of age									
Rumen content		9.03	11.1	0.29	10.1	10.1	0.91	10.08	1.12
Sum of VFA		129	177.9	0.30	160.9	146	0.72	153.45	20.5
% mol	C_2	54.23	56.01	0.62	55.47	54.78	0.80	55.12	1.35
	C_3	32.64	34.62	0.07	33.15	34.11	0.81	33.63	1.25
	C_4	6.72	5.62	0.02	6.15	6.19	0.92	6.17	0.28
pH	min	6.07	5.83	0.60	5.93	5.97	0.91	5.95	0.21
	max	6.35	6.03	0.51	6.13	6.27	0.79	6.20	0.18

[1] Rumen content/100 kg of body mass; [2] Sum of VFA= C_2+ C_3 + iso-C_4 + C_4 + iso-C_5+ C_5; [3] mmol/100 mmol sum of LKT

Higher daily weight gains (DWG) and efficiency of nutrient components utilization per 1 kg of weight gain of calves in Group M than of calves in Group MR were noted (P ≤0.04, Table 4).

Table 4. Daily weight gains (DWG) and feed utilization per 1 kg of weight gain (WG) from 7 to 120 days of age)

Item		Liquid feed			Frequency			Means	SEM
		M	MR	P=	1	2	P=		
DWG, g		939	731	0.02	835	834	0.89	835	41.4
Per 1 kg of WG:	Dry matter, kg	1.84	2.42	0.01	2.08	2.19	0.80	2.13	0.06
	Crude protein, kg	354	453	0.02	393	413	0.82	403	8.70
	PDI, g	281	351	0.02	307	324	0.90	316	6.01

UFL	2.32	2.94	0.02	2.57	2.69	0.89	2.63	0.05

DISCUSSION

The results obtained demonstrate that the content of butyric acid in the sum of VFA in rumen fluid of calves before weaning depends of the type of liquid feed. Calves receiving milk were characterized by significantly higher content of butyric acid compared with those fed milk-replacer ($P \leq 0.01$), although daily concentrate mixture intake was similar ($P \leq 0.72$). The reasons for these differences are unclear. The liquid feeds used in our experiment were characterized by similar levels of protein and energy. However, not only amount of nutrient compounds, but their quality influences the utilization processes. Montagne et al. (2003) described the effects of type of protein on their digestion. Authors found that both the intestinal breakdown of protein and the absorption of oligopeptides from plant protein were significantly lower compared with those derived from milk. On the other hand, milk is a rich source of components with beneficial functionality in young animal nutrition (bioactive pe ptides, hormones, lactoferrin); milk replacers are not supplemented with substances like those (Zabielski, 2001). It is difficult to explain, which component of liquid feed influenced the rumen fermentation.

It seems that the considerably higher weight ga ins of milk-fed calves noted in our study could have proceeded from the higher butyric acid production. Calf's rumen development is accompanied by an increase in oxidation of butyrate, the main source of energy for ruminal epithelial tissue (Baldwin and Jesse, 1992).

In conclusion we can say that in the 36 days of age calves the type of liquid feed did not influence the concentrate intake but induced the differences in rumen fermentation.

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