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Effects of diet on the rumen and blood volatile fatty acid concentrations of growing calves.

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Abstract

Twenty-four calves belonging to the White Fulani (WF) Friesian and German Brown (GB) breeds were used to evaluate the effects of milk based diets, on rumen fermentation pattern and blood volatile fatty acid concentrations. The calves were assigned randomly to four diets as they became available at the age of 4 days, and fed their respective diets for 84 days. The diets were:

1. milk fed twice daily plus a concentrate and grass supplement (TMCG).
2. milk fed twice daily plus a concentrate supplement (TMC).
3. milk fed once daily plus a concentrate and grass supplement (OMCG).
4. milk fed once daily plus a concentrate supplment (OMC).

Rumen and blood samples were taken on the last 3 days of the 4th, 8th and 12th week of the experiment for the measurement of rumen pH, rumen and blood volatile fatty acid (VFA) concentrations.

Significant age, breed and dietary effects were observed on rumen and plasma volatile fatty acids concentrations but not on rumen pH. Friesian and GB calves had higher total rumen VFA than WF calves (3.3, 3.1 and 2.4 meg/100ml respectively) and plasma VFA concentration followed a similar pattern. Both plasma and rumen total VFA increased ($P < .01$) with age, and grass supplemented calves tended to have higher VFA concentrations. Significant positive correlations were observed between rumen and plasma VFA concentrations, while significant negative correlations were observed between rumen pH and VFA concentrations.

Introduction

Rumen volatile fatty acids concentrations as well as pH are good indices of rumen activity. This activity varies with the feeding cycle, and is well reflected in the amounts and composition of volatile fatty acids (Oskorv

1977). A close relationship has been shown to exist on the one hand between rumen pH and volatile fatty acid concentration and absorption (Badaway, 1958), and on the other hand between rumen and plasma VFA concentrations (Olatunji, 1974). These parameters are therefore being used in the present study to evaluate the extent of rumen activity in young growing calves fed milk based diets.

Materials and Method

A total of 24 calves of White Fulani, German Brown and Friesian breeds were used for this study. They were kept indoors in individual pens measuring 5.5 by 3.7m, and provided with adequate bedding material. The calves were assigned as they became available at 4 days old, to one or the other of 4 dietary treatments, care being taken such that sex and breed were equally represented in each dietary group.

The four dietary treatments were:

1. Whole milk given twice daily plus concentrate and grass (TMCG).
2. Whole milk given twice daily plus concentrate without grass (TMC).
3. Whole milk given once daily plus concentrate and grass (OMCG).
4. Whole milk given once daily plus concentrate without grass (OMC).

Milk was fed at 10% of body weight while the fresh, chopped forage *(C. nlemfuensis)* and the concentrate mix whose composition is shown in Table 1, were fed *ad libitum.* The calves were fed twice daily at 8a.m. and 4 p.m. and were weighed weekly during the 84-day experimental period.

Blood and rumen fluid samples were collected 1 hour before and after feeding. Ten (10) mls blood samples were taken from the jugular vein into heparinised tubes, centrifuged immediately at 2,500 rpm and stored at -5°C for subsequent analyses. Rumen fluid samples were strained through muslin cloth and deproteinised before being analysed for total volatile fatty acids. (VFA) by the AOAC (1975) method. Individual VFA concentration were determined by a gas-liquid chromatograph equiped with a column packed with 20% carbowax 20, phosphoric acid celite. The column had a recovery rate ranging from 98 to 105%. Data obtained were analysed using the analysis of variance technique, and regression equations were developed to determine the correlations between pH and total VFA and between rumen VFA and plasma VFA.

Results

The chemical composition of the grass and concentrate supplements are shown in table 2, while rumen pH and VFA concentrations as well as plasma VFA concentrations are summarised in tables 3 and 4. Significant ($P. < .01$) breed, age and dietary effects were observed on rumen and plasma VFA concentrations but not on rumen pH. Mean rumen total VFA values were 2.4, 3.3 and 3.1 meq/100ml for the WF, Friesian and GB respectively (Table 3). Total plasma VFA followed the same pattern, with the values increasing as total rumen VFA values increased. Significant ($P < .01$) and positive correlations were therefore observed between rumen and plasma VFA, with r values of 0.93, 0.95 and 0.94 being obtained for the WF, Friesian and GB breeds respectively. As indicated earlier, age, breed and diet had no effect on rumen pH. Significant and negative correlations were obsered between rumen pH and VFA, with r values of -.87, -.94 and -.90 for WF, Friessian and GB respectively.

Table 4 shows the effect of age and breed on the parameters measured. Rumen and plasma VFA values obtained one hour after feeding were higher than those obtained one hour before feeding. Both parameters also increased ($P < .01$) with age. Results of the VFA molar proportions determinations in the rumen showed that acetic (60.1%), propionic (25.1%) and butyric (14.4%) acids were the major acids. Age had a significant effect on the molar proportions with acetic acid increasing with age, while both propionic and butyric acids decreased with age. Only acetic acid (91%) was found in appreciable amounts in the plasma. Mean propionic acid content was 3.3%, while only traces of butyric acid were detected.

Discussion

The ruminal VFA concentrations obtained in the study were generally low campared with values for mature animals. The mean ruminal VFA concentrations of 12.3, 14.9 and 14.6 meq/100ml at 12 weeks of age for WF, F, GB Calves respectively were however higher than 9.8 meq/100ml rumen liquor obtained by Prange *et al.*, (1978), but within the range of 8.6 13.4 meq/100ml rumen fluid reported by Slyter *et al.*, (1979) with calves of similar live weight and on a similar diet.

The values reported in the present study were higher than 4.14 -- 10.44 meq/100ml rumen fluid observed by Mba and Olatunji (1972) for growing sheep. Milligan and Grieve (1969) reported that there were no significant changes in the concentrations or proportions of the individual VFA'S in

the rumen fluid from calves between 5 and 9 weeks of age. The observations of these workers did not agree with the findings in the present study because animals that had grass as part of their diet, had a higher VFA concentration in the rumen.

The generally low ruminal VFA values showed that rumen activity was still low even at 12 weeks age. However, the total ruminal VFA content increased with age more rapidly for the Friesian and GB calves than WF calves. The total VFA in the plasma was low compared with total rumen VFA, with post-feeding plasma values of 2.6, 3.4 and 3.3 meq/100ml plasma for the WF, F and GB calves respectively. The positive correlation ($r = .94$) observed between rumen and plasma VFA in the present study has been reported by others.

TABLE 1 – COMPOSITION OF THE DIETS FED TO EXPERIMENTAL CALVES

Ingredient	%
Maize meal	32.5
Groundnut cake	20.0
Dry Brewer's grain	40.0
Molasses	7.5
	100.0

Salt lick and Vitamin mixture (Microzone)

5kg/tonne of concentrate ration.

1kg of microzone contains:

Vit. A. (IU) 0.500, Vit. D (IU) 0.250, Mn (g) 16.00, Zu (g) 12.00, Fe (g) 6.00, Cu (g) 3.00 1 (g) 1.20, Mg (g) 2000.00.

TABLE 2 – COMPOSITION OF EXPERIMENTAL DIETS (GRASS AND CONCENTRATES).

Nutrient (% DM)[1]	*Concentrate*	*Grass*
Dry matter	85.38	88.89
Crude protein	21.18	12.11
Crude fibre	13.89	27.05
Ether extract	3.16	1.09
Nitrogen – free extract	57.77	52.16
Ash	4.00	7.59

[1]Mean of 12 determinations.

TABLE 3: EFFECT OF DIET AND BREED ON RUMEN pH, PLASMA AND RUMEN VOLATILE FATTY ACIDS CONCENTRATIONS OF EXPERIMENTAL CALVES

		Rumen		*Plasma*
Breed	*Dietary Treatment*	*pH*	*Total VFA meq/100ml.*	*Total VFA meq/100ml.*
White Fulani	TMCG	6.3	10.8	2.5
	TMC	6.4	10.4	2.3
	OMCG	6.3	11.2	2.6
	OMC	6.4	9.7	2.3
Mean		6.4	10.5	2.4
Friesian	TMCG	6.1	12.9	3.2
	TMC	6.0	12.4	3.0
	OMCG	6.0	13.3	3.6
	OMC	6.0	12.6	3.2
Mean		6.0	12.8	3.3
German Brown	TMCG	6.1	12.1	3.0
	OMC	6.2	12.7	3.0
	OMCG	6.1	12.7	3.3
	OMC	6.1	12.5	3.1
Mean		6.1	12.5	3.1

TABLE 4 : EFFECT OF AGE AND BREED ON RUMEN pH, PLASMA AND RUMEN VOLATILE ATTY ACIDS CONCENTRATIONS OF EXPERIMENTAL CALVES

Breed	Age	Rumen pH	Rumen Total VFA meq/100ml.		Plasma Total VFA meq/100ml.	
			b	a	b	a
White Fulani	4	6.6	7.8	9.6	1.8	2.0
	8	6.4	9.6	11.5	2.1	2.7
	12	6.2	11.8	12.8	2.9	3.1
		6.4	9.7	11.3	2.3	2.6
Friesian	4	6.3	9.8	11.6	2.4	2.5
	8	6.0	11.8	13.7	2.8	2.8
	12	5.7	14.2	15.7	4.0	4.0
		6.0	11.9	13.7	3.1	3.1
German Brown	4	6.3	9.3	11.3	2.2	2.4
	8	6.1	12.1	13.3	2.8	3.2
	12	5.9	13.9	15.2	3.8	4.2
		6.1	11.8	13.3	2.9	3.3

b = Before feeding
a = After feeding

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