Dietary Effects on the utilization of crude protein by white Fulani, Friesian and german brown Calves for maintenance and growth.

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Summary

Twenty–four White Fulani, Friesian and German Brown male and female calves aged between one and eighty–four days were used in these studies. Each of the calves was assigned to one of the following treatments:

(a) milk given twice daily in addition to concentrate and grass,

(b) milk given twice daily in addition to concentrate,

(c) milk given once daily in addition to concentrate and grass,

(d) milk given once daily in addition to concentrate.

Digestibility studies were carried out on all the calves at the 4th, 8th and 12th week of age and crude protein utilization was determined.

The results indicated that there were significant differences (P / 0.01) in the crude protein digestibility between the treatments, and between the breeds. Both faecal–N and urinary nitrogen increased significantly (P / 0.01) with age in all the treatments and breeds. The digestible crude protein (DCP) values of 0.81 to 0.92 and 33.8 to 45.2g/Wkg.734/day were obtained for maintenance and maintenance plus growth from regression equations respectively for all the breeds.

Introduction

Some breeds of cattle like the Friesian and German Brown have been imported into Nigeria in a bid to increase milk production. Consequently considerable interests have been aroused in the studies of nitrogen metabolism of these animals under good dietary regime in their new environments – Adebowale (1976) and Adeneye (1974). While this kind of information is not available with regards to the calves of these exotic animals;

abndant information exists in the literature concerning nitrogen utilization under temperate conditions, Roy (1959) and ARC (1965 have estimated the DCP requirement of a 50–kg Friesian calf to be 30g nitrogen per day.

This experiment was therefore designed to furnish information on N utilization of Friesian and German Brown calves along with the White Fulani calves and to estimate the crude protein requirements of these calves.

Materials and Methods

Animals and their management:

The animals were housed in individual pens of 5.5 by 3.7m. The house was roofed with galvanized iron sheets with sawdust spread over concrete floor to serve as bedding for the calves. Inside each pen was a feed through for both the concentrate and forage. In front of each compartment was attached a plastic bucket for both milk and water consumption. To ensure maximum ventilation, the house was covered half–way on the sides. Movement of animals from one compartment to another was prevented by a partition with teak poles.

Each of the calves was transferred to any of the compartments four days after birth. It was fed there daily with milk and concentrate with or without forage depending on whether it formed part of the treatment.

Plant of experiment and diets

The experiment consisted of the following treatments:

Treatment I – Milk fed twice daily in addition to Concentrate and forage (TMCG)

Treatment II – Milk fed twice daily plus concentrate but without forage (TMC).

Treatment III – Milk fed once daily plus concentrate and forage (OMCG).

Treatment IV – Milk fed once daily plus concentrate but without forage (OMC).

Weekly weights of the animals were taken throughout the trial period.

One male and one female from each breed were assigned to each treatment. All the calves were fed with the milk at 10% of their body weights. *Cynodon nlemfuensis* was offered fresh, properly chopped and weighed. The concentrate which consisted of maize meal, groundnut cake, dry brewer's grain and molasses was offered dry and *ad lib* (Table 1). Feeding of milk was at 08.00 and 16.00 hours each day.

Digestibility studies were carried out on Nutilization from milk, concentrate

TABLE 1. COMPOSITION OF THE RATION FED TO WEANED CALVES OF WHITE FULANI, FRIESIAN AND GERMAN BROWN CATTLE.

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)* added at 5kg/tonne of concentrate ration.

* 1 kg of microzone contains

Vit A	(iu)	0.500
Vit D	(")	0.250
Mn	(g)	16.00
Zu	(")	12.00
Fe	(")	6.00
Cu	(")	4.00
Co	(")	3.00
I	(")	1.20
Mg	(")	200.00

and forage together on all the calves at 4, 8 and 12 weeks of age. This is because consumption of concentrate and particularly forage was very small at this age. During this time they were all transferred to metabolism cages at the ages indicated to enable faeces and urine to be collected.

Collection of faeces and urine

The males were harnessed and fitted with collection bags to prevent contamination of faeces with urine. The collection of faeces and urine, carried out on the male animals, was as described by Oyenuga (1961), while that on the female animals was a described by Akinsoyinu (1974). Thus with the modified cages for the female calves they were without harnesses and collection bags during the 7–day collection period.

Analytical procedure

The AOAC (1970) method was used for the determination of the proximate composition of the feeds and faeces while the semi–micro Kjeldahl technique with Markham's distillation apparatus was used for the N contents of feeds, faeces, urine and milk (Markham, 1942). The metabolic faecal nitrogen (MFN) was determined using the detergent method of Mason, (1969).

In addition, the milk samples were analysed for total solids, butterfat and lactose.

Faeces and urine were collected each morning just before feeding. 2ml of 10% mercuric chloride solution were added to each plastic bucket in order to preserve the urine and prevent loss of ammonia from the urine and 10% of the daily urinary output were taken. The daily urine samples for the 7 days were bulked and stored in a deep freeze at – 50°C until required for analysis. A similar sampling procedure was adopted for the faeces except that the daily samples were dried to constant weight at 105C bulked and mixed for 7 days.

The forage and concentrate samples daily at each feeding were also bulked and dried to a constant weight. All the dried samples of faeces and feeds were milled in a Christy and Norris Hammer Mill using 1mm mesh sieve and stored in air–tight bottles until required for analysis. Analysis of variance was used to test the significance of the digestibilities.

Milk Sampling

10ml of milk fed to the calves were collected daily during the collection period and bulked and stored in deep freeze at –5 °C until required for analysis. The means of the various constituents were then obtained, total ash, gross energy, Calcium (Ca), Phosphorus (P) Sodium (Na) and Chloride (Cl).

The total solids were determined by drying a weighed amount of samples (approx. 10ml) to constant weight at 105°C for 24h. Butterfat was by the Gerber method (British Standards Institution, 1955), while lactose was by

TABLE 2 MEAN+ COMPOSITION OF MILK CONSUMED BY WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES.

Constitutents	
Total Solids (g/100g fresh milk)	13.78 ± 0.34
Fat (")	4.95 ± 0.21
Solids-not-fat (g/100g fresh milk)	8.83 ± 0.19
Lactose (")	4.47 ± 0.08
Crude Protein (N x 6.38) (g/100g fresh milk)	3.29 ± 0.01
Ash (g/100g.fresh milk)	0.68 ± 0.03
Energy (KJ/g dry milk)	21.33 ± 0.24
Ca (g/100ml fresh milk)	0.14 ± 0.02
P (")	0.11 ± 0.01
Na (")	0.04 ± 0.01
Cl (")	0.12 ± 0.01

+ Mean of 12 determinations

TABLE 3. MEAN + CHEMICAL COMPOSITION OF THE RATION AND GRASS (C. NLEMFUENSIS) CONSUMED BY WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES.

Constituent		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
Energy (KJ/g)		18.24	20.98

\+ Mean of 12 determinations

\# On dry matter basis

TABLE 4: MEAN + NITROGEN INTAKE (g/day/$W^{.734}$) AT 4, 8 AND 12 WEEKS OF WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES kg MAINTAINED ON MILK AND CONCENTRATE WITH OR WITHOUT GRASS.

Breed	Stages of (Age in weeks)	TREATMENTS			
		TMCG (1)	TMC (2)	OMCG (3)	OMC (4)
White Fulani	4	3.75	3.46	3.55	3.27
	8	5.51	5.36	5.43	5.00
	12	6.64	6.31	7.30	6.09
Mean		5.30±0.84	5.04±0.84	5.43±1.08	4.79±0.82
Friesian	4	3.49	3.07	4.02	3.90
	8	4.90	4.78	6.47	5.26
	12	5.98	5.86	8.13	7.00
Mean		4.79±0.72	4.57±0.81	6.21±1.19	5.39±0.90
German Brown	4	3.66	4.30	3.53	3.54
	8	5.57	6.72	6.17	5.54
	12	6.57	7.44	6.71	6.06
Mean		5.27±0.86	6.15±1.03	5.47±0.98	5.05±0.77

\+ Each value is a mean for 2 animals
(1) TMCG = Twice milk feeding plus concentrate with grass
(2) TMC = " " " " " " "
(3) OMCG = Once " " " " " " "
(4) OMC = " " " " " " "

TABLE 5: MEAN+ VALUES OF N INTAKE AND UTILIZATION BY WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES MAINTAINED ON MILK AND CONCENTRATE WITH OR WITHOUT GRASS.

Breed	Treat-ments	Treat-ment Live-weight (W_{kg}.734)	N-Digesti-bility %	Faecal N Output (g/day)	Urine N output (g/day)	Absorbed N g/W_{kg}.734/ day	N-balance g/W_{kg}.743/ day	MFN g/kg DM intake	DCP requ-ireme-nt for mainte-nance	DCP requ-irement for ma-intena-nce and growth
White	1	16.87	86.1	10.93	13.08	4.4	3.8	3.55		
Fulani	2	15.25	92.4	6.04	14.91	4.5	3.7	2.59		
	3	15.25	88.2	9.78	12.24	4.6	4.0	2.83	0.81	33.8
	4	15.63	91.6	7.00	15.11	4.2	3.4	2.88		
Mean		15.75	90.1±2.01	8.44±0.94	13.84±0.89	4.4±0.11	3.7±0.15	2.96±0.28		
	1	22.07	88.5	12.74	20.48	4.1	3.4	4.41		
	2	22.35	92.2	8.14	16.41	4.1	3.5	4.06		
Friesian	3	20.83	89.6	17.91	17.01	5.2	4.6	4.84	0.85	45.2
	4	20.48	91.2	9.25	17.54	4.8	4.1	4.20		
Mean		21.43	90.5±1.88	12.01±2.04	18.09±0.96	4.5±0.32	3.9±0.34	4.38±0.21		
	1	20.12	92.0	10.08	15.50	4.6	4.0	4.08		
German	2	19.62	93.4	10.73	15.72	5.3	4.8	4.72		
Brown	3	19.37	90.0	10.32	16.50	4.8	4.1	4.37	0.92	42.4
	4	18.97	91.5	6.39	16.37	4.5	3.9	3.95		
Mean		19.52	91.7±1.32	9.38±1.1	16.02±0.37	4.8±0.23	4.2±0.20	4.28±0.21		

1 = Milk given twice daily plus concentrate and grass
2 = " " " " " " " "
3 = " " once " " " " "
4 = " " " " " " " "

+ = Each value is a mean for 2 animals
DCP (g/day/W_{kg}.734) = Digestible crude protein
MFN = Metabolic faecal nitrogen

Barrett and Tawab's (1957) method as modified by Marrier and Boulett (1959). Total ash was determined when a known weight of sample (approx. 5ml.) was evaporated to dryness and ashed in a muffle furnace at 500 – 550°C for 2h.

Gross energy was determined by absorbing 0.5ml on weighed "ashless" Whatman No. 540 filter paper, drying and igniting in an Adiabatic Bomb Calorimeter; the gross energy of the feeds after pelleting was also determined using this Bomb Calorimeter. The Chloride of the milk sample was determined according to Davies (1932) method. A weighed amount of well mixed sample (Approx. 5ml.) was wet digested with 5ml of perchloric acid (A.R.), 25ml of conc. nitric acid (A.R.) and the digest made up to the 100ml mark in a volumetric flask with deionised water. From the digest Ca and Na were determined with Perkin – Elmer Atomic Absorption Soectrophotometer model 290. The P from the digest was determined as phosphovanado–molybdate (AOAC, 1970) and the yellow colour was read on Acta III Beckman Spectrophotometer at 425um.

Results

(a) The chemical composition of the milk, concentrate and grass forage fed to these animals are shown in Tables 2 and 3. The total solid content of the milk was high as well as the butterfat content.

(b) Nitrogen intake.

The mean values of N intakes and digestibility are shown in Tables 4 and 6. The results showed that there were no significant differences (P / 0.05) in N intake when expressed on a metabolic size basis and the values ranged between 4.57 and 5.21 gN/Wkg. 734/day.

The crude protein (or N) digestibility values were high about 93% for all the calves at 4 weeks (Table 5). This was statistically significant with respect to breed,treatment, age and breed/treatment interaction (P / 0.01) (Table 7).The drop in CP digestibility with age was however more marked in calves having grass as part of their ration. Generally the Friesian calves tended to have higher CP digestibility values than the German Brown and the latter than White Fulani calves on the same treatment (Table 6).

In all the breeds, the faecal–N excretion steadily increased significantly with age (P/0.01) and increased consumption of dietary N. Significant breed and treatment differences (P / 0.01) were also obtained in faecal–N output. The Friesian calves appeared to utilize nitrogen more efficiently than the German Brown, and the latter better than the White Fulani calves on treatments (2 and 4) which contained no forage. Consumption of forage, though not high appeared to depress nitrogen digestibility.

Urinary N output did not differ significantly (P / 0.05) between breeds and treatment when expressed on metabolic size basis.

TABLE 6: MEAN * CRUDE PROTEIN DIGESTIBILITY (%) AT 4, 8 and 12 WEEKS OF WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES MAINTAINED ON MILK AND CONCENTRATE WITH OR WITHOUT GRASS.

Breed	Stages of growth (Age in weeks)	TREATMENTS			
		TMCG (1)	TMC (2)	OMCG (3)	OMC (4)
White	4	92.0	94.8	92.5	94.1
Fulani	8	88.2	92.6	87.5	91.3
	12	84.0	89.8	84.5	89.4
Mean		88.1±2.31	92.4±2.05	88.2±2.33	91.6±1.37
	4	92.6	94.3	93.5	94.5
Friesian	8	87.6	92.7	89.7	91.8
	12	85.3	89.6	85.6	87.3
Mean		88.5±2.15	92.2±1.3[illegible]	89.6±2.28	91.2±1.66
German	4	94.0	94.0	92.8	94.0
Brown	8	92.1	93.5	90.5	92.1
	12	90.0	92.2	86.8	88.3
Mean		92.0±1.16	93.4±0.69	90.0±1.75	91.5±1.68

* Each value is a mean for 2 animals
(1) TMCG = Twice milk feeding plus concentrate plus grass
(2) TMC = " " " " " " "
(3) OMCG = Once " " " " " "
(4) OMC = " " " " " " "

TABLE 7:

ANOVA.

Factor	D.F.	Sum SQ	MEAN SQ	F Cal	S. E
Breed	2	38.48	19.24	16.88**	0.22
Treatment	3	140.55	46.85	41.10**	0.25
Age	2	416.79	208.40	182.8**	0.22
Breed/Treat.	6	35.17	5.86	5.14*	0.44
Breed/Age	4	13.03	3.26	2.86	0.38
Treat/Age	6	18.77	3.13	2.74	0.44

** - Highly significant (P 0.01)

* - Significant (P 0.05)

The MFN values obtained from the detergent method were 2.96, 4.38 and 4.28g/kgDM consumed for the White Fulani, Friesian and German Brown calves respectively. It was however observed in this experiment that treatment had no significant differences (P / 0.05) in MFN values, but tended to increase with age and there were significant (P / o.05) breed differences in the NFN values.

The absorbed N, nitrogen balance and retained N did not show significant differences (P / 0.05) between the breeds and treatments. However, they all tended to increases with age of the calves.

The mean digestible crude protein (DCP) g/day required by the different breeds were obtained by regression equations when N balance was regressed on N intake (Table 8).

The mean DCP required for maintenance and maintenance plus growth were 0.81, 0.85 and 0.92, 33.8, 45.2 and 42.4g DCP/Wkg.734/day for the White Fulani, Friesian and German Brown calves respectively.

Discussion

The mean dietary N intakes of the calves were between 77.8 and 133gN/day compared with 60 – 105gN/day recommended by Roy *et al* (1966) for calves of similar body weight. These values were however in general agreement with 107gN/day obtained by Stobo et al (1972) for a 45–kg calf. The values in the present studies were also higher than the 105gN/day recommended by ARC (1965) for a 50–kg calf. The high N intake in the present studies was due largely to the high quantities of whole milk offered and the high CP content (21%) of the concentrate fed to the calves.

The CP digestibility was high in all the breeds and treatments and ranged between 86 and 93%. These values did not vary very much from 88 to 93% obtained by Raven and Robinson (1958) and 84.9 to 95.7% got by Titus (1961) with calves fed whole milk and concentrate. These high CP digestibility values were due to high consumption of whole milk whose CP digestibility had been reported to be about 100% (Roy *et al*, 1966) and good quality dry feed.

The faecal N and urinary N values were low being 7.2 – 8.8gN/ka DM consumed and 13.84 – 18.09g/day respectively. Both values were lower than 23.7gN/day obtained by Stobo et al (1973). The higher losses could largely be due to higher levels of deamination of amino acids which occurred in the body of their animals. The increased excretion of N from both the urine and faeces as intake increased was in agreement with the trend observed by Pilgrim *et al* (1970). The average metabolic faecal nitrogen (MFN) values obtained for the three breeds was low about 3.89g/kg DM consumed. This was close to 3.70g and 3.90g/kg DM obtained by Loofgreen and Kleiber (1953) and Walker and Faichney (1964) respectively with young calves fed liquid milk. The low MFN values could be due to minimum wear and tear taking place at this period of the calves' growth.

Absorbed N and retained N values were high and varied between 4.4 and

TABLE 8: THE REGRESSION EQUATIONS SHOWING RELATIONSHIPS BETWEEN NUTRIENT UTILIZATION IN WHITE FULANI, FRIESIAN AND GERMAN BROWN CALVES MAINTAINED ON MILK AND CONCENTRATE WITH OR WITHOUT GRASS.

X	Y	EQUATIONS	SE	R
N intake (g/day)	Faecal N g/DM intake	$Y_1 = 2.36 + 75.17\ X_1$ WF	1.46	0.88**
		$Y_2 = 2.95 + 44.30\ X_2$ F	1.39	0.77**
		$Y_3 = 2.66 + 42.14\ X_3$ GB	1.43	0.83**
Absorbed N (g/day/W_{kg}.734)	Urinary N (g/day/W_{kg}.734)	$Y_1 = 0.173 + 0.155\ X_1$ WF	0.15	0.74**
		$Y_2 = 0.298 + 0.091\ X_2$ F	0.12	0.61*
		$Y_3 = 0.302 \pm 0.096\ X_3$ GB	0.08	0.71*
Absorbed N (g/day/W_{kg}.734)	N Balance (g/day/W_{kg}.734)	$Y_1 = 0.156 + 0.88\ X_1$ WF	0.17	0.98**
		$Y_2 = 0.211 + 0.97\ X_2$ F	0.12	0.99**
		$Y_3 = 0.123 + 0.86\ X_3$ GB	0.14	0.84**
Live weight gain (kg/day)	N intake (kg/day)	$Y_1 = 0.19 + 2.37\ X_1$ WF	0.14	0.52*
		$Y_2 = 0.53 + 2.67\ X_2$ F	0.15	0.67*
		$Y_3 = 0.25 + 2.25\ X_3$ GB	0.13	0.61*
N intake (g/day/W_{kg}.734)	N Balance (g/day/W_{kg}.734)	$Y_1 = 0.142 + 0.70\ X_1$ WF	0.15	0.98**
		$Y_2 = 0.151 + 0.728\ X_2$ F	0.16	0.99**
		$Y_3 = 0\ 160 \pm 0\ 749\ {}_3$GB	1.41	.80**

WF = White Fulani calves
F = Friesian calves
GB = German Brown calves

SE = Standard error
r = Coefficient of correlation
** = Highly significant
* = Significant.

5.0g N/Wkg.734/day; and 0.71 to 0.78g/gN intake respectively. The absorbed N values were close to 0.9gN/Wkg. 734/day obtained by Adegbola (1974). Also the retained N values were closed to 0.69g/gN intake reported by Whitelaw (1967). These high values generally reflected the high N intake and low loses of N in both the faeces and urine. The mean DCP required for maintenance plus growth were quite higher than the 30g/day obtained by Roy (1959) and also 30/day recommended by ARC (1965) for Friesian calves. The high values obtained in the present studies was due to high N intake coupled with high digestibility.

It should be emphasized that the amount of whole milk fed could be further reduced to enhance better utilization of dietary N hereby resulting in lower DCP for maintenance and growth.

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