EFFECT OF PARITY ON INTAKE AND UTILIZATION OF A HIGH FORAGE LOW CONCENTRATE RATION BY BUNAJI COWS IN EARLY LACTATION

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ABSTRACT

During the early lactation of three groups of four Bunaji cows each in the first, fourth and seventh parities, a 3:1 hay mixture of *Cyonodon nlemfuensis* variety *robustus* and *Gliricidia sepium* leaves fed *ad libitum* was supplemented for ten weeks with concentrate that supplied 16% of the daily total dry matter intake (DMI). On metabolic size basis, the intake of actual and digestible dry matter, crude protein (CP) and energy declined with increasing parity, the values for the seventh parity being significantly lower (P<0.05) than those for earlier parities. Animals in the 4th parity produced maximum fat-corrected milk (FCM), solids-corrected milk (SCM) and actual milk that contained the least total solids (TS), fat, and caloric value but highest solids-not-fat (SNF) and lactose (P<0.05). They also most efficiently converted DM, digestible CP (DCP) and digestible energy (DE) consumed into actual milk, FCM and SCM and the nitrogen intake or absorbed into milk nitrogen. Differences in these parameters during the earlier and later parities were similar (P>0.05). On the average, animals in the 4th parity apparently lost or gained no weight. Primiparous animals gained one and half times as much weight as the oldest animals and more efficiently utilized the DM, DCP and DE consumed for weight gain while the ratio of their live weight gain to milk yield was higher (P<0.05). Multiparous animals required 110% of the recommended CP but all animals required 70 - 85% of the recommended DE for maintenance and productive purposes.

Key words: **Parity, milk yield, weight gain, Bunaji, *Cynodon, Gliricidia.***

INTRODUCTION

Escalating prices of feed ingredients have continued to sustain inadequate concentrate feeding, low milk production and poor growth among tropical cattle breeds. The productive performances of these unselected animals have therefore depended largely on the amount and quality of available forages. The fresh or dried leaves of the leguminous browse plant, *Gliricidia sepium*, for example, have been shown to be a valuable high protein forage which when fed with grasses or crop residues have improved ruminant nutrition especially during the dry season (Chadhokar and Sivasupiramaninam, 1983; Ifut, 1987).

Reports are few on the intake and utilization of rations in which the supplementary concentrate contributed less than 20% of the total daily dry matter intake (DMI) of lactating cows, the animals consumed 32.2g dry matter (DM) per kilogramme of their body weight. A much lower DMI of 13.6g per kilogramme of their body weight. A much lower DMI of 13.6g per kilogramme body weight of Bunaji cows fed a similar ration was reported by Adebowale and Mba (1979).

According to Poos *et al.* (1979), Cressman *et al.* (1980) and Hubbell *et al.* (1991), multiparous cows consumed more feed, produced more actual milk, fat-corrected milk (FCM) and solids-corrected milk (SCM) and the milk contained lower total solids (TS), fat, solids-not-fat (SNF) and lactose ($P<0.05$) than primiparous cows on the same ration.

The typical milk of Bunaji cattle in Western Nigeria has been reported to contain 11.2-15.8% TS, 4.2-6.2% fat, 3.4-4.3% protein, 4.1-4.8% lactose, and 86.0-88.6 kilocalories gross energy per 100g milk (Olaloku, 1972; Apori, 1988).

Information is needed on the intake and utilization of high forage low concentrate rations fed during the early lactation of Bunaji cows in different parities. The effect of parity of Bunaji cows on the voluntary intake, yield and composition of milk and live weight changes, when fed a high forage low concentrate ration during the early lactation under the hot humid tropical conditions in Western Nigeria are contained in the present report.

MATERIALS AND METHODS

Three groups of four Bunaji animals each in the first, fourth and seventh parities and which had been in lactation for two weeks were chosen from the milking herd at the diary unit of the University of Ibadan Teaching and Research farm and individually housed in cleaned, disinfected and well-ventilated pens with concrete floor and asbestos roof. The pens had individual feeding and watering facilities. The animals were dewormed and sprayed against ectoparasites before the trial started and were weighed at the beginning of the experiment. Throughout the ten-week feeding trial, they were managed under hygienic conditions and their live weights determined once weekly before feeding and watering. They were hand-milked twice daily, 6.30-7.00 a.m. and 2.30-3.00 p.m. local time. Since all the animals did not come into lactation at the same time, the experiment lasted 22 weeks.

The basal forage offered *ad libitum* twice daily consisted of a 3:1 hay mixture of manually chopped *Cynodon nlemfuensis* variety *robustus* and *Gliricidia sepium* leaves which had been manually harvested, sundried for three to five days depending on solar energy intensity and stored in surface silo until ready for use. The concentrate supplement fed at the rate of one kilogramme per head daily was served in two equal instalments at milking times. It comprised 30% ground maize, 20% palm kernel meal, 20% wheat offals, 28% dried brewer's grains, 1% oystershell. Clean water and salt lick were provided *ad libitum*.

Records of feeds offered and rejected after 24-hour feeding and of milk produced at each milking were kept daily for individual animals throughout the feeding trial. Representative samples of the feeds and orts were taken weekly for dry matter and nutrient analysis.

Representative samples of morning and evening milk in proportion of the yields were taken once fortnightly to the laboratory within fifteen minutes after milking, composited and analysed for TS, fat, SNF, protein and total ash according to AOAC (1984) methods. Lactose was determined by Barnett and Tawab (1957) procedures as modified by Marier and Boulet (1959). FCM yield of each animal was calculated with the formula of Gaines (1928) while SCM yield and caloric value of actual milk yield were calculated as described by Tyrrell and Reid (1965).

The apparent digestion coefficients of DM and nutrients of the ration were determined with three Bunaji steers that averaged 125kg and 18 months in weight and age respectively. The steers were dewormed and sprayed before use and individually housed in cleaned, disinfected and well-ventilated digestibility stalls that had feeding and watering facilities. A 7-day total faecal collection period was preceded by a 14-day preliminary period of adaptation to feeds, feeding and stall environment. The feeds and feeding were as for lactating cows.

During faecal collection period, accurate records of the actual intake and weight of faeces of each steer were kept daily. Representative samples (10%) of the feeds, orts and faeces voided by each animal were taken daily in polythene bags for laboratory analysis. Each sample of feed and orts of each cow or steer and of the faeces of each steer was divided into two. A sub-sample was dried to constant weight at 105°C in a forced-draught electrically controlled air oven for DM determination. The other sub-sample was also oven-dried at 70°C for 3-5 days and milled to pass through a 2mm mesh in a Christy-Norris hammer mill and stored in polythene bags until needed for analysis. The weekly feed and residue samples for five weeks for each cow were composited, mixed thoroughly and sampled for analysis of residual moisture, CP, ether extract, crude fibre (CF), nitrogen-free extracts (NFE) and total ash by the standard procedures (AOAC, 1984). The gross energy was determined in a ballistic bomb calorimeter, with benzoic acid as the standard. The milled samples for the seven days for each steer were bulked, thoroughly mixed and sub-samples analysed.

Statistical analysis was according to Steel and Torrie (1980). Parity means were compared using the paired t-test.

RESULTS AND DISCUSSION

The chemical composition of the feeds is shown in Table 1. Sundrying increased the DM content of the harvested *Cyonodon* two-fold and of *Gliricidia* two and one quarter times. The 10.2% CP content of *Cynodon* suggested that the grass was a medium quality forage that would be readily consumed by ruminants. The CP content was approximately half of that found in the concentrate or Gliricidia but the fibre content was about twice of each of the two other feeds. The chemical composition of the forages agreed with that in literature (Onwuka, 1983; Carew, 1983).

The concentrate diet was poorer in protein, fibre and total ash but richer in ether extract content than *Gliricidia*. Its high fibre (18.8%) and ether extract (5.6%) content might be due to high fibre and ether extract content of the palm kernel meal, dried brewer's grains and rice bran components which were equally responsible for the high protein content of the concentrate.

It was observed that the concentrate offered was usually completely consumed within 15 minutes. In addition, although the *Cynodon* and *Gliricidia* were thoroughly mixed on offer, the animals, irrespective of their parities, usually selectively consumed most of the *Gliricidia* before eating the grass which therefore constituted a large proportion of the forage refused. This preference was a probable indication of the higher palatability, protein and mineral composition of the legume.

Animals also varied in their choice of parts of the *Gliricidia* leaves consumed. While some consumed the whole leaves, others preferred only the leaflets or the leaflets and the tender parts of the petiole.

Daily hay DM intake by animals in the first to seventh parities averaged 71.3, 68.0 and 60.2g per metabolic size respectively and constituted 84.1% of the total DM intake of each group. Since *Cynodon* and *Gliricidia* were offered in a ratio of 3:1, animals in the first to seventh parities expectedly consumed 69.8, 71.8 and 68.6% of their forage DM respectively from *Cynodon*. However, the higher CF (34.4%) and lower CP (10.2%) content of *Cynodon* than *Glyricidia* might account for the apparently inadequate DM intake from the grass.

The higher proportion of *Gliricidia* consumed in the forage DM was probably due to the observed selection of the legume in the hay mixture offered. It was a probable indication of both the superior nutritive value of *Glyricidia* to the animals and an exhibition of the nutritional wisdom, that is, euphagia, of the animals to maximize pleasure and satisfaction. Previous reports support the findings (Arnold, 1970; Ifut, 1987).

In the present work, the mean age of the animals in the first to seventh parities was 48.4, 98.2 and 143.5 months respectively in

TABLE 1 CHEMICAL COMPOSITION OF FEEDS

Constituent		*Cynodon nlemfuensis* var. *robustus*	*Gliricidia sepium*	Concentrate
Dry matter (at harvest) %		43.0	36.4	-
Dry matter (residual) %		86.1	81.6	88.3
Crude protein	(% dry matter)	10.2	22.9	20.4
Crude fibre	(.. .. ..)	35.4	19.7	18.8
Ether extract	(.. .. ..)	2.6	3.2	5.6
Nitrogen-free extract	(.. .. ..)	47.1	43.4	50.7
Total ash	(.. .. ..)	4.7	10.8	4.5
Gross energy	(kcal/g)	4.3	4.3	4.6

agreement with Dettmers and Williams (1978) and Mrode and Akinokun (1986).

When expressed on the metabolic size of the animals, the average daily DM intake from the individual feeds and total ration was inversely related to the parity of the animals (Table 2). The mean daily total DM intake of the oldest animals was significantly lower ($P<0.05$) than the similar values for animals in earlier parities. It constituted 84.4 and 88.4% of the total DM intake of these animals while the mean DM intake of primiparous animals was 5% higher than that of animals in the fourth parity. This result is contrary to the reports of Poos *et al.* (1979), Cressman *et al.* (1980) and Hubell *et al.* (1991) on higher milk yielding temperate breeds. Furthermore, abdominal fat deposition and consequent reduction in abdominal volume, decrease in the digestive ability caused by wear and tear in the digestive tract as well as diseases are associative effects of senescence. These might have reduced the voluntary intake of the average 12-year old Bunaji cow to a level that was significantly lower than that of the primiparous animal.

Total DM intake per day averaged 2.10, 1.93 and 1.70% of the live weight of animals in the first to seventh parities respectively. The high proportion of forage consumed (84% of total DM intake) was apparently responsible. Previous work (Olaloku, 1972; Apori, 1988) in which the supplementary concentrate diets supplied 16-31.7% of the total DM intake has shown that lactating Bunaji cows in Western Nigeria are capable of consuming higher percentages (2.2-3.2%) of their body weight as DM.

On metabolic size, the mean daily total CP intake (Table 2) declined with increasing parity ($P<0.05$), a trend that was similar to that of total DM intake. Animals in the seventh parity apparently consumed only 85% of CP intake of primiparous animals. Forage contributed about 78% of the total CP intake. *Gliricidia* hay offered as 25% of the hay mixture supplied approximately half of the forage CP consumed, thus confirming its importance in ruminant nutrition.

The observed protein content of the total DM consumed daily by animals in the first to seventh parities, 15.0, 14.8 and 15.1% respectively, appeared adequate compared with 13%

TABLE 2. EFFECT OF PARITY OF BUNAJI COWS ON MEAN INTAKE OF DRY MATTER, NUTRIENTS AND ENERGY OF RATION

Mean intake ($g/day/W^{.75}$)	Parity 1	4	Number 7	Standard error
Dry matter				
Cynodon	49.8a	48.8a	41.3b	0.76
Gliricidia	21.5	19.2	18.9	0.07
Concentrate	13.5	12.9	11.4	0.06
Total	84.8a	80.9a	71.6b	0.84
Crude protein				
Cynodon	5.1	5.0	4.2	0.02
Gliricidia	4.9	4.4	4.3	0.02
Concentrate	2.7	2.6	2.3	0.01
Total	12.7a	12.0a	10.8b	0.06
Crude fibre				
Forage	21.8	21.1	18.3	0.05
Concentrate	2.5	2.4	2.1	0.01
Total	24.3a	23.5a	20.5b	0.08
Gross energy (kcal)				
Forage	306.3a	292.4a	258.6b	2.78
Concentrate	61.9a	59.2a	52.3b	0.62
Total	368.2a	351.6a	310.9b	3.24
Digestible dry matter	52.7a	50.3a	44.5b	0.58
Digestible crude protein	9.1a	8.6a	7.8b	0.05
Digestible energy (kcal)	243.5a	232.4a	205.4b	2.68

Means with different letters along the row differ ($P < 0.05$).

CP recommended by NRC (1978) for lactating cows that weigh less than 400kg and produce less than 8kg milk daily as in the present study.

The total DM actually consumed daily by animals in each parity contained 29% CF, the bulk (approximately 90%) of which was expectedly derived from the forage. As with the total DM and CP intake, parity exerted a marked influence ($P<0.05$) on CF intake of the animals.

The animals in each parity averagely consumed a substantial proportion (83.2%) of their gross energy (G.E.) from the hay. The total daily G.E. intake averaged 24.0, 26.0 and 23.2 Mcal or 368.2, 351.6 and 310.9 Kcal per metabolic size of animals in parities one to seven respectively. The results showed that each kilogramme of the total DM consumed daily by each group of animals contained 4.35 Mcal G.E. in agreement with the value of 4.4 Mcal in NRC (1978) recommendations. Furthermore, as parity increased, the decline in G.E. intake on metabolic weight basis was similar to that of DM intake.

The average daily intake of digestible DM, digestible CP (DCP) and digestible energy (DE) per metabolic size declined with increasing parity (Table 2), the values for the oldest animals being 84.4-85.2% of the values for the primiparous animals.

The observed DE content of one kilogramme of DM consumed by each group of animals was 2.87 Mcal. while the DCP contained in the DM consumed by animals in the first to seventh parities was 10.74, 10.60 and 10.83% respectively. Furthermore, 37.36, 36.87 and 37.70g DCP were correspondingly consumed per Mcal DE intake. The differences were negligible ($P>0.05$).

Animals in the 4th parity produced 1.52kg or 50.7% more milk per day than primiparous animals in agreement with Poos *et al.* (1979), Cressman *et al.* (1980) and Hubbell *et al.* (1991). However, contrary to the reports of these workers, the milk yields of primiparous and 7th parity cows in the present report were approximately the same (Table 3) due probable to reduced milk production capacity among the oldest animals. Yields of FCM and SCM followed a similar trend, the increase being 41.5 and 45.4% respectively in favour of animals in the 4th parity, and reflecting the highest DM intake of these animals.

Total solids (TS) content of the milk of animals in the 4th parity was significantly lower ($P<0.05$) than those of animals in earlier and later parities, the average values being 14.76, 14.98 and 14.88% respectively. The significantly lower ($P<0.05$) milkfat (5.28%) and slightly lower protein (3.82%) content of the milk might be responsible. Milk yield and fat content are inversely related (Schmidt, 1971; Webb *et al.*, 1983).

Both the SNF and lactose content of the milk of animals in the 4th parity, 9.48 and 4.94% respectively, were significantly ($P<0.05$) superior to those of other animals. The high correlation between milk yield and lactose content has been documented (Holt, 1983; Jenness, 1985).

Since parity had no effect on milk protein content in this report (Table 3), variations in SNF content at each parity were probably due largely to those in lactose content.

Milk total ash increased with parity, the values for multiparous animals being significantly higher ($P<0.05$) than those for primiparous cows.

The milk of temperate cattle breeds has a lower caloric value of 66Kcal/100g (Jenness, 1986) compared with 89-93 Kcal/100g in this report. The higher fat, protein and lactose content of the milk of tropical breed might be responsible. Parity significantly influenced ($P<0.05$) the caloric value of milk, the lower value for animals in the 4th parity apparently reflecting the significantly lower milk fat content. Thus, caloric value is controlled largely by milkfat content.

Efficiency of production of actual milk, FCM and SCM was influenced by parity. Animals in the 4th parity were most efficient ($P<0.05$) compared with the similar efficiencies of younger and older animals. The results also showed that for the production of actual milk, FCM and SCM, both the DE and DCP consumed were better utilized ($P<0.05$) during the fourth than at any other parity. (Table 3).

When efficiency of nitrogen utilization was calculated as milk nitrogen expressed as a percentage of nitrogen intake or nitrogen absorbed, the result (Table 3) indicated that multiparous animals were more efficient in converting nitrogen intake or nitrogen absorbed into milk nitrogen. The conversion efficiency was significantly higher ($P<0.05$) during the fourth than subsequent parities and was attributable to the increase in milk production and in milk nitrogen at that parity.

Under the conditions of the present experiment, the average Bunaji cow in the 4th parity apparently lost or gained no weight during weeks 3-12 of early lactation (Table 4). This suggested that such animals were probably mature and that the nutrients they consumed in excess of maintenance requirements were apparently utilized for milk production. Improved nutrition, selection and breeding would probably reduce the age of

TABLE 3 EFFECT OF PARITY OF BUNAJI COWS ON MILK YIELD, COMPOSITION AND EFFICIENCY OF FEED CONVERSION.

Parameter	Parity 1	4	Number 7	Standard error
Mean milk yield (kg/day)	3.00a	4.52b	3.02a	0.03
Mean fat-corrected milk (FCM) yield (kg/day)	3.81a	5.39b	3.75a	0.04
Mean solids-corrected milk (SCM) yield (kg/day)	3.72a	5.41b	3.70a	0.05
Mean total solids (%)	14.98b	14.76a	14.88b	0.62
Mean milkfat (%)	5.80b	5.28a	5.62b	0.06
Mean solids-non-fat (%)	9.18a	9.48b	9.26a	0.05
Mean protein (%)	3.86	3.82	3.88	0.02
Mean lactose (%)	4.66a	4.94b	4.64a	0.03
Mean total ash (%)	0.66a	0.72b	0.74b	0.06
Mean caloric value (kcal/100g)	93.00a	89.65b	91.71a	0.84
Milk/dry matter intake (kg/kg)	0.54a	0.76	0.57a	0.03
FCM/dry matter intake (kg/kg)	0.69a	0.90b	0.70a	0.04
SCM/dry matter intake (kg/kg)	0.67a	0.91b	0.69a	0.05
Actual milk/digestible energy	0.19a	0.26b	0.20a	0.02
FCM/digestible energy	0.24	0.31	0.24	0.03
SCM/digestible energy	0.23	0.32	0.24	0.03
Actual milk/digestible crude protein	5.06a	7.14b	5.21a	0.06
FCM/digestible crude protein	6.42a	8.51b	6.47a	0.08
SCM/digestible crude protein	6.27a	8.55b	6.39a	0.08
Milk N/N intake (%)	13.65a	19.08b	14.15a	0.62
Milk N/N absorbed (%)	19.12a	26.72b	19.82a	0.84

Means with unlike letters along the row differ ($P<0.05$).

attaining this desirable dairy trait and increase the animals' milk production.

The observed mean daily live weight gain (143g) among animals in the 7th parity was apparently due to a decline in milk production capacity and suggested that it is economically unreasonable to keep such 12-year old animals in the milking herd.

Primiparous animals apparently gained one and a half times as much weight as the oldest cows (Table 4) in accord with Miller and Hooven (1970) due probably to continued growth. In essence, the ratio of live weight gain to milk yield was higher among primiparous than multiparous cows (71.40 v. 47.32). This is supported by NRC (1989).

Efficiency of feed conversion to live weight gain, expressed as gain per unit DM intake, was affected by parity. Although animals in the first and seventh parities were similarly efficient in milk production, Table 4 shows that primiparous animals were more efficient ($P<0.05$) in converting the DM consumed into live weight gain and confirmed that it is

TABLE 4. EFFECT OF PARITY OF BUNAJI COW ON LIVE WEIGHT GAIN, EFFICIENCY OF FEED CONVERSION AND GAIN: MILK RATIO

Parameter	Parity 1	4	Number 7	Standard error
Mean initial live weight (kg)	255	310	310	14.2
Mean final live weight (kg)	270	310	320	12.6
Mean live weight gain (g/day)	214.30a	-	142.90b	103.2
Gain/dry matter intake (g/kg)	38.79a	-	26.72b	16.8
Gain/digestible energy intake (g/kcal)	13.50a	-	9.30b	5.4
Gain/digestible crude protein intake (g/g)	0.36a	-	0.25b	0.14

Means with unlike letters along the row differ (P<0.05)

economically unreasonable to keep 12-year old Bunaji cows either for milk or meat production. Efficiency of conversion of DE and DCP intakes into live weight gain followed trends similar to that of DM intake.

A comparison of the observed and NRC (1978) recommended CP and DE requirements of animals that produced the amount and quality of the milk and gained the weight observed in this report is shown in Table 5. Only the recommended CP for primiparous animals was adequate. The mature lactating multiparous Bunaji cows required 110% of the recommended CP value. Adebowale and Mba (1979) similarly reported that lactating Bunaji cows required 112% of the available protein recommended by ARC (1965).

However, the recommended DE requirements were apparently much higher than the needs of the tropical breed that must necessarily dissipate rather than conserve heat

TABLE 5. EFFECT OF PARITY ON OBSERVED VERSUS NRC (1978) CRUDE PROTEIN AND DIGESTIBLE ENERGY REQUIREMENTS OF BUNAJI CATTLE

Daily requirement	Parity 1	4	Number 7
Crude protein (g)			
NRC (1978)	840.35	806.56	738.61
Observed	830.80	886.49	811.16
Observed (%) / NRC (1978)	98.86	109.91	109.82
Digestible energy (Mcal)			
(NRC 1978)	22.61	20.27	19.43
Observed	15.88	17.17	15.36
Observed (%) / NRC (1978)	70.23	84.71	79.05

under the hot humid environment. Consequently, the average primiparous Bunaji cow required only 70.2% of the NRC (1978) DE value compared with 79-84.7% for the older animals.

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