OBSERVATIONS ON THE WHITE FULANI (BUNAJI) ZEBUCATTLE OF NORTHERN NIGERIA IN A SOUTHERN NIGERIA ENVIRONMENT

VIII: Performance of lactating cows on improved tropical pastures without supplementation.

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SUMMARY

Sixteen lactating White Fulani cows blocked in fours according to stage of lactation were used in assessing milk yield and composition and herbage consumption from four tropical grass/legume pasture mixtures over four-28 day periods in an orthogonal 4 × 4 latin square design.

Available herbage dry matter averaged 29.70 kg/cow/day but the cows only consumed an average of 9.64 kg/day. Crude fibre content of the herbage was generally high (range 38.7 to 39.2%) whilst organic matter digestibility was low (range 60.7 to 65.7%). Differences in milk yield and composition, except percentage milk protein which was significant at 5% level, were not statistically significant.

Indigenous cattle, grazing improved tropical pastures under the Southern Nigerian environment, have been shown to be capable of consuming and digesting enough herbage to provide adequate nutrients for both maintenance and substantial liveweight gains during a greater part of the year (Ogor & Henrich, 1961: McIlroy, 1962; Okorie, Hill & McIlroy, 1965; Oyenuga 1968 and Olubajo, 1969).

By inference such pastures would be expected to provide sufficient energy protein and other nutrients for maintenance and milk production of cattle producing about 6.8 to 9 kg milk per day.

Such an assumption, however, lacks validity, since there are at present, no data on the performance of milk producing cattle grazing improved pastures under local conditions.

This study was therefore undertaken to determine the consumption and utilization of some improved tropical grass/legume pasture mixtures by the lactating indigenous White Fulani Zebu Cattle.

EXPERIMENTAL

Animals:

Sixteen White Fulani (Bunaji) cows with an average weight of 343 kg and in the 4th to 20th weeks of lactation were selected from the University of Ibadan dairy herd (Olaloku, Hill and Oyenuga, 1971) for this study. They were grouped in fours, according to the stage of lactation and level of milk yield prior to the start of the experiment.

Pasture treatments:

The four improved grass/legume mixtures designated H, J, K, L had been established some 2 yeats prior to the trial. The pastures were fertilized routinely at the beginning and towards the end of the rainy season, in May and October respectively with 223.5 kg super phosphate, and 111.7 kg sulphate of ammonia per hectare on each occassion.

Each pasture treatment consisted of two legume species — *Centrosema pubescens* and *Stylosanthes gracilis* plus the following grasses:-

Treatment:-

- H: *Cynodon nlemfuensis* var *robustus*
- J: *Pennisetum purpureum*
- K: P. *purpureum* + *Panicum Maxiumu*
- L: C.*nlemfuensis* var *robustus* + P. *purpureum* + P. *maximum.*

The pasture mixtures were in four randomized blocks each consisting of 1.21 hectare. Each treatment was replicated four time and divided into subplots of 0.101 ha. each of which was rotationally grazed.

Grazings from the pasture treatments were expected to furnish the requirements of the cows for maintenance and milk production.

Experimental design:

The four sequences of pasture treatments were alloted at random to the four cows in each group using an orthogonal 4 × 4 Latin Square design. There were four experimental periods each composed of a 28—day milk collection and analysis with 7—days in between periods for change over from the previous treatment.

Milk Sampling and Analysis:

The cows were hand-milked twice daily at 0500hrs and 14.30 hours and yields recorded. Composite samples of milk representative of a 24—hour production of each cow were taken on the same day each week and analysed for fat and solids-not-fat (s.n.f.) by the standard Gerber and B.S.I. methods respectively as described by Davis (1959). Milk protein was determined by the macro-Kjeldahl method, and lactose concentration by the colorimetric phenol-sulphuric acid method of Barnett and Tawab (1957) as modified by Marier and Boulet (1959). Milk ash was determined by igniting the dried milk sample in a muffle furnace at 550°C for 48 hours. Solids — corrected milk was calculated using the formula proposed by Tyrell and Reid (1965).

Measurement of Feed Intake:

The herbage intake of each cow in each experimental period was measured indirectly, using the chromic oxide (Cr_2O_3) and faecal nitrogen index methods for estimating faecal output and predicting digestibility respectively.

Each cow was dosed twice daily with 20g of shredded Cr_2O_3 paper, one at 07.30 hours and the other at 14.30 hours. The "pat-sampling" method of Raymond and Minson (1955) was used to obtain faecal samples from each cow in the field, coloured polystrene granules being used to determine which animal was the source of each defaecation, (Minson, Tayler, Alder, Raymond & Mead, 1960).

Each cow's daily faecal samples were dried and ground separately and bulked over a nine—day collection period for chemical analysis, Cr_2O_3 and nitrogen concentrations.

Faecal output (FO) was calculated from the formula:—

$$FO = \frac{\text{Wt of } Cr_2O_3 \text{ administered}}{\text{Per cent } Cr_2O_3 \text{ in faeces}} \times 100$$

"Local regression equations relating percentage nitrogen concentration (×) in cattle faeces and the percentage digestibility of the organic matter of the rations (y), obtained using eight wether West African Dwarf Sheep (Mason, 1951) in metabolism crates, were applied in calculating the digestibility of the organic matter (OM) of the herbage consumed by each cow.

Knowing the FO, and the digestibility of the herbage, the total organic matter intake by each cow per day was calculated using the equation:—

$$OMI = \frac{FO \times 100}{100 - \text{percent digestibility.}}$$

hence, the digestible organic matter intake (DOMI)

$$= \frac{OMI \times \text{digestibility}}{100}$$

The daily intake of digestible nutrients for each cow was calculated using the digestion coefficients for each nutrient obtained from wether sheep in metabolism crates.

Herbage Production and Botanical Composition:

The available herbage dry matter yields were determined from cuttings of six ran-

Herbage Production and Botanical Composition:

The available herbage dry matter yields were determined from cuttings of six random samples from each plot at heights of about 5.0 — 7.5 cm from the ground, by means of sheep shears using 0.91m × 91m quadrats, pre and post grazing.

For the analysis of botanical composition, six random quadrat samples were similarly obtained, as the animals were introduced into the pasture at the beginning of each grazing cycle. The samples were weighed, followed by a hand-separation of the individual species. Each pasture component separated was then weighed and dried at about 100°C in a forced-air electric oven for 48 hours, cooled in a desicator and then weighed. The percentage composition of each component in the treatment sward was then calculated from the weights.

Management of the Animals:

The Animals were grazed daily from 0800 to 13.30 hours and from 15.30 to 18.30 hours when they were finally brought back to the dairy paddocks. The movement to and from pastures each day involved walking approximately 4.0km.

During the digestion trials and estimation of faecal output, the animals were grazed as usual, but were housed at night in individual stalls on concrete floors to facilitate the easy collection of faecal samples.

The cows were weighed once a week immediately after the morning milking, and average daily gains calculated from the records kept throughout the entire period.

Statistical Analysis:

Statistical analysis followed the methods outlined by Federer (1963) and differences between means were analysed by Duncan's Multiple Range Test (1955).

RESULTS

Herbage Production, Composition and Intake:

The average chemical composition, estimated availability and intake of the herbage dry matter are shown in Tables 1 and 2.

TABLE 1

Chemical Composition of Herbage Grazed (% Dry Matter)

	Treatments			
	H	J	K	L
Dry matter	90.6	90.3	91.0	91.5
Crude protein	11.5	12.5	12.2	9.6
Ether extract	2.3	2.4	2.7	2.0
Crude fibre	38.5	35.7	38.1	39.2
Ash	12.3	12.5	11.7	10.9
Nitrogen-free-extract	35.4	36.9	35.3	38.3
Gross Energy (cal/g)	4.6	4.7	4.6	4.2

TABLE 2
Estimated Herbage Production and Consumption

	Treatments			
	H	J	K	L
Dry matter yield (kg/ha)...	4158	4897	4964	5538
Dry matter available (kg/cow/day)	25.3	29.8	30.2	33.6
Dry matter consumed (kg/cow/day)	10.74 ± 0.46	9.62 ± 0.39	9.40 ± 0.38	8.82 ± 0.17
Organic matter digestibility of herbage (%) ...	65.8^{b} ± 0.97	61.9^{a} ± 0.63	61.1^{a} ± 0.44	60.8^{a**} ± 0.93

**P. 0.01 a,b... Means not followed by the same super scripts in the same horizontal columns are significantly different from one another.

Crude protein was highest on treatment J and lowest on L. The crude fibre content of the herbage was fairly high on all the treatments being highest on treatment L and lowest on J.

Soluble carbohydrates were also highest on L, whilst the ether extracts and mineral ash were highest on treatments K and J respectively. The gross energy values of the herbage were however about the same on treatments H, J and K and only slightly lower on L.

.The results also show that herbage yield was highest on treatment L and lowest on H. Mean daily intake of herbage dry matter was however significantly higher (P 0.05) on treatment H as compared to treatment L. The differences between H, J and K were non-significant.

By applying 'local' regression equations obtained from the digestibility determinations to the faecal nitrogen concentrations, the digestibility of the organic matter (OMD) of the herbage consumed by each cow was calculated. The results showed a significantly higher ($P < O.01$) OMD on treatment H as compared to the other treatments. The differences between J, K and L were not significant.

The botanical composition of the swards as grazed (Table 3) clearly shows that only one legume specie — *Centrosema pubescens* was present in all the treatments, there were no traces of the *Stylosanthes gracilis*. The proportion of the *Centrosema pubescens* was highest on treatment H and decreased through to L.

TABLE 3

Botanical Composition of Treatment Swards (% Dry Matter)

	Treatments			
	H	J	K	L
Cynodom nlemfuensis var robustus	80.21	—	—	22.58
Pennisetum purpureum	—	80.19	45.02	31.26
Panicum maximum	—	—	38.59	30.20
Centrosema pubescens	19.21	18.44	16.39	15.67
Stylozmthes gracilis	—	—	—	—
Other species (Weeds etc.)	0.52	1.37	—	0.29

The mean daily intake of the major nutrients — digestible organic matter, frude protein, crude fibre and energy — are shown in Table 4.

The intake of digestible organic matter was significantly higher ($P < 0.05$) on treatment H as compared to the other treatments, the differences between J, K and L were not significant.

Digestible crude protein intake was significantly higher ($P < 0.05$) on treatments H, J and K as compared to L; H, J and K however, did not differ significantly. Intake of digestible crude fibre was significantly higher ($P < 0.05$) on treatment H compared to the others which did not differ from one another whilst the digestible energy intake was significantly lower on treatment L ($P < 0.05$) as compared to the others, the differences between which were not significant.

TABLE 4

Mean daily intake of digestible nutrients

		Treatments			
		H	J	K	L
Digestible organic matter	(Kg)	6.24^{b}	5.22^{a}	5.06^{a}	4.76^{a*}
		±0.30(SE)	±0.21	±0.20	±0.10
Digestible crude protein	(Kg)	0.79^{a}	0.76^{a}	0.69^{a}	0.44^{b*}
		±0.04	±0.04	±0.03	±0.01
Digestible crude fibre	(Kg)	2.57^{b}	1.94^{a}	2.07^{a}	2.06^{a*}
		±0.10	±0.07	±0.04	±0.04
Digestible energy	(Mcals)	34.54^{a}	29.08^{a}	27.51^{a}	22.82^{b*}
		±0.26	±0.19	±0.16	±0.09

*P 0.05.

a, b = Means not followed by the same superscripts in the same horizontal columns are significantly different from one another.

SE = Standard error.

Animal Production:

Milk production and composition are shown in Table 5. There were only small variations in the milk and SCM yield on the different treatments. Both the milk and SCM were higher on treatment H as compared to the others, although the differences were not significant.

TABLE 5

Mean Daily Milk Production and Composition

	Treatments			
	H	J	K	L
Milk (kg/day)	2.32 ± 0.11	2.12 ± 0.11	2.11 ± 0.11	2.17 ± 0.13
SCM (kg/day)	2.85 ± 0.12	2.55 ± 0.13	2.57 ± 0.10	2.63 ± 0.14
Fat (kg/day)	5.96 ± 0.22	5.74 ± 0.19	5.87 ± 0.20	5.69 ± 0.20
Protein (kg/day)	3.82 ± 0.09^{a}	3.86 ± 0.10^{a}	3.92 ± 0.15^{d}	$3.77 \pm 0.07^{*b}$
Lactose (kg/day)	3.69 ± 0.03	3.65 ± 0.04	3.66 ± 0.01	3.73 ± 0.06
Minerals (kg/day)	0.69 ± 0.01	0.68 ± 0.02	0.67 ± 0.02	0.69 ± 0.02
S. n. f. (kg/day)	8.98 ± 0.09	8.59 ± 0.10	8.75 ± 0.23	9.12 ± 0.14
Weight Losses (gms/day)	26.3 ± 1.3	28.3 ± 1.5	15.1 ± 0.9	21.7 ± 1.1

*** P 0.05** **SE = Standard error.**

a, b Means not followed by the same superscripts in the same horizontal column are significantly different from one another.

The major influence of the pasture treatments on chemical composition was the significantly higher (P 0.05) percentage protein in milk on treatments H, J and K as compared to L. The differences between H, J and K were however statistically not significant.

Variations in the percentage milk fat, minerals, lactose and s.n.f. were very small, and none of the differences between treatment means was significant. Percentage milk fat and mineral ash were highest when the cows were on treatment H, whilst lactose and s.n.f. content of milk were highest on treatment L.

All the cows lost weight during the experiment, although the losses were very small and statistically non-significant. The highest losses were recorded on treatment J and the lowest was on treatment K.

DISCUSSION

In considering the results of this experiment, the estimates of herbage intake by the chromic oxide — faecal index method has been adopted in preference to the herbage cutting method, since the latter tends to overestimate actual forage consumption (Peterson, Lofgreen and Meyer, 1956; Carter, Bolin and Erickson, 1960; Holmes, Jones & Adeline, 1966). It was also considered that more of the stemmy fibrous materials of the tall-growing species would be left ungrazed under the free-grazing system adopted in this study, in view of the reportedly high selective grazing habits of the Zebu (Brendon and Marshall, 1962). Such materials would be included in the estimates of consumption by the herbage cutting method.

The results have shown that although the yields of herbage dry matter were high in all the treatments, the level of consumption by the cows was comparatively low. The utilization efficiency (consumed herbage expressed as a percentage of available herbage) ranged from 26.2% on treatment L to 42.4% on treatment H.

Oyenuga (1968) reported similar trends, but lower utilization efficiency figures for similar pasture swards grazed by White Fulani and N'dama steers. The differences in intake, apart from those associated with differences in herbage quality, may have been due to differences in the physiological status of the animals, for lactating cows have generally been shown to consume more herbage than either non-lactating cows or steers grazing the same pasture (Elliot, Fokkema and French, 1961; Campling, 1966).

The higher intake of herbage dry matter on treatment H as compared to the other treatments may be due in part to the comparatively higher percentage of the legume as well as the shorter nature of the grass specie (*C. nlemfuensis*) as compared to the other treatment swards in which the tall growing grass species *(P. purpureum* and *Panicum maximum)* with their greater stem to leaf ratio predominated.

The crude fibre content of the herbage dry matter consumed by the cows on all treatments was high, and it would appear that this may have been responsible for the comparatively low digestibility figures and hence the total feed intake of the animals.

Conrad, Pratt and Hibbs (1964) concluded that with diets less than about 67% digestible, digestibility was an important determinant of the intake of dairy cows.

The significantly higher digestible organic matter intake on treatment H and the declining trend through J and K to the lowest level on treatment L, when taken together with the digestibility figures, lends support to the conclusions of Corbett, Langlands and Reid (1963) that the decline in digestible organic matter intake by grazing stock was due more to changes in digestibility as such, than to consequent changes in the actual feed intake.

A consideration of the milk yield and composition as well as the liveweight changes with those of nutrient intake, reveals very little in terms of a direct cause and effect relationship that is often interpretable in many feeding experiments. This difficulty is one of many encountered in using milk production (as compared to beef gains for example) as a yardstick in measuring grassland productivity. Castle (1951, 1953, 1955); Cox, Foot, Hosking, Line and Rowland (1956) and Huffman (1959) have outlined some of the other difficulties encountered in the assessment of the animal production results in dairy grazing trials.

The intake of feed and nutrients were generally highest on treatment H, which also had the highest but non-significant yields of milk and SCM. On the other hand, the yields of milk and SCM were higher on treatment L than those on J and K from which the cows had higher intakes of nutrients. Similarly, percentage milk protein was much higher on treatment K from which the cows had much lower intakes of digestible crude protein than on treatments H and J.

The low level of milk yield and the accompanying losses in liveweight may have been due in part to a gross underestimation of the maintenance requirements of the animals, and consequently an overestimation of the energy and protein available for production.

An underestimation of the maintenance requirements of the animals could have arisen from an increase in the activity of the cows during grazing, as the reports of Brendon and Marshall (1962) and Haggar (1968) on the grazing habits of zebu cattle would seem to suggest. Musangi (1965) reported that Nganda steers spent less time grazing but walked around the pasture more than their Friesian counterparts. This, he suggested, might have been partly responsible for the increased maintenance cost and the consequent reduction in the ME available for production.

The results of Co-op and Hill (1962), Langland, Gorbett and McDonald (1963), Lambourne and Readon (1963) for sheep, and those of Wallace (1961) as well as Corbett, Langlands and Boyne (1962) have also indicated that some estimates of the maintenance needs of sneep and lactating cows at pasture grossly exceed the maintenance costs determined indoors in calorimeters.

It is equally conceiveable that because of the high crude fibre content of the herbage consumed, the overall economy of energy usuage was dominated by the greater losses of energy in digestive movements and increased heat of fermentation as indicated by Raymond (1966).

Although the calorific value of the grazed herbage in this experiment fell well within the range reported for pasture herbage in the temperates (Hutton, 1962; Blaxter, 1964), they were probably not sufficiently accurate enough to base the calculations of the available energy for maintenance and production. For, Blaxter (1964) pointed out that such calculations would be grossly inaccurate, particularly where animals are fed on grassland products or grazed *ad libitum*, as was the case in this experiment.

These results cannot therefore be regarded as conclusive evidence that feed and nutrient intake from tropical grass/legume pasture mixtures are inadequate to meet the requirements of a 340kg lactating cow producing as much as 10kg milk daily.

Further studies are required to elucidate the nature of the rumen fermentation resulting from grazed tropical pasture herbage, in relation to the quality of the herbage and the utilization of the nutrients therefrom.

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