

THE EFFECT OF VARYING CONCENTRATE: GRASS HAY RATIOS
ON FEED INTAKE AND NUTRIENT DIGESTIBILITY BY GROWING
WEST AFRICAN FOREST SHEEP

By

Adeleye, I. O. A. and Ikhatua, U. J.,
Department of Animal Science,
University of Ibadan, Ibadan, Nigeria.

SUMMARY

Twelve ram lambs of the West African Forest type of between 15.7 and 24.6 kg were divided into four groups of 3 animals each. A group was assigned to one of four diets consisting of the following concentrate: grass hay ratios - 20 : 80 (A), 40 : 60 (B), 60 : 40 (C) and 80 : 20 (D). Feed intake, nutrient digestibilities and efficiency of feed utilization were measured.

As the level of concentrate increased, the contents of crude protein ether extract, nitrogen-free extract (NFE) and gross energy of the diets increased, while the crude fibre and ash contents decreased almost linearly. Voluntary feed intake increased with increasing levels of concentrate, with diet C having a significantly higher ($P < 0.01$) Relative Intake (RI) value than the other diets. Both the Nutritive Value Index (NVI) and Digestible Energy (DE) intake values were significantly higher ($P < 0.01$) in diets C and D than the other diets. Generally, the digestion coefficients for the gross energy, crude protein, crude fibre and nitrogen-free extract increased with increasing levels of concentrate, the values being significantly higher ($P < 0.01$) in diets C and D, while diet A showed a significantly

lower ($P < 0.05$) dry matter digestion coefficient value when compared with either diets. Although a similar trend was observed in the digestion coefficient for ether extract, the differences were not significant ($P < 0.05$). With the exception of animals on diet C which had the highest daily weight gains, average daily weight gains and efficiency of feed utilization increased with successive substitution of concentrate for grass hay.

INTRODUCTION

Under favourable conditions and on well-managed grazing paddocks, forage consisting of grasses and legumes usually supplies all the nutrients necessary for sheep feeding (Crampton, Donefer and Lloyd, 1960). However, the condition of the sheep, the amount and kind of pasture available frequently determine the amount of supplements to feed and when to feed them (Cole and Ronning, 1974). Lack of energy is probably the most common manifestation of nutritional deficiency of sheep. This may result from lack of sufficient feed or from little net energy available to the animal from the feed consumed.

The absolute level of energy intake at which animals control feed intake varies with the nutrient content of the diet and the physiological demand of the animal (Balch and Campling, 1962). Donefer, Lloyd and Crampton (1963) have shown that voluntary intake of forages is determined largely by rumen load and rate of passage. With ruminant animals, the feeding of concentrates can have

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one of two effects, viz: the reduction of cellulose digestion, owing to preferential attack of the more soluble carbohydrate of the concentrate by the micro-organisms of the rumen (El-Shazly, Dehority and Johnson, 1961; Loosli, 1963), or the stimulation of crude fibre digestion when the soluble carbohydrate is used at fairly low levels (Kane, Jacobson and Damewood, 1959).

The present work was undertaken to study the effects of increasing levels of concentrate to forage on voluntary feed intake and efficiency of feed utilisation of West African Forest sheep. The demand for sheep in this country both for home consumption and religious festivals is increasing very rapidly. Notwithstanding, production practices have been mainly traditional and very little is known about the responses of these animals to improved management systems and supplementary feeding.

MATERIALS AND METHODS

Animals and their Management.

Twelve rams of the West African Forest sheep of between 10-12 months of age and weighing between 15.7 and 24.6 kg were selected from the flock of the University of Ibadan Teaching and Research Farm and used for the experiment. Prior to the experiment, the animals were put on a semi-intensive

system of management. Sexes were usually separated at weaning (about 100 days of age) and the animals kept on concrete floor pens in groups of 20 to 25 animals per pen, using saw-dust as the bedding material. They were grazed on paddocks containing predominantly Cynodon nlemfuensis and scattered stands of Centrosema pubescens from 07.00 to 12.00 hrs. Afterwards, they were returned to the pens and group-fed some concentrate supplement at approximately 0.25 kg per head daily.

Diets and plan of the experiment

The experimental diets consisted of Cynodon nlemfuensis which was used as the hay. The grass was harvested with a forage harvester towards the end of the rainy season in October 1973. The harvested pasture was sun-dried for a week, ground in the feed mill into particles of about 0.2 to 0.5 cm in length and stored in juts sacks. The concentrate portion of the experimental diets were made up of ingredients as shown in Table 1(a).

Table 1.

(a) Composition of the Concentrate Portion of the Diet.

Ingredients	Percent Composition
Yellow maize (ground)	50.0
Brewer's grains (dried)	35.0
Groundnut cake	12.5
Molasses (dehydrated)	2.5
Total	100.0

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Table 1(b) Chemical Composition of the Concentrate and Grass Hay Portions of the Diet (Dry Matter Basis)

Components (%)	Concentrate	Grass Hay
Crude protein	16.7	7.1
Crude fibre	14.4	38.9
Ether extract	6.8	2.4
Ash	5.3	8.9
Nitrogen-free extract (NFE)	56.8	42.7
Gross energy kJ/g*	17.82	16.78

* (kJ/g = Kcal/g x 4.184)

The 12 rams were randomly divided on weight basis into four groups of 3 animals per group. A group was assigned to one of the four experimental diets shown in Table 2. Throughout the experimental period the animals were

Table 2. Chemical Composition of Experimental Diets (concentrate + Grass hay) DM basis.

Component of ration dry matter	Concentrate : Grass hay			
	20 : 80 (A)	40 : 60 (B)	60 : 40 (C)	80 : 20 (D)
Crude protein (%)	9.43	10.91	13.00	14.62
Crude fibre (%)	34.10	28.13	24.34	19.46
Ether extract (%)	3.48	4.46	4.68	5.71
Ash (%)	7.98	7.29	6.74	6.23
N. F. E. (%)	45.01	49.21	51.24	53.98
Gross energy (kJ/g)*	16.86	17.32	17.36	17.66

* (kJ/g = Kcal/g x 4.184).

put in individual feeding pens and fed the appropriate diet ad libitum once daily in order to allow for maximum voluntary feed intake determinations. Any unconsumed feed was weighed and discarded before giving the day's feed. Fresh water was available in plastic buckets and each animal was provided with a block of trace-mineralized salt lick. The animals were weighed weekly for the first 8 weeks while the ninth week was used for digestibility studies.

Faecal Collection.

Faecal collection was done by means of collection bags fitted to harnesses. The total wet faeces excreted daily were weighed and dried in a forced-draught oven at 80°C for 24 hours. The daily dried faeces for each animal over the 7-day collection period were bulked and sampled. The samples were milled and stored in tight-fitting glass bottles until required for analysis.

Analytical Procedure.

Proximate chemical analyses of the feed and faecal samples were carried out using the A. O. A. C. (1970) methods. Relative Intake (RI), Digestible Energy (DE) intake and Nutritive Value Index (NVI) values were determined according to the methods of Crampton, Donsfer and Lloyd (1960, 1962).

Statistical Analysis.

The data were analysed by the analysis of variance in accordance with Steel and Torrie (1960), while significance between treatment means was determined by Duncan's (1958) Multiple Range Test.

RESULTS AND DISCUSSION

The chemical composition data of the experimental diets are presented in Table 2. It can be noted from this table that the major effect of increasing the levels of concentrate supplement in the diets on a dry matter basis was an increase in the contents of crude protein, ether extract, gross energy and nitrogen-free extract (NFE), while the crude fibre and ash content decreased with progressive substitution of concentrate supplement for grass hay. This was expected since the concentrate supplement was higher in crude protein, ether extract, gross energy and NFE but lower in crude fibre and ash contents than the grass hay (Table 1b). Although the crude protein content of the diets showed a wide variation (9.43 to 14.62%), cognizance was taken of the requirements of sheep of similar age and weight (NRC, 1968).

The average feed intake values and apparent nutrient digestibility coefficients are presented in Table 3. Digestion coefficients for the crude fibre fraction of the diets increased progressively with increasing levels of concentrate supplement, indicating that there was better digestion of the crude fibre at higher concentrate: grass hay ratios. Although the total crude fibre content of the diets decreased with increasing concentrate supplement, the higher concentrate supplement has, no doubt, led to a build-up of rumen micro-organisms which are responsible for the breakdown of crude-fibre (Kane et. al. 1959).

Table 3. Feed Intakes and Apparent Nutrient Digestibilities.

	Experimental Diets				SE of means
	A	B	C	D	
Relative Intake (RI)	42.3 ^b	45.4 ^b	55.2 ^a	48.1 ^b	1.18**
Nutritive Value Index(NVI)	20.6 ^b	24.1 ^b	33.6 ^a	29.5 ^a	0.88**
Digestible Energy (DE) intake	71.9 ^b	85.2 ^b	119.6 ^a	106.4 ^a	3.11**
Digestion coefficients:					
Dry matter (%)	52.2 ^b	56.2 ^{ab}	66.0 ^a	64.7 ^a	3.27*
Crude protein (%)	51.6 ^c	57.5 ^b	63.7 ^a	64.0 ^a	0.97**
Crude fibre (%)	48.2 ^b	48.7 ^b	53.5 ^{ab}	58.6 ^a	1.52**
Ether extract (%)	62.7	63.4	67.0	66.9	1.67(NS)
NFE (%)	62.5 ^b	69.2 ^{ab}	72.4 ^a	74.2 ^a	1.73**
Gross energy (%)	48.6 ^b	53.1 ^b	60.8 ^a	61.4 ^a	1.22**

** Highly significant treatment differences (P 0.01)

* Significant treatment differences (P 0.05)

NS No significant treatment differences (P 0.05)

a, b, c, Values on the same line having different superscript letters differ significantly (P 0.05).

With the exception of diet C, which had the highest dry matter digestion coefficient, dry matter digestibility values also increased with increasing levels of concentrate supplement. This observation is in agreement with most reported data in

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literature (Balch and Campling, 1962; Donefer et. al., 1963). It can also be noted that the coefficients of gross energy digestibility was similar to those of dry matter. This similarity could be explained by the fact that the dry matter fraction of the diet, excluding the ash, is predominantly a source of energy. The digestion coefficients for the other ration components reflected what might be expected with additions of the more available nutrients as contained in the concentrate supplement, that is, marked increases in their digestion coefficients. Except for the ether extract digestion coefficient which did not show significant differences ($P > 0.05$), the coefficients for other nutrients (dry matter, crude protein, crude fibre, NFE and gross energy) were significantly higher ($P < 0.01$) in diets C and D (Table 3). In general, there appeared to be an inverse relationship between the content of crude fibre and coefficients of nutrient digestibility. This observation is in agreement with those reported in the literature (Sullivan, 1955; Van Soest, 1968).

The voluntary feed intake values were expressed relative to the voluntary consumption of good quality hay (Crampton, Donefer and Lloyd, 1960), assuming that sheep of similar age and weight would voluntarily consume about 80 g per unit of metabolic size. The Relative Intake (RI) values increased with increasing levels of concentrate supplement. However, the differences were not significant

($P < 0.05$), except diet C which had a highly significant ($P < 0.01$) RI value than the other diets. This observation agreed with that of Baumgardt (1970) who showed that at low nutritive value, feed intake was limited by gut fill, whereas at high nutritive value, feed intake was controlled by the energy level of the diet. In the present study, feed intake increased with progressive substitution of concentrate supplement for hay up to 60 percent concentrate (diet C) after which the RI decreased. Strozinski and Chaudler (1971) observed the highest RI value by Holstein calves at a concentrate level of 32.5 percent, which is lower than the present study. This disparity is most likely due to the quality of the grass hay used in this trial. The hay was prepared towards the end of rainy season when the crude fibre content was rather high (Oyemuga, 1960). This could affect its digestion and rate of passage, thus limiting its intake.

The nutritive value index (NVI) and the digestible energy (DE) intake values were calculated from the RI values and the coefficient of energy digestibility (Crampton et al., 1962). The trend and magnitude of the differences observed in the NVI and DE intake values were similar to those of RI, from which they were calculated. However diets C and D had significantly higher ($P < 0.01$) NVI and DE intake values than diets A and B.

Data on body weight changes and efficiency of feed utilization are given in table 4. Average daily weight gain appeared to be related to the nutritive value

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Table.4. Body Weight Changes and Efficiency of Feed Utilization

	Experimental Diets				SE of means
	A	B	C	D	
Number of Animals	3	3	3	3	-
Experimental period (days)	63	63	63	63	-
Average daily feed intake (g)	368.1 ^b	397.4 ^b	511.6 ^a	442.2 ^{ab}	23.91*
Initial liveweight (kg)	20.8	20.6	20.9	21.0	-
Final liveweight (kg) 56 days	24.2	24.3	26.2	25.9	1.12 (NS)
Average daily weight gain (g)	60.8	65.7	93.9	89.7	9.82 (NS)
Feed efficiency (gain/feed %)	16.4	16.5	18.3	20.2	1.62 (NS)

* Significant treatment differences (P 0.05)

(NS) No significant treatment differences (P 0.05)

a, b Values on the same line having different superscript letters differ significantly (P 0.05).

of the diets. Although the differences were not significant (P 0.05), progressive substitution of concentrate supplement for grass hay resulted in linear increases in daily liveweight gains up to diet C, with animals on diet D having the highest average daily liveweight gains than those on diet C although the differences were not significant (P 0.05). The final liveweight of the animals were also closely

related to the nutritive value of the diets and the trend in magnitude was similar to that of daily weight gains. Although the average daily liveweight gains (between 60.8 and 93.9g per day) appeared to be low when compared with what lambs of similar age and weight ought to gain (NRC, 1968), cognizance is taken of the fact that this breed of sheep grows very slowly and has small mature size (Williamson and Payne, 1959). The efficiency of feed utilization, like the daily liveweight gains, increased linearly with increasing levels of concentrate supplement, but the differences were not significant ($P > 0.05$).

The results of this study have clearly shown that there is little or no advantage in feeding growing West African Forest lambs a diet containing more than 60 percent concentrate. Also the proportion in which concentrates are fed with roughage is of importance in the ability of these animals to handle large amounts of fibre in their diets.

REFERENCES

- A.O.A.C., 1970. Official Methods of Analysis (11th edition). Association of Official Analytical Chemists, Washington, D. C.
- BALCH, C. C. and CAMPLING, R. C., 1962. Regulation of voluntary food intake in ruminants. *Nutr. Abs. and Rev.* 32 : 669.
- BAUMGARDT, B. R., 1970. Voluntary feed intake by ruminants : models and practical applications. *Proc. Cornell Nutr. Conf. for feed Manufacturers* pp. 85-92.

Concentrate: Grass Hay Ratios and Performance of West African Dwarf Sheep.

- COLE, H. H and RONNING, M. 1974. *Animal Agriculture*. W.H. Freeman and Co., San Francisco.
- CRAMPTON, E. W., DONEFER, E. and LLOYD, L. E. 1960. A nutritive value index for forages. *J. Anim. Sci.* 19 : 538 - 544.
- CRAMPTON, E. W., DONEFER, E. and LLOYD, L. E., 1962. Calorific equivalent of the nutritive value index. *J. Anim. Sci.* 21 : 628 - 632.
- DONEFER, E., LLOYD, L. E. and CRAMPTON, E. W., 1963. Effect of varying alfalfa : barley ratios on energy intake and volatile fatty acid production by sheep. *J. Anim. Sci.* 22 : 425 - 428.
- DUNCAN, D. B. 1955. Multiple Range and Multiple F-Tests. *Biometrics* 11:1-42.
- EL-SHAZLY, K., DEHORITY, B. A. and JOHNSON, R. R., 1961. Effect of starch on digestion of cellulose *in vitro* and *in vivo* by rumen micro-organisms. *J. Anim. Sci.* 20 : 268-273.
- KANE, E. A., JACOBSON, W. C. and DAMEWOOD Jr. P. M., 1959. Effect of corn starch on digestibility of alfalfa hay. *J. Dairy Sci.* 42 : 849.
- LOOSLI, J. K. 1963. Molasses as a dairy feed. *Hoard's Dairyman* 108 : 220.
- N. R. C., 1968. Nutrient requirements of domestic animals. No. 4. Nutrient requirements of sheep. National Research Council, Washington, D. C.
- OYENUGA, V. A. 1960. Effect of stage of growth and frequency of cutting on the yield and chemical composition of some Nigerian fodder grasses - *Panicum maximum* Jacq. *J. Agric. Sci. (Camb)*. 55 : 339 - 350.
- STEEL, R. G. D. and TORRIE, J. H., 1960. *Principles and Procedures of statistics*. McGraw-Hill Book Co. Inc. N. Y.
- STROZINSKI, L. L. and CHANDLER, P. T., 1971. Effects of dietary fibre and acid-detergent lignin on body fill of ruminating calves. *J. Dairy Sci.* 54 : 1491 - 1495.

SULLIVAN, J. T. 1955. Cellulose and lignin in forage grasses and their digestion coefficients. J. Anim. Sci. 14 : 710 (Abstr.)

VAN SOEST, P.J. 1968. Chemical estimate of the nutritional value of feeds. Proc. Cornell Nutr. Conf. for Feed Manufacturers. p. 38.

WILLIAMSON, G. and PAYNE, W. J. A., 1959. An Introduction to Animal Husbandry in the Tropics. Longmans Green and Co. Ltd., London.