

Feed selection and water intake of indigenous goat wethers under stall-feeding conditions

M.M. Qinisa and E.A. Boomker

Department of Veterinary Physiology, University of Pretoria, Private Bag X04, Onderstepoort, 0110

Received 28 August 1998; accepted 23 September 1998

Six indigenous (Pedi) goat wethers (18 months old) with an average body mass of 25.1 kg were fed five diets, consisting of a mixture of lucerne (*Medicago sativa*) and teff (*Eragrostis tef*) in a cafeteria style arrangement (Trial 1). The diets were formulated to be iso-caloric with crude protein (CP) levels of 7, 9, 11, 13 and 15%. In Trial 2, the 15% CP diet was excluded. Intake of DM was highest on the highest CP diet and declined rapidly on the diets where the CP content was lower. Water was available *ad lib.* leading to an average daily water intake of 1.4 ± 0.4 litres in both trials. It was concluded that goats have the ability to select for a higher protein diet and can utilise less water than sheep.

Ses inheemse (Pedi) bokkapaters (ouderdom 18 maande) met 'n gemiddelde liggaamsmassa van 25.1 kg is vyf diëte in 'n kafeteria-stelsel aangebied. 'n Mengsel van lusern (*Medicago sativa*) en tef (*Eragrostis tef*) is voorberei om isokalories te wees met ruproteïëinhoud (RP) van 7, 9, 11, 13 en 15% (Proef 1). Die 15% RP-dieet is tydens die tweede proef weggelaat. Die DM-inname was die hoogste op die hoogste RP-dieet en het verminder met 'n daling in RP-inhoud. Water was *ad lib.* beskikbaar en het gelei tot 'n gemiddelde daaglikse waterinname van 1.4 ± 0.4 liter vir beide proewe. Die gevolgtrekking is dat die bokke die potensiaal besit om 'n hoër proteïë dieet te kan selekteer en minder water as skape te gebruik.

Keywords: indigenous goats, feed selection, crude protein, water intake

Introduction

Information available on the nutrition of indigenous goats is limited. There has been a tendency to extrapolate available information from sheep to goats. Goats, however, have special feeding habits, which are typical of the species as a whole (Lu, 1988). Goats appear to be able to tolerate a wide range of tastes and can use a wider range of feeds than cattle or sheep. They are selective feeders and have the advantage over other domestic ruminants of being able to select a relatively high quality diet when a variety of feeds are available (Devendra & Burns, 1982, cited by Wilkinson & Stark, 1987; Morand-Fehr *et al.*, 1991; Pond *et al.*, 1995).

Water is an absolute necessity for all livestock and a lack of an adequate supply can be a seriously limiting factor in many parts of the country. The demand for water increases in the dry season. The water content of available forage as well as its nutritional value tends to be very low during this period (Devendra & Burns, 1970). Where water is scarce, those animals capable of using it as efficiently as possible will maximize production. According to Devendra (1980), Narjisse (1991) and Tisserand *et al.* (1991), goats are adapted to water shortages and are efficient users of water. The aim of this trial was to:

- (i) Determine the average daily water intake of Pedi goats kept indoors at night at 16°C;

(ii) Test the ability of the goats to select a diet from a range of diets, each with a known crude protein content.

Materials and methods

Animals

The study was conducted at Onderstepoort during March 1997. Six indigenous Pedi goat wethers were used. The body mass of the wethers ranged from 23.9 to 27.6 kg with an average of 25.1 kg. They were all approximately 18 months old. The goats were housed in individual pens for the duration of the trial. The average daily mean temperature was 19.3°C.

Diets

Five diets were prepared from a mixture of lucerne (*Medicago sativa*) and teff (*Eragrostis teff*) with a crude protein (CP) content of 17 and 6% respectively. After milling the diets were physically as uniform as possible with a particle length of approximately 2 cm. The five diets were formulated so that they contained 7; 9; 11; 13, and 15% CP (Table 1). Molasses (8 kg per 250 kg) was added to each diet to act as a binding agent. Diets were numbered according to the CP content (Diet 1 = 7% CP and Diet 5 = 15% CP). The fibre content decreased from Diet 1 (60% NDF and 45% ADF) to Diet 5 (48% NDF and 35% ADF), with the three other diets falling evenly between them. When not exposed to the five different diets to test feed selection the goats were maintained on Diet 3 (11% CP).

Table 1 The amount of lucerne and teff mixed to form five different diets

Diet	Crude protein level (%)	Proportion (teff:lucerne)	Total mixture (kg)	Teff + lucerne (kg)
1	7	10:1	250	227 + 23
2	9	8:3	250	182 + 68
3	11	6:5	250	136 + 114
4	13	4:7	250	91 + 159
5	15	2:9	250	45 + 205

Molasses (8 kg) was added to each diet to act as a binding agent.

Feeding procedure

The five diets were offered to five goats in a cafeteria style arrangement, three times a day. The goats were first fed at 08h00. At 12h00, all the diets were removed, weighed, recorded and replaced. This procedure was repeated at 16h00 and the following morning at 08h00. The sequence in which the diets were positioned was changed daily over a period of five days for each goat. The sixth goat was offered at random, one diet per day, at the same intervals, to estimate undisturbed food intake each day.

The goats were given 5 litres of water once a day in the morning. The amount of water consumed during the day was measured at 16h00 and the amount consumed overnight at 08h00. The daily water intake was then determined by difference, after subtracting daily evaporation losses measured from a container similar to those provided for the goats. Directly after the first trial (five days), the second trial repeated the above procedure for four days using four diets (excluding the 15% CP

diet). This time all six goats were included in the trial.

Results

In the first trial each of the five goats consumed more of Diet 5 (15% CP) than the other diets. The average feed intake of this diet was 592.3 ± 102.1 g, followed by Diet 4 (127.6 ± 76.6 g). The sixth goat also consumed more of the three highest protein diets (11, 13 and 15% CP), even though these diets were randomly offered, each on a different day. The total amounts eaten by this goat, per day, in ascending order of CP content in the diet, were 802, 751, 1585, 1353 and 1110 g.

When Diet 5 with the highest CP content (15% CP) was excluded in the second trial, the goats ate more of Diet 4 (average intake of 804 ± 230.2 g).

The proportions of the diets consumed by the goats are illustrated in Figures 1 and 2. Although the differences in chemical composition between the diets varied evenly from Diet 1 to Diet 5, these figures indicate a striking selection for the diet having the highest crude protein content. Using a one-tailed *t*-test to investigate the statistical validity of this observation, it was found that the selection of Diet 5 in the first trial and Diet 4 in the second trial was highly significant (significance level 0.0002 in the first trial and 0.0001 in the second trial).

In both trials, the goats consumed the least feed in the period 12h00 to 16h00 (Table 2). The amount consumed during the period 16h00 to 08h00 showed great variations between the different goats. The average daily water intake of goats remained constant over the duration of the two

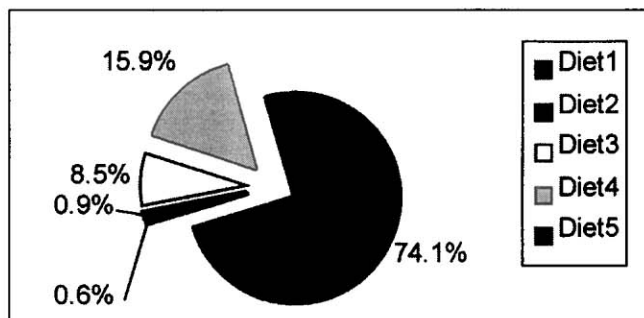


Figure 1 Proportion of diets eaten in Trial 1.

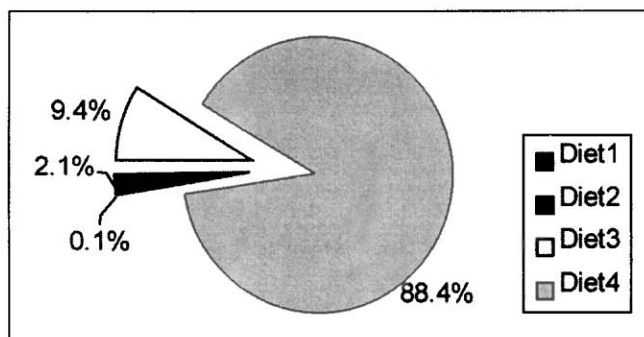


Figure 2 Proportion of diets eaten in Trial 2.

Table 2 Average feed intake (g) of goats per feeding period during two trials

Period	Trial 1 intake (g)	Trial 2 intake (g)
08h00 to 12h00	314.4 ± 54.3	287.1 ± 80.0
12h00 to 16h00	241.8 ± 41.4	260.6 ± 60.8
16h00 to 08h00	297.0 ± 109.4	362.2 ± 137.8

All values are means ± SD

Table 3 Average daily water intake (ml) of Pedi goats, Blackhead Persian, Dorper and Mutton Merino lambs (means ± SD)

	Pedi goats	Blackhead Persian*	Dorper*	Mutton Merino*
Body weight (kg)	25.1 ± 2.5	34.0 ± 0.79	53.0 ± 1.55	50.0 ± 1.57
Water intake (l/day)	1.4 ± 0.4	2.3 ± 0.28	4.8 ± 0.58	5.6 ± 0.85
Water consumed (l/kg feed intake)	1.59 ± 0.2	1.82 ± 0.22	2.56 ± 0.197	5.6 ± 0.41
Water efficiency (ml/kg ^{0.75} /day)	124.9 ± 35.7	163.4 ± 19.6	246.1 ± 29.8	300.6 ± 45.6

* Derived from Schoeman & Visser (1995)

experiments (1.4 ± 0.4 litres). The average amount of water consumed per kg feed intake was calculated to be 1.59 ± 0.2 litres which resulted in a value of 124.9 ± 35.7 ml/kg^{0.75}/day as a reflection of water efficiency (Table 3).

Discussion

According to Forbes (1995), selection of food may be euphagic, i.e. implying nutritional wisdom, or hedyphagic, i.e. selection for pleasurable flavours. Animals generally select a nutritious diet when given suitable choices (Fontenot & Blaser, 1965). Provenza (1995), however, has linked both taste and the postingestive effect of the food to the preference for certain foods. This would imply that these are integrated thus leading to an active choice of certain feeds, when a selection is offered. Animals thus appear to use experience to select nutritious foods based on the taste of the food.

Elliot & Topps (1963) fed cattle four rations containing different amounts of protein (5, 7, 9 and 11% CP). The cattle selected the rations containing higher levels of protein and ate very little of the 5% CP diet. A similar observation was also made in both trials where the goats consumed little or nothing at all of the 7% CP diet and ate the most of the diet with the highest CP content. As Wahed & Owen (1986) found that goats could select for leaves within a mixture, the possibility of a similar selection was considered, but in these trials the milling of the diets used resulted in a homogenous mixture, which would exclude the selection for particular parts of the diet. The goats were also maintained on Diet 3 before and after the trial and no selection for part of the diet was observed.

Huston *et al.* (1988) found that when goats and sheep were fed three forages, (wheat straw 3.4% CP, sorghum 5.9% CP and oats hay 13.8% CP) with different levels of supplemental protein, goats responded with an increased intake of higher levels of supplemental protein, when compared to sheep. In another comparative study of roughage intake and selection in sheep and goats fed straw and nettle (Wahed & Owen, 1986), goats consistently ate more of the nettle than did sheep. The nettle contained more ash and crude protein than the straw. When dietary preferences of indigenous camels, cattle, donkeys, sheep and goats were studied by direct observation, Rutagwenda *et al.*,

(1990) found that goats and camels selected a diet with higher protein and lower cellulose contents than did the other animal species. These observations were supported by the consistent selection of the higher protein diets by the goats in this study. The significant difference in the level of selection (74% and 88%) for the preferred diet in each trial indicates the strong preference for Diet 5 and Diet 4. Although the amount of fibre in these diets could have contributed to the selection of the preferred diet (as this was slightly lower in each diet as the level of crude protein increased), the combination with the high protein level was not significantly different between diets. It would thus appear that the goats were selecting for the most nutritious diet available.

Animals can also learn the position of food, if it is consistent between exposures. The changing of position of the diets during this study never influenced the goats' selection, as they continued to select the diet with a higher protein content. This is similar to a trial by Gillingham & Bunnell (1989), reported by Forbes (1995), where three feeds were offered to a deer in a small enclosure. Initially, apples were preferred to dairy pellets or alfalfa and when the feeds were placed separately 5 m apart, the deer searched for apples. When these were depleted, a second feed was accepted. Although the dietary composition of the apples was not stated, they would appear to have been the most nutritious of the three.

Although other factors, such as early life feeding experience and learning, were not investigated, it can be concluded from this study that indigenous goats have the ability to select a highly nutritious, and usually high protein, diet, when given a choice.

Although the aim of this study was not to investigate behaviour, the goats showed a tendency to eat more in the morning and again in the late afternoon (Table 2), which is in agreement with observations made by Silanikove (1992). Peacock (1996) reported that during the hottest part of the day goats may stop eating; not because they are full, but because they will have great difficulty in keeping their body temperatures down to a tolerable level if the rumen is very actively digesting feed and producing heat. This could also be the reason for the difference in feeding behaviour during these trials.

The amount of water consumed by indigenous Pedi goats (1.4 litres) was less than the 2.2, 4.6 and 5.4 litres for the Blackhead Persian, Dorper and Mutton Merino lambs respectively, reported by Schoeman & Visser (1995). When the amount of water consumed by Pedi goats was compared to that of these sheep, on a per kilogram feed intake basis, it was found that the goats consumed less than the sheep (data compared in Table 3). On calculating the efficiency of water consumption (i.e. ml/kg^{0.75}/day, Table 3) the Pedi goats were significantly better ($p < 0.014$, Comparison of Means) than the sheep. It would thus appear that these goats are adapted to situations where water is scarce. This adaptation can be utilized in areas where water is in scarce supply. Sixty four per cent of the water was consumed during the period 08h00 to 16h00. Similarly, pen-fed goats in Malaysia drank 680 ml water per day of which 80% was also drunk between 07h00 and 19h00 (Devendra, 1969 cited by Devendra, 1980). This higher consumption during the daylight hours shows how important it is to give penned goats water during the day.

Acknowledgements

Dr J.H. Randall is thanked for his assistance with the statistical analyses and advice. The authors thank the staff at the Department of Veterinary Physiology, University of Pretoria for their assistance.

References

- DEVENDRA, C. & BURNS, M., 1970. Goat production in the tropics. Commonwealth Agricultural Bureaux, Edingburgh.

- DEVENDRA, C., 1980. Feeding and nutrition of goats. In: Digestive physiology and nutrition of ruminants. Vol. Practical nutrition. 2nd edn (eds) D. C. Church *et al.* O and B Books, Corvallis, Oregon. p. 239.
- ELLIOT, R. C. & TOPPS, J. H., 1963. Nitrogen metabolism of African cattle fed diets with an adequate energy, low-protein content. *Nature* 197, 668.
- FONTENOT, J. P. & BLASER, R. E., 1965. Symposium on factors influencing the voluntary intake of herbage by ruminants: selection and intake by grazing animals. *J. Anim. Sci.* 24, 1202.
- FORBES, J. M., 1995. Voluntary food intake and diet selection in farm animals. Cab International, UK.
- HUSTON, J. E., ENGDAHL, B. S. & BALES, K. W., 1988. Intake and digestibility in sheep and goats fed three forages with different levels of supplemental protein. *Small Rum. Res.* 1, 81.
- LU, C.D., 1988. Grazing behaviour and diet selection of goats. *Small Rum. Res.* 1, 205.
- MORAND-FEHR, P., OWEN, E. & GIGER-REVERDIN, S., 1991. Feeding behaviour of goats at the trough. In: Goat nutrition. (Ed.) P. Morand-Fehr EAAP Publication no. 46, Pudoc, Wageningen, The Netherlands. p. 3.
- NARJISSE, H., 1991. Feeding behaviour of goats on rangelands. In: Goat nutrition. (Ed.) P. Morand-Fehr. EAAP Publication no. 46, Pudoc, Wageningen, The Netherlands. p. 13.
- PEACOCK, C., 1996. Improving goat production in the tropics. Oxfam, UK.
- POND, W. G., CHURCH, D. C. & POND, K. R., 1995. Basic animal nutrition and feeding. 4th ed., John Wiley & Sons, Canada.
- PROVENZA, F.D., 1995. Role of learning in food preferences of ruminants: Greenhalgh and Reid Revisited. *Ruminant Physiology: Digestion, Metabolism, growth and Reproduction: Proceedings of the Eight International Symposium on Ruminant Physiology.* p. 233.
- RUTAGWENDA, T., LECHNER-DOLL, M., SCHWARTS, H. J., SCHULKTA, W. & VON ENGELHARDT, W., 1990. Dietary preference and degradability of forage on a semiarid thornbush Savannah by indigenous ruminants, camels and donkeys. *Anim. Feed Sci. Tech.* 31, 179.
- SCHOEMAN, S. J. & VISSER, J. A., 1995. Water intake and consumption in sheep differing in growth potential and adaptability. *S. Afr. J. Anim. Sci.* 25, 75.
- SILANIKOVE, N., 1992. Effects of water scarcity and hot environment on appetite and digestion in ruminants: a review. *Livestock Prod. Sci.* 30, 175.
- TISSERAND, J.L., HADJIPANAYIOTOU, M. & GIHAD, E. A., 1991. Digestion in goats. In: Goat nutrition. (Ed.) P. Morand - Fehr. EAAP Publication no. 46, Pudoc, Wageningen, The Netherlands. p. 46.
- WAHED, R. A. & OWEN, E., 1986. Comparison of sheep and goats under stall-feeding conditions: Roughage intake and selection. *Anim. Prod.* 42, 89.
- WILKINSON, J. M. & STARK, B. A., 1987. The nutrition of goats. In: Recent Advances in Animal nutrition. (Eds) Haresign, W. & Cole D. J. A., Butterworths, London. p. 91.