Milk production of Tswana goats fed diets containing different levels of energy

T. Adogla-Bessa[1] and A.A. Aganga
Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana

Abstract

The aim of this experiment was to characterize the milk yield of the Tswana goat of Botswana. Twenty-one Tswana goat does were allocated to one of three diets formulated to provide energy for maintenance and a milk yield of either 1.5 kg/d, 1.0 kg/d or 0.5 kg/d. Intake, milk yield and kid growth rate was monitored for 14 weeks. Dry matter intakes of up to 5% of body weight were recorded. Energy intake and milk yield differed between treatments ($p < 0.01$). Daily ME intake for the low, medium and high-energy diets was 1.01, 1.42 and 1.64 MJ ME/kg metabolic weight; the corresponding milk yields were 0.47, 0.53 and 0.72 kg/day. Kid birth weight ranged from 2.6 to 2.9 kg, and daily gains over the 14-week period were 95, 116 and 128 g/day for the low, medium and high energy diets respectively. Milk output accounted for 62% of the variation in kid growth rate. It was concluded that Tswana goats have the potential to respond to increasing levels of energy intake by increasing milk yield to relatively high levels.

Keywords: milk yield, lactation, energy intake, goat.
[1]Author to whom correspondence should be addressed; present address: University of Ghana, Agricultural research station Legon, P O Box LG 68, Legon, Ghana; E-mail: agriclib@libr.ug.edu.gh

Introduction

Although they rank second to cattle in number, goats are more important to the subsistence needs and economic development of peasant farmers because they provide a regular supply of meat, milk and cash throughout the year (FAO, 1990). Goats are important milk producers (Devendra & McLeroy, 1982), however, except for the Boer goat that has been subject to genetic selection, the genetic potential of tropical livestock for milk is generally low. Females with high milk production promote faster growth and better survival of the young. Between 20 and 60% of the variation in weaning weight of kids is accounted for by variation in milk output or the amount suckled by the kids (Peart, 1982). The Tswana goat of Botswana is phenotypically similar to many of the goats in southern Africa. The goats are relatively large and are frequently kept by subsistence farmers in areas of low rainfall. Limited information is available on the milking capacity of the Tswana goat. Energy intake is an important consideration when characterizing milk yield, as it has been shown that energy intake accounts for 71% of the variation in milk yield observed in Matabele goats (Sibanda, 1992). The aim of this study was to determine the effects of different levels of dietary energy on milk yields of Tswana goats and the growth rates of their kids.

Materials and Methods

The study was conducted at the Botswana College of Agriculture, Sebele, Gaborone, in the south-east of Botswana. Twenty-one Tswana goats bearing single kids in their second parity were allocated at random to treatments within 72 hours after kidding. Animals were housed in individual pens (1.7 m^2) with concrete floors and corrugated iron roofs. Does and their kids were kept together and kids were allowed to suckle at all times except for two six-hour periods each week when milk yield was measured.

Three diets were formulated to supply energy requirements for maintenance and a milk yield of either 1.5 kg/d (high-energy diet (H)), 1.0 kg/d (medium energy diet (M)) or 0.5 kg/d (low energy diet (L)). Allowances for milk production were formulated on the assumption that 5.2 MJ ME are required to produce 1 kg of milk with 4% fat content (NRC, 1981). Weekly feed allocation for the maintenance component of the diet was based on the live weight of the doe at the end of the previous week. The ingredients used to formulate the experimental diets were pelleted concentrate, *Cenchrus ciliaris* (buffalo grass) hay and *Medicago sativa* (lucerne) hay. The composition of the feed components is shown in Table 1. Pellets, which were usually consumed immediately, were offered first; and the hay mixture was offered one hour thereafter. Feed intake was measured daily. Drinking water and a mineral supplement were available ad *libitum.*

Table 1 Composition and estimated energy content of ingredients used to formulate the experimental diets

	Cenchrus ciliaris hay	*Medicago sativa* hay	[++]Pelleted concentrates
Dry matter content (g DM/kg)	933	950	920
Crude protein (g/kg DM)	70	143	100
Crude fibre (g/kg DM)	280	296	120
[+]Energy content (MJ ME/kg DM)	6.5	7.5	13.5

[+]From Oliver & Topps (1971); [++]Agrifoods Ltd., Zimbabwe

Does were hand-milked twice weekly for 14 weeks. Kids were removed from the does and the udder was hand-stripped of milk at 07.00. Six hours later, goats were hand-milked following stimulation of udder by hand (Peaker and Fleet, 1979). The same person did milking throughout the experimental period. Daily milk yield was calculated from the six-hour yield. Kids were weighed within 24 hours of birth, and thereafter does and kids were weighed weekly. Analysis of variance and regression analysis were done using a general linear models procedure (SAS, 1990). Data were analyzed as a completely randomized design of 3 treatments with 7 replicates each.

Results and Discussion

Dry matter intake decreased as energy intake decreased ($p < 0.01$) (Table 2). Dry matter intakes of does offered the high-energy diet were equivalent to 5% of body weight. Intakes of does fed the low energy diet were equivalent to 3.3% of body weight and are comparable to that reported for Matabele goats (3.6%; Sibanda, 1992) and indigenous tropical breeds (3.2%; Devendra, 1980). Intakes for the high-energy treatment were comparable to that reported for tropical goats (4–5%; Devendra & McLeroy, 1982). This indicates that Tswana goats have a high intake capacity for high-energy diets.

Table 2 Intake of dry matter, energy, crude protein and water in Tswana does fed high, medium or low energy diets

Daily intake	Dietary energy level			
	High	Medium	Low	SE
Dry matter (DM) intake				
g DM	1591^{a}	1162^{b}	847^{c}	11.9
g DM/kg W	50.4^{a}	46.1^{b}	33.1^{c}	0.56
g DM/kg $W^{0.75}$	119.3^{a}	103.3^{b}	74.3^{c}	1.09
Energy (ME) intake				
MJ ME	21.8^{a}	15.9^{b}	11.6^{c}	0.17
MJ ME/kg W	0.69^{a}	0.63^{b}	0.45^{c}	0.008
MJ ME/kg $W^{0.75}$	1.64^{a}	1.42^{b}	1.01^{c}	0.015
Crude protein intake (g CP)	1.59^{a}	116^{b}	85^{c}	1.19
Water intake (ml)	3799^{a}	3197^{b}	2851^{c}	65.8

[a,b,c]Means in the same row with different superscripts are significantly different ($p < 0.05$); W: liveweight

Daily milk yield and milk yield per unit body weight decreased ($p < 0.01$) as the energy content of the diet decreased (Table 3). Total milk yields up to week 7 were higher for the high energy treatment ($p < 0.01$) than for the medium or low energy treatments which did not differ ($p > 0.05$) (Table 3). Total lactation yield up to week 14 was highest for the high energy treatment (68.5 kg) but the medium and low energy treatments (50.8 and 44.8 kg) did not differ (Table 3). The pattern of milk production is shown in Figure 1. Milk yield peaked at weeks 3–4 for the high-energy treatment and declined thereafter; lactation curves for the medium and low energy treatments were flatter with no obvious peak.

Table 3 Weights and milk yields of Tswana goat does fed diets with high, medium or low energy contents

	Dietary energy level			
	High	Medium	Low	SE
Doe live weight (kg)	32[a]	25[b]	26[c]	0.35
Doe live weight change (kg/week)	1.7[a]	-1.6[b]	-2.0[c]	0.66
Kid birth weight (kg)	2.9	2.8	2.6	
Kid weight gain (g/day)	128[a]	116[b]	95[b]	0.009
Daily milk yield				
kg	0.72[a]	0.53[b]	0.47[c]	0.015
kg/kg W	0.023[a]	0.021[b]	0.018[c]	0.006
kg/kg $W^{0.75}$	0.054[a]	0.047[b]	0.041[c]	0.0013
Total milk yield (kg)				
week 1–7	41.5[a]	28.6[b]	24.7[b]	1.51
week 8–14	26.9[a]	22.3[b]	20.1[a]	2.32
week 1–14	68.5[a]	50.8[b]	44.8[b]	2.75
Milk conversion (kg gain/kg milk)	0.21[a]	0.22[a]	0.22[a]	0.019

Means in the same row with different superscripts are significantly different ($p < 0.001$); W: liveweight

Regression analysis showed that energy intake (MJ ME intake/kg $W^{0.75}$) accounted for 62% of the variation in milk yield ($p < 0.05$). The mean daily milk yields measured in this trial are comparable with the results of Sibanda (1992) who reported yields of 0.66 kg/day for Matabele goats, but are higher than the figure of 0.3 kg/day reported for the Malawi goat (Banda et al., 1992) or the West African Dwarf goat (Akinsoyinu et al., 1977). They are, however, lower than that reported for the Boer goat (1.5–2.5 kg/day; Casey & Van Niekerk, 1988). In a review, Paggot (1992) reported that 0.56 kg/day was typical of tropical goats. Responses measured in this trial indicate that given adequate feed, the milk yield of Tswana goat can surpass this average. Milk yields reported here were obtained by hand milking. The yield capacity of the Tswana goat could be higher, as Banda et al. (1992) and Ueckermann et al. (1974) found that estimates produced by this method were 36.5% less than those obtained by suckling and weighing or following injection of oxytocin. The pattern of daily milk yield rising to a maximum within 3 weeks and then decreasing until the end of lactation (Figure 1) was also observed by Banda et al. (1992) in the Malawian local goat and Sibanda (1992) in the Matabele goat.

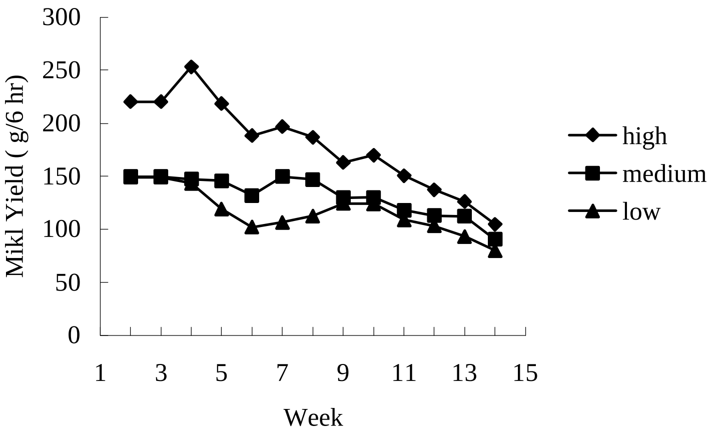

Figure 1 Milk yield of Tswana does fed high, medium or low energy diets

Later occurring peaks have, however, been reported by Badamana (1989) when peak yield occurred at week 6 in Kenyan goats and by Akinsoyinu et al., (1977) working with the West African Dwarf goat whose peak occurred from week 4 – 6. Goats have also been reported to reach peak yields at 8-12 weeks and to have a flatter lactation curve than cattle (Devendra and McLeroy, 1982; Chamberlain, 1989). It is difficult to comment on these peaks since the observed trends are likely to have been influenced by the feeding regime. Does fed the high-energy diet gained weight ($p < 0.01$) while does fed the medium and low energy lost weight (Table3).

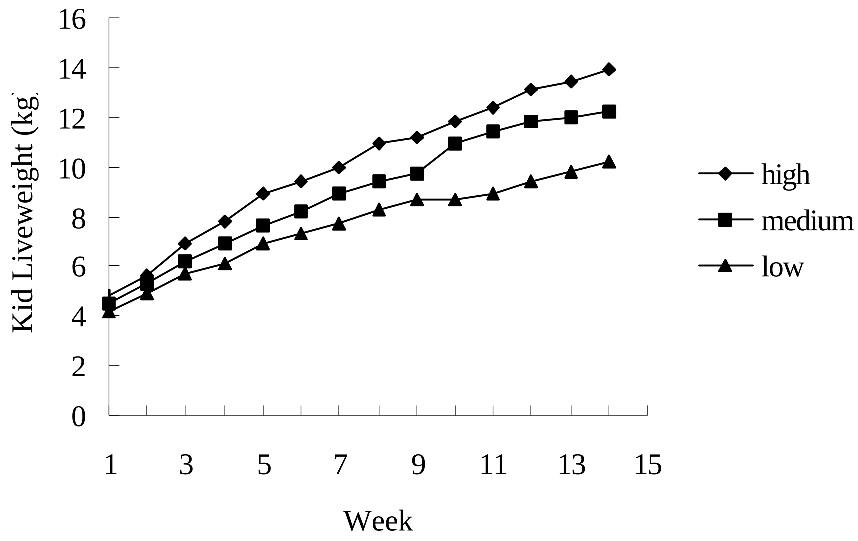

Figure 2 Pre-weaning weights of kids suckling does fed high, medium or low energy diets

The mean birth weight of 2.7 kg is comparable to that reported by Karua and Banda (1992) for Malawi goats and Sibanda (1992) for Matabele goats (2.8-2.9 kg). The mean birth weight is equivalent to 6% of mature female weight (36 kg) and is similar to percentages recorded for other breeds (Devendra and Burns, 1970). Daily growth rate of kids on treatment H (128 g) was higher ($p < 0.01$) than for treatments M and L (116 g and 95 g) which did not differ ($p > 0.05$). Growth curves are shown in Figure 2. Although birth weights were similar (2.6–2.9 kg) kids in treatment H were still growing rapidly at week 14 whereas growth rate of kids on treatments M and L tended to decrease from week 10 onwards. The amount of milk produced has a strong influence on kid growth, as 20–60% of the variation in weaning weight is accounted for by the volume of milk produced or suckled (Peart, 1982). This is consistent with findings in this trial where milk yield accounted for 62% of the variation in kid performance. Sibanda (1992), working with Matabele goats found that 80% of the variation in kid weaning weight was due to milk production. Milk conversion was similar ($p > 0.05$) for all treatments (Table 3) and further emphasizes the influence of milk yield on kid performance. Kid growth rates of 95–28 g/day in this trial were comparable that reported by Sibanda (1992) for Matabele goats (95–144 g/day) and by Karua & Banda (1992) for Malawi goats (88 g/day).

Conclusions

The Tswana goat has the potential to respond to high dietary energy levels during lactation. A diet that provides an energy intake of 16–22 MJ ME/kg W appears to be adequate for the attainment of above average milk yields and kid growth rates.

Acknowledgements

The trial was sponsored jointly by the International Livestock Research Institute (ILRI), Addis-Ababa, Ethiopia, and the Botswana College of Agriculture, Gaborone, Botswana.

References

Akinsoyinu, A.O., Mba, O.A.U. & Olubajo, F.O., 1977. Studies on energy and protein utilization for pregnancy and lactation by the West African dwarf goats in Nigeria. Dairy Sci. Abstr. 40, 113.

Badamana, M.S., 1989. Comparison of forage intake and milk production of lactating Saanen goats offered grass hay, grass silage or a mixture of hay and silage. Proceedings of the Seventh SR-CRSP Scientific Workshop. Nairobi, Kenya. 234 pp.

Banda, K.W., Steinbach, J. & Zerfas, H.P., 1992. Composition and yield of milk from non-dairy goats and sheep in Malawi. In: Small ruminant research and development in Africa. Eds. Roy, B., Lebbie S.H.B. and Reynolds, L. Proceedings of the first biennial conference of the African Small Ruminant Research Network. International Livestock Centre for Africa, Nairobi, Kenya. 568 pp.

Casey, N.H. & Van Niekerk, W.A., 1988. The Boer goat: I Origin, adaptability, performance testing, reproduction and milk production. Small Rumin. Res. 1, 291-302.

Chamberlain, A., 1989. Milk production in the tropics. Intermediate tropical agriculture series. Longman Group, U.K. 241 pp.

Devendra, C., 1980. Goats. In: An introduction to animal husbandry in the tropics. Eds. Williamson, G. & Payne, W.J.A. Butler and Tanner Ltd, London.

Devandra, C. & Burns, M., 1970. Goat production in the tropics. Technical communication, No. 19, Commonwealth bureau of animal breeding and genetics. Commonwealth Agricultural Bureau, Farnham Royal, UK.

Devendra, C. & McLeroy, G.B., 1982. Goat and sheep production in the tropics. Intermediate tropical agriculture series. Longman Group, U.K. 271 pp.

FAO, 1990. Production yearbook, Vol. 4. FAO statistics series, No. 99. Food and agriculture organisation of the United Nations, Rome, Italy.

Karua, S.K. & Banda, J.W., 1992. Dairy goat breeding in Malawi: Gestation length, birth weights, and growth of the indigenous Malawi goats and their Saanen crosses. In: Small ruminant research and development in Africa. Eds. Roy, B., Lebbie S.H.B. and Reynolds, L. Proceedings of the first biennial conference of the African Small Ruminant Research Network. International Livestock Centre for Africa, Nairobi, Kenya. 568 pp.

NRC, 1981. National research Council. No. 15. Nutrient requirements of goats: Angora, dairy and meat goats in temperate and tropical countries. Nat. Academic Press, Washington D.C.

Oliver, J. & Topps, J.H., 1971. Animal foods of central Africa. Eds. Topps, J.H. & Oliver, J. Rhodesia Agricultural Journal technical handbook 2. Government Printer, Salisbury, Rhodesia.

Paggot, J., 1992. Animal production in the tropics and subtropics. Macmillan, London. 512 pp.

Peaker, M. & Fleet, I.R., 1979. Autotransplant of the goat mammary gland. J. Dairy Res. 46, 589.

Peart, P.N., 1982. Lactation of suckling ewes and does. In: World animal Science C: Production systems approach. 1. Sheep and goat production. Ed. Coop, I.E. Elsevier Publishing Co., Amsterdam.

SAS, 1990. Statistical analysis systems procedures guide, release 6.03. SAS Institute Inc., Cary, N.C.

Sibanda, L., 1992. Studies on the productivity and nutrition of the Matabele goat. PhD thesis, University of Reading, Reading, U.K.

Ueckermann, L., Joubert, D.M. & Van Der Stein, G.J., 1974. The milking capacity of Boer goat does. World Review of Animal Production. 10, 73-83.