

EFFECT OF FEEDING FREQUENCY ON WATER TURNOVER RATES AND FASTING METABOLIC RATES OF GROWING GOATS.

A.E. Kimambo *Department of Animal Science, Sokoine University of Agriculture, P.O. Box 3004, Chuo Kikuu, Morogoro, Tanzania.*

SUMMARY

An experiment was designed to investigate the effect of feeding frequency and of age on the fasting metabolic rate and water turnover rates by young goats. The fasting metabolic rate was estimated indirectly by measuring the oxygen consumption using an open circuit calorimeter. Water turnover rate was estimated using Tritium labelled water. The results showed that both the fasting metabolic rate and water turnover rates decreased significantly as the animals grew older. Fasting metabolic rate decreased from $(555 \text{ kJ/kg}^{0.75})$ per day at age of 9 days to $(360 \text{ kJ/kg}^{0.75})$ per day at 5 months. Water turnover rates decreased from $(281 \text{ ml/kg}^{0.82})$ per day at 9 days to $(197 \text{ ml/kg}^{0.82})$ per day at 5 months. Feeding frequency had no effect on both water turnover rate and fasting metabolic rate.

INTRODUCTION

Livestock productivity in the tropics is limited by both energy and water availability especially during the dry season. Animals with both low fasting metabolic and water turnover rates will survive better under arid conditions than those whose water turnover rates and energy expenditure are high.

Water turnover rate is usually estimated by measuring the rate of dilution of labelled water (TOH) in the animal body with time. It differs in different species and it depends on the ecological regions in which the particular species evolved (MacFarlane *et al.*, 1974) also between breeds (Macfarlane, 1964; Springell, 1968; Siebert and Macfarlane 1969), it is also affected by age, being normally higher in young animals than in adults (Macfarlane and Howard, 1970).

Water turnover rates are increased in lactation (Brockway *et al.*, 1963; Thomas, 1971; Macfarlane and Howard, 1972) and in pregnancy (Lynch *et al.*, 1972; Davies, 1972). The level of intake of food (Siebert 1971; Macfarlane and Howard, 1972; More *et al.*, 1983), the composition of the diet (Payne, 1964; Utley *et al.*, 1970) and type of feed (Macfarlane and Howard, 1970; Bond *et al.*, 1976) also influence water turnover rates.

Basal energy expenditure is important in the calculation of an animals requirements for

growth and for production of useable products. It is also important for the selection of animals to be reared in different ecological zones.

Basal energy expenditure can be measured indirectly by measurement of oxygen consumption using an open circuit calorimeter or a closed circuit calorimeter (Blaxter and Wainman, 1966).

Like water turnover rates, basal or fasting metabolic rate varies with species. It is higher in cattle than in sheep and this is an indication of the differences in the availability of feed where those animals evolved (Graham, 1967; Blaxter and Wainman, 1966). Breeds of the same species display variations in their fasting metabolism and this have been shown in cattle (Blaxter and Wainman, 1966; Vercoe, 1970) and in sheep (Graham, 1968).

Fasting metabolic rate is higher in young suckling animals than in adults and this rate decline after weaning (Blaxter, 1962; Graham *et al.*, 1974). It is increased in pregnancy and in lactation to meet the higher energy requirement for the conceptus or for the synthesis of milk. An increase of up to 50% in basal metabolic rate in lactating animals has been reported (Blaxter, 1967). It has been reported that the level and type of feed has a remarkable effect on fasting metabolic rate. It is high in cattle on high plane of nutrition (Frisch and Vercoe, 1977).

Although the level of nutrition and type of feed are known to affect both the fasting metabolic rate and water turnover rates, the effect of feeding frequency on these parameters is scarce. Thus the present experiment was designed to investigate the effect of age and feeding frequency on fasting metabolic rate and water turnover rates in growing goats.

MATERIALS AND METHODS

Animals and their management

Three entire males and three female feral goat's kids were separated from their mothers when 3 days old and confined indoors in 2 groups of 3 animals for the first 2 weeks. They were then transferred to individual pens and were weaned at the age of 8 weeks.

Diet and feeding

The kids were reared from 3 days to 8 weeks old on freshly reconstituted milk substitute (Denkavit). They were fed 0.3 litres three times per day for 14 days. Thereafter they were divided into two groups on a body weight basis as to minimize the differences between group mean weight. During the six weeks one group was fed 1.2 litres once daily between 0700 - 0900 h while the other group was fed the same amount of feed twice daily in equal meals between 0700 - 0900 h and between 1700 - 1800 h.

After weaning at 8 weeks the two groups were given ration comprising 80% Lucerne Chaff and 20% crushed oats. They were given the quantity they could finish within 12 h. The quantity was established by preliminary feeding period. (Usually between 0.5 and 1.0 kg). The amount was adjusted weekly. Feeding times for the two groups were the same as those used before weaning.

Estimation of water turnover rate

Prior to determination of TOH spaces the animals were deprived of water and food as follows: 18 h for animals of 0 - 1 months of age 24 h for animals of 2 - 6 months of age. After deprivation the animals were injected with a known dose of tritiated water in isotonic saline water into

the thigh muscle as described by Macfarlane *et al.* (1974). After the tracer injection, 2 blood samples were taken for measurement of tritium concentration. First sample was taken 3 h after injection in milk fed animals and 6 h after injection in weaned animals. The second samples was taken a week later. Blood samples were drawn from the jugular vein. The determination of water turnover was performed at monthly intervals. Before tritium was injected, blood samples were taken for the estimations of background activity from previous estimations.

Assay of tritium

Water was extracted using the method of Vaughan and Boling (1961) by freeze transfer of whole blood. The activity of TOH was counted for 10 minutes in a Packard-Tricarb liquid scintillation counter.

Calculation of water turnover rate

Water turnover rate, k , was calculated from the exponential equation.

$$C_t = C_0 e^{-kt}$$

where C_t - counts at time t (7 days)

C_0 - counts at time 0

k - rate constant for the turnover process.

water turnover rate was expressed as: (ml/kg) per day (Macfarlane and Howard, 1970).

Measurement of fasting metabolic rate

Fasting metabolic rate was measured at monthly intervals, by determining oxygen consumption in an open circuit system. A heat equivalent of 20.1 kJ per litre of oxygen (Blaxter, 1967) was used to calculate fasting metabolic rate from the oxygen consumption. The fasting metabolic rate was expressed per unit of metabolic body size i.e. kg body weight to the power of 0.75.

Animals between 1 week and 4 weeks of age were fasted for 24 hours; older animals were fasted for 36 to 60 hours before measurement. Fasting weight was taken and the animal was placed in the measuring chamber maintained at 20°C for 12

b. Readings were taken at 2 h intervals without disturbing the animal. The lower of the 6 samples was used for calculation.

Statistical analysis

A two way split plot analysis of variance by standard computer programme was performed using 'F' and LSD as tests for significance.

RESULTS

The water turnover is shown in Table 1. Water turnover rate changed with age; at 9 days of age the turnover rate was significantly higher than the water turnover at one month ($P < 0.05$) and 2 months ($P < 0.001$). The water turnover rate at 2 months was significantly lower than that at 1 month ($P < 0.05$) or 4 months ($P < 0.01$). Feeding regime had no significant effect on water turnover rate although it was slightly higher for the group fed twice daily at all occasions

The fasting metabolic rate of goats (Table 2) decreased with age. A significant decrease was observed between 9 days and 1 month of age ($P < 0.05$).

Thereafter the decrease in fasting metabolic rate up to 5 months was not significant. Feeding regime had no significant effect on the fasting metabolic rate of goats. However, the metabolic rate for the group fed once each day was slightly higher than that of the group fed twice daily.

DISCUSSION

The high water turnover rate observed in 9 days old goats (Table 1) resulted from ingestion of milk which was 75% - 80% water, and probably the higher proportion of water in their tissues. Similar high rates of water turnover in young animals were reported by Keightley (1971) and Macfarlane *et al.* (1974).

Table 1: Effect of age and feeding patterns on water turnover rates in goats (group mean)

Age months	Fed once daily	Fed twice daily	Both groups means ¹
	(ml/kg ^{0.75}) per day	(ml/kg ^{0.75}) per day	(ml/kg ^{0.75}) per day
0	291	282	281a
1	186	195	191b
2	133	142	137c
3	169	273	221ab
4	212	239	225ab
5	193	203	198b
Mean for all ages	196	222	209

SED between age mean = 0.1229

LSD 5% = 0.2605

Statistical analysis was performed on logarithmic (ln) transformation of the original data.

¹Means in the same column with at least one different superscripts differ significantly ($P < 0.05$).

Table 2: Effect of feeding regime and age on the fasting metabolic rate of goats (group mean).

Age months	Fed once daily	Fed twice daily	Both group mean ¹
	(kJ/kg ^{0.75}) per day	(kJ/kg ^{0.75}) day	(kJ/kg ^{0.75}) per day
0	606	506	555a
1	321	407	364b
2	365	365	365b
3	304	301	303b
4	411	188	299b
5	421	299	360
Mean for all ages	405	344	375

SED of age means = 65.13

LSD 5% = 142.32

¹Means in the same column with different superscripts differ significantly (P < 0.05).

The decrease in water turnover at the age of 1 month was probably associated with the decrease in total body water and the increase in proportion of body fat (Kimambo, 1978). Similar observations were reported by Keightley (1971) who observed a 50% decrease in water turnover of lambs at 30 days of age when compared to that at 4 days of age in the present experiment the rate of water use had declined by 32% at age of one month.

After weaning the decrease in water turnover rate resulted from both change in diet from liquid to dry feed and to low energy intake associated to weaning. The slight increase in water turnover rate from 3rd month was contrary to what was expected but this could be due to the rise in environmental temperature which was observed during this period. The observed water turnover rates in the present experiment was lower than those reported for lambs (Kimambo, 1978) suggesting that goats would be better adapted to drier regions. This would be consistent with their evolution in drier areas. The higher fasting metabolic rate observed during the milk stage in kids (Table 2) indicates that the animals expended more energy at younger ages than when older due probably to rapid cell division, protein synthesis and growth. This

high metabolic rate supports the findings of Graham and Searle (1970) in young lambs. The fasting metabolic rate decreased by 30% from the age of nine days to one month. This decrease in fasting metabolic rate agrees with the findings of Graham and Searle (1970) who observed a rapid decline in metabolic rate of young growing lambs.

The observed fasting metabolic rates for goats in the present experiment was lower than those of lambs reported by Kimambo (1978), Graham and Searle (1970).

CONCLUSION

Both the water turnover rates and fasting metabolic rates were higher in suckling animals and declined by similar proportion with age. These findings suggest that water turnover rate is closely related to energy metabolism. A close relationship between water turnover rate and energy metabolism was also reported by Macfarlane *et al.* (1974). The high water turnover rates in young animals suggest that provision of water to animals should take age into consideration.

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