

WATER REQUIREMENT AND WATER FEEDING STRATEGIES IN GOATS

T.K. Ghosh

Department of Animal Nutrition
Faculty of Veterinary & Animal Sciences
Bidhan Chandra Krishi Viswavidyalaya
Mohanpur, Nadia, West-Bengal, INDIA

ABSTRACT

Normal body temperature regulation in the goat appears to be similar to that for sheep. Increased respiration rate and heat loss from water evaporation are the chief mechanisms for control of body temperature under hot conditions. Goats are reported to be non-sweating animals and pant one-half as much as sheep. The higher concentrations of goats than sheep in tropical and subtropical areas might indicate that they are more heat tolerant than sheep. Even at the temperature of 45°C, goats in tropical and subtropical areas were found to graze normally without affecting productivity.

MEASUREMENT OF WATER TURNOVER AND WATER REQUIREMENT

The water turnover rates and water requirements were determined by tritiated water (TOH) dilution technique. The animals were prepared with jugular vein cannula a day before the experiment. A polyethylene cannula (internal diameter 0.155 mm and outer diameter 0.205 mm) was fitted in the veins on both sides of the neck. The animals were deprived of food and water for 18 hours prior to the injection of the isotope (Panaretto, 1968). The animals were injected intravenously with tritiated water at 10/ μ CI/kg body weight. Blood samples were collected in heparin-containing centrifuge tubes at hourly intervals from six hours and daily for eight days. At the end of the sampling, the animals were weighed and allowed to have their normal feed and water. Plasma was separated and stored at 0°C for further analysis.

Water was extracted from plasma by sublimation as per the method of Vangham and Boling (1961): 0.2 ml of the extracted water was transferred into scintillation vial and 10 ml of Bray's scintillation fluid (Bray, 1960) was added and counted for radioactivity in Liquid Scintillation Spectrometer (Packard Tricarb Model 3320) at 20°C. The tritiated water (TOH) space was estimated from the activity of tritium at equilibration time.

The biological half-life of tritium was determined as described by Black et al. (1964). Water turnover rate was calculated as the product of half TOH space and the inverse of the biological half life of tritium (Springell, 1968).

$$\text{TOH Space (litres)} = \frac{\text{Dose injected (CPM)}}{\text{Sample count (DPM/ml water)}}$$

$$\text{Water turnover} = \frac{1/2 \text{ corrected TOH space (liters)}}{\text{Biological half-life (hr)}} \\ (\text{L/animal/day})$$

Corrected TOH space was calculated as per Pannaretto (1968). The water turnover rates (ml/animal/hr) were converted to ml/kg 0.82/hr.

The analysis for moisture in feeds, residue, feces and urine was carried out according to AOAC (1960). Metabolic water and evaporative loss of water were calculated by indirect method of Taylor (1970).

Metabolic water (ml) = total digested CHO (g) X 0.62 + total digested fat (g) X 1.1 + total digested protein (g) X 0.42.
Evaporation loss = (water from feedstuff + metabolic water + free drinking water) -- Water losses from urine and feces).

OR

Metabolic water (ml) = (total water turnover) -- (water from feedstuff + free drinking water).

Evaporation loss (ml) = (total water turnover) -- (Water from feces + urine).

Total water requirement = (water from feed + free drinking water + metabolic water).

BODY WATER OF GOAT

Water content of the goat body varies considerably being influenced over the long run by age and the amount of fat in the tissues. However, the water content of the fat free adult body is relatively constant for 80-85% of empty body weight. There is a negative correlation between body water and percent of fat as in all vertebrates. The total body water of goats varied from 64 to 79.9% as reported by Baruah (1975). The total body water for goats was increased in the summer compared to winter (Macfarlane, 1964; Kamal, 1972; Ghosh et al., 1970). The average total body water (ml/kg) was 761.00, 786.00, and 765.00 for doe, castrated

male and buck, respectively, for temperatures of 23-39°C (Ghosh and Maitra, 1982).

WATER REQUIREMENT

Water requirement has been expressed in a number of different ways, viz., per unit of body weight or metabolic size, per unit of dry matter intake or relationship to energy, protein, or salt consumption and in relationship to ambient temperature.

Measurement of water intake (drinking) gives an indication of water requirement. The water drunk is only the visible balance of a much larger total requirement including water from feeds, fodder and metabolic water production.

There are considerable genetic difference between ruminants in water requirement (Table 1). Goats use less water than sheep. Water requirement of goats is 10-25% less than sheep in different ambient temperatures. Water required for cattle and buffalo is 75 to 100% that for goats. Goats are efficient animals in use of water. They have a low rate of water requirement/unit of body weight (Maloity and Taylor, 1971). In comparison with other ruminants, goats can adapt to high temperatures relatively easily (Schoen, 1968) by keeping the same dry matter intake level, by reducing their water losses in the urine and feces and by increasing their pulmonary ventilation. Ghosh (1982) found that urine loss was almost double compared to grazing goats. Water consumption and requirement is highly variable because it depends on climatic conditions, dry matter intake and production stage, i.e., lactation level, growth, etc. The water requirement (water of the feeds + drinking water + metabolic water) of goat averages about 1.5 to 3.5 liters but can vary up to about 6.0 liters depending on several factors, i.e., size, activity, lactation length, and environmental temperature. The total requirement for water (water of the feed + drinking water) were about 4.0-4.5 kg/kg DM in experiments in tropical areas (Devendra, 1967). Martin et al. (1974) observed that non-lactating goats reared in temperate climates at temperatures between 12 and 18°C need 2 kg of water/kg DM. Ghosh (1982) found that water requirement to be as follows (temperature in °C, liter water intake/kg dry matter consumed): 38°, 4.85; 35°, 4.71; 23°, 3.15; and 30°, 3.14. As shown in Table 2, water requirement was increased considerably at increasing ambient temperature. Appleman and Delonche (1958) observed that water intake is relatively constant at air temperature of 10-20°C and increases when the temperature rises up to about 35°C.

Free drinking water intake will also vary with feed. Goats on pasture may not require additional water offering as that confined in the feed may be more than 70% of water. Ghosh (1982) reported that both stall and grazing goat did not consume water when the goat was offered para grass or para pasture at a level of 70-75% water between the temperature 15-35°C; when the

temperature was more than 35°C, additional free drinking water was consumed. Penfed goats in Malaysia drank 680 ml of water/day of which 80% was drunk between 0700 and 1900 hours (Devendra, 1967).

Water requirements of 18 kg stallfed goats was about 135-225 ml/kg^{0.82}/day, or 1200-1800 ml/day at temperature between 23-35°C.

Water requirement of grazing goats was 1800-2800 ml/day throughout the year. Ghosh (1982) found that water requirement to be as follows (temperature in °C, liter water intake/kg drymatter consumed): 38°C, 5.89; 35°C, 5.15; 23°C, 3.54; and 30°C, 4.19 (Table 3). The average water intake of goats is about 3-5 kg/kg DM intake between temperature 23-38°C. It was very interesting to note that water requirements at maintenance levels was 15-20% more in grazing goats compared to stallfed.

Lactating goats need about 3.5 kg of water per kg of DM (Martin et al., 1974). The water requirement of lactating goats was observed 145.6 g/kg^{0.75} at maintenance level. As shown in Table 4, the water requirement per kg of milk was 1.45 kg as reported by Giger et al. (1982).

Ghosh and Moitra (1984) observed that the water requirement was 25% more in the third month and 40-50% more in the last month of pregnancy compared to dry goats. The water requirement depends upon the number of fetuses in the pregnant goat.

The water requirement of 2.15 liter/kg DM intake was observed in kids (Sengar and Mudgal, 1982). The water requirement of does, castrated males and bucks (not using in service) was 175, 178, 181 ml/kg^{0.82}/day throughout the seasons (Ghosh, 1982).

Sodium chloride added to either feed or water will increase water intake. Goats reared on salt ground ingest water containing several grams of salt per liter without difficulty but non-adapted goats generally refuse water rich in salt. A diet rich in protein also will increase water intake (Sengar and Mudgal, 1982). Goats do not like water that is too cold (Fehr and Disset, 1969). Consumption of water is considerably reduced when temperature is lower than 5°C. Ample quantities of water are essential for lactating goats and for maximum growth.

WATER TURNOVER OF GOATS

In any hot or dry region, water is of high biological importance. The amount of water passing through an animal in a unit time is the water turnover. This water is derived from food, drink and the metabolic water. Water turnover is readily measured by following the rate of dilution with such markers as TOH (tritiated water). The biological half life of TOH in goats

is 85.00 and 134.00 hr during summer and winter, respectively (Ghosh et al., 1980). Argenzio and co-workers (1968) reported that rumen water turnover averaged 10 hr in a cow and 17 hr in goats. The water turnover of goats was ranged from 70-125 ml/kg/day, respectively, throughout the season whereas the values were 124, 130, 132 ml/kg/day in grazing does, castrated males and bucks, respectively (Ghosh, 1982).

The average water turnover of goats was 120 and 228 ml/kg^{0.82}/day at temperatures of 18 and 32°C, respectively, as observed by Kamal (1982).

The water turnover rate depends upon many factors such as species differences, effects of age, lactation, temperature and humidity, seasonal differences related to water content of forage and effects due to consumption on plants high in salt, and also nitrogen level.

The water turnover is rather called water requirement (water feed + free drinking water + metabolic water).

REFERENCES

- Aggray, E.K. 1977. Water content and water turnover of cattle, sheep and goats at pasture under humid tropical conditions in Ghana. Paper presented in FAO/IAEA Coordinate research meeting on "Water requirements of tropical herbivorous based on measurements with tritiated water" in Khartoum. Nov. 7-11.
- AOAC. 1960. Official Methods of Analysis. 9th Ed. Association of Official Agricultural Chemists. Washington, D.C.
- Appleme, R.D., and J.C. Delonche. 1960. J. Anim. Sci. 17, 326-335.
- Argenzio, R.A., G.M. Ward, and J.E. Johnson. 1968. J. Anim. Sci. 27: 1121.
- Baruah, D.N. 1975. M.V. Sc. Thesis. Faculty of Vet. Uni. Agra, U.P. India.
- Black, A.I., N.F. Backer, J.C. Baitley, T.E. Chapman, and R.L. Philips. 1964. Science 144:876.
- Bray, C.A. 1960. Analyt Biochem. 1: 279.
- Devendra, C. 1967. Malaysian Agric. J. 46: 80-97.
- Fehr, P.M., and R. Disset. 1969. Rev. Elevage, 45th Spec. No. 145-51.

- French, M.H. 1970. Observation on the Goat. FAO Agr. Studies No. 80. FAO. Rome.
- Ghosh, T.K., and D.N. Moitra. 1984. Kerala J. Vet. Sci. 15(2): 131-134.
- Ghosh, T.K. 1982. Ph.D. Thesis, FAC. Vet. BCKV, India.
- Ghosh, T.K., U.B. Singh, S.K. Ranjhan, D.N. Verma, and K.K. Saxena, 1980. Indian J. Ani. Sci.
- Gigers, J. Hervieu, P. Suvant, and P. Morand-Fehr. 19892. Ann. Zootech.
- Kamal, T.H., C. Shehata, and I.M. Elebanne. 1971. "Effect of heat omel water restriction on water metabolism and body fluid components inturn animals." Proc. of a sym. organized by PAO/IABA. Athens, Greece, 20-24 March 1972.
- King, J.M., P-O. Stunley Nyamore, M.R. Prince, and B.R. Heath. 1977. Proc. of FAO/AEA. Coordinate Research meeting on "Water requirement of tropical herbivorous based on with tritiated water." Khartoum, Nov. 7-11.
- Macfarlane, W.V. 1964. "Terrestrial animals in dry heat unguulates." Handbook of physiology Environment. pp. 509-530. Ed., B. R. Bill, Washington, D.C., Am. Physiol. Soc.
- Maliot, G.M.O., and C.R. Taylor. 1971. J. Agric. Sci. 77:203-208.
- Martin, D., P.M. Fehr, J. Hervieu, and A. Cucci. 1974. IN: Journee 'd' 'etudej sur e' alimentation de la chevre laitiere. pp. 151-158. ITO/IC, Paris.
- Pannarette, B.O. 1960. Aust. J. Agric. Res. 19: 267.
- Schoon, A. 1968. E. Afric. Agric. Forestry. J. 34, 256-62.
- Sengar, S.S., and V.D. Mudgal. •1982. J. Dairy Sci. 398-410.
- Springell, P.H. 1968. Aust. J. Agric. Res. 19:129.
- Taylor, R. 1970. Am. J. Physiol. 214: 1131.
- Vangham, B.E., and E.A. Boling. 1960. J. Lab. Clin. Med. 57, 159.

Table 1. Water requirement among cattle, buffalo, sheep and goat.

Species	Water requirement ml/kg ^{0.82} /day	Environments	References
Buffalo	227.35 237.00	Winter Summer	Ghosh et al. (1980)
Crossbreed cattle (Haryana X Holstein)	227.66 351.72	Winter Summer	temperature 23°C
Sheep	162.30 211.74	Winter Summer	temperature 35°C
Goat	101.60 182.11	Winter Summer	
Boram cattle	347.00	Tropical	Macfarlane (1964)
Oganden sheep	107.00	Tropical	
Somali goat	96.00	Tropical	
Somali camels	61.00	Tropical	
Buffalo	209.00	Average value throughout the year	King et al. (1977)
Cow	203.00		
Sheep	169.00		
Goat	174.00		
Cattle	229.00	Humid tropical	Aggney (1977)
Sheep	145.00		
Goat	139.00		
Camel	185.00	37°C	French (1970)
Goat	188.00	37°C	
Sheep	197.00	37°C	
Cattle	347.00	37°C	

Table 2. Water requirement of stall fed goat in respect to total water intake and DM intake.

Temperature (°C)	Relative humidity (%)	Total DM intake (g)	Total water intake (ml)	Ratio of DM intake to water intake	Water requirement ml/kg w ^{0.82} /day
38	70	319	1900	4.85	196.48
35	80	470	2215	4.71	226.79
23	50	419	1320	3.15	136.06
30	62	503	1584	3.18	156.67

Table 3. Water requirement of grazing goat in respect to total water intake and DM intake.

Temperature (°C)	Relative humidity (%)	Total DM intake (g)	Total water intake (ml)	Ratio of DM intake to water intake	Water requirement ml/kg w ^{0.84} /day
38	70	408	2460	5.89	222.57
35	80	536	2765	5.15	249.28
23	50	518	1838	3.54	165.20
30	62	505	2110	4.19	191.75

Table 4. Water requirement for lactating goats in temperate climate.

Dry matter intake (DMI) (kg)	Total water intake (TWI) (kg)	Total water intake (DMI) (kg)	Milk production (kg)	References
2.43 ± 0.58	8.44 ± 1.97	3.51 ± 0.41	3.64 ± 0.98	Giger et al. 1982