Effects of Exercise and Intermittent Watering on the Water and Feed Intake of Sheep

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ABSTRACT : This experiment was conducted to investigate the water requirement of exercising sheep. Nine Merino ewes were allocated into three groups differing in water supply after exercise, group 1(G1) supplied water *ad libitum*, group 2 (G2) supplied with water twice a day, and group 3 (G3) supplied with water once a day. The ewes were exercised outdoors using a circular exercising machine at a speed of 5 km/h for 1 hour for 12 consecutive days. Total daily water intake (TDWI) of animals in G3 was significantly lower ($p < 0.05$) than that of those in G1 and G2. TDWI of the 2 later groups was not different. TDWI of G3 was about 60% of that of G1. Feed intake of G3 was significantly ($p < 0.05$) lower than that of the other two groups. Immediately after exercise, rectal temperature (RT) of animals in G1 was significantly ($p < 0.05$) lower than those in the other groups. Respiration rate (RR) of animals in all three groups was not significantly different. Faecal moisture of animals in G3 was significantly lower ($p < 0.05$) than those in the other groups. The results indicate that for optimum productivity sheep should be given water at least twice a day.
(Key Words : Sheep, Exercise, Feed Intake, Water Intake, Intermittent Watering)

INTRODUCTION

The problem of sheep grazing, especially in arid areas, is that the animals must walk long distances to water, often inadequate in supply and quality. Squires and Wilson (1971) studied the effect of distance walked from water to food on Merino sheep, and showed that sheep drank twice daily when the distance between food and water was less than 4.0 km, but only once a day (intakes as much as 7 litres) at distances of 4.8 km. Food intake decreased as the distance from water increased. A similar result was reported by Singh et al. (1976), i.e. dry matter intake was significantly reduced when animals were offered drinking water only once in 48 or 72 h compared with those offered it once every 24 h. Animals watered at 72 h intervals drank (per kg body weight) about 15% less water than those watered at 24 or 48 h intervals.

However, information on the water requirements of walking sheep is still lacking. Thus the present experiment was aimed to measure the effects of walking and water rationing on daily feed and water intake.

MATERIALS AND METHODS

Nine mature, non-pregnant and non-lactating, trained Merino ewes, with an average body weight of 42.8 kg, were exercised outdoors using a circular exersising machine (1.5 m wide track; 28.5 m inner circumference) at the rate of 5 km/h for 1 h daily from 10:00 to 11:00 h for 12 consecutive days. They were randomly divided into 3 groups which differed in the quantity of water supplied and were housed in individual pens. Fresh drinking water was provided to G1 ewes immediately after exercise *ad libitum* (i.e, unlimited access when not exercising). Those in G2 were given water for a total of 1 h 20 min (i.e., 11:00 to 12:00 h and again from 16:40 to 17:00 h) while those in G3 had access for only 1 h (i. e., 11:00 to 12:00 h), immediately after exercise. The diet used was a commercial sheep pellet (table 1) and was supplied *ad libitum*.

The daily feed allotment was given 1 h after exercise (at 12:00 h), and feed intake was measured daily imediately before exercise (10:00 h). Water intake was measured daily 1 h after exercise and immediately before exercise.

RT was measured using a clinical thermometer inserted into the rectum 10 cm and held in place for 1 minute. RR was measured by counting flank movements with a stopwatch. RT and RR were measured before, immediately after, and 1 h after walking. Jugular venous

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Table 1. Composition of the sheep pellet used in the experiment

Ingredient	Proportion
Lucerne meal (%)	60.00
Millrun (%)	20.25
Sorghum (%)	19.40
Salt (%)	0.30
Sheep micromix (%)	0.03
Ferrous sulphate (%)	0.015
Energy (MJ/kg)	9.2
Crude protein (%)	14.3
Fat (%)	2.9
Fibre (%)	19.8
Calcium (%)	0.63
Phosphorus tot. (%)	0.35
Sodium (%)	0.21

blood samples were collected on days 0 (before exercise started), 2, 4, 8, 10 and 12. Haematocrit concentration was measured by standard laboratory procedures (Jain, 1986). Faecal samples (by manual collection from the rectum) were collected at 17:00 h (after watering G2 for the second time) each day, for the purpose of measuring faecal moisture then were dried in an oven at 104℃ for 24 h and faecal moisture was then calculated.

Data were subjected to analysis of variance (ANOVA) for a completely randomized design. Treatment means were compared by LSD and significance was declared at $p < 0.05$.

RESULTS AND DISCUSSION

Feed and water intake

The daily water intake of animals in G3 was significantly lower than that of those in G2 and G1. Daily water intake of animals in G2 was similar to that of those in G1, indicating that the G2 treatment was sufficient to fulfill the water requirements of these sheep. The daily water intake of animals in G3 was only 60% of that of animals in G1 and G2. However, water intake in the 60 min period following exercise followed a different pattern: animals in G3 consumed significantly more than those in G2 which in turn consumed more than those in G1 (see table 2).

Table 2. Feed, water intake, and gain during experiment

Parameters	Group[1]		
	G1	G2	G3
Feed Intake (g/head/day)	1,608 ± 68[a]	1,546 ± 55[a]	1,067 ± 50[b]
Total Water Intake (ml/head/day)	3,611 ± 192[a]	3,265 ± 137[a]	2,068 ± 124[b]
Water Intake (60 min postexercise ml/head/day)	244 ± 93[a]	1,810 ± 82[b]	2,068 ± 124[c]
Gain (kg) (day 1 - day 12)	4.0 ± 1.76	2.5 ± 1.44	1.0 ± 1.32

[1] G1 = water available *ad libitum*; G2 = water available for 1 h + 20 min.; G3 = water available for 1 h.
Values are shown as mean ± SEM.
Means in the same row with different superscripts differ ($p < 0.05$).

In the present experiment animals walked at the rate of 5 km/h for 1 hr each day, a programme more sever than that reported by Squires and Wilson (1971) in the field. However, daily water intake of sheep in the present experiment was lower than that reported by Squires and Wilson (1971) (2 − 3.6 litres vs 7 litres). The most likely reason for this is that the feed used by Squires and Wilson (1971) contained 15% of sodium chloride, whereas in the current work the feed contained only 0.30% salt. In addition, the discrepancy may be due to the fact that under field conditions their animals received solar radiation, whereas in the present experiment, after exercise (1 hour), animals stayed in the shade for the rest of the day.

Feed intake of animals in G3 was significantly lower than that of those in the other 2 groups. This is probably related to the positive relationship between daily water intake and feed (dry matter) intake (Clark and Quin, 1949; Macfarland and Howard, 1972; Silanikove, 1987). The higher weight gain in G1 animals than in those of G2 and G3, reflects their higher feed and water intake. This result clearly indicates the advantages of unrestricted access to water.

Rectal temperatures

Exercise significantly elevated RT (figure 1). Immediately after exercise, the RT of animals in G1 was significantly lower than those in the other groups. An elevation in body temperature (as indicated by RT) was described by Astrand and Rodhal (1970) as a physiological necessity in working animals to increase the rate of chemical reactions, to change internal frictional resistance in muscles and to elevate the supply of oxygen to working muscles. An explanation for the lower RT in G1 animals immediately after exercise probablies lies in their high water intake (Schmidt et al., 1980), which can act as a sink of heat from feed fermentation and muscular activity, and augment evaporative heat loss.

One hour post-exercise however, while RT had fallen dramatically, all three groups continued to differ significantly. Animals in G3 had the highest reduction in RT (−1.6℃) followed by G2 (−1.3℃) and G1 (−0.9 ℃). At the time the RT of animals in G2 and G3 had returned to normal (pre-walking) levels, while that of those in G1 remained higher than it had been before walking. The higher reduction in RT of animals in G2 and G3 than those in G1 is probably related to their higher water intake during the first 1 h after exercise.

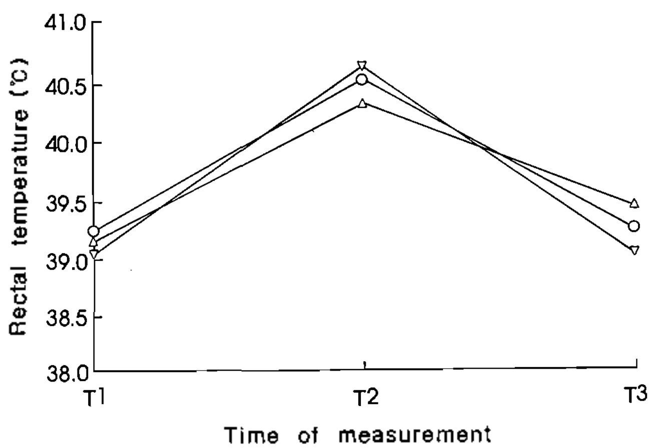

Figure 1. Effect of exercise and water restriction on rectal temperature. △ : G1 (*ad libitum*); ○: G2 (1 h 20 min); ▽ : G3 (1 h).

Respiration rate

The pattern of RR was similar to that of RT (see figure 1 and 2). Before exercise, RR of animals in G3 was significantly lower than that of animals in the other groups. Immediately after exercise, RR was significantly increased in all three groups and at that time no significant differences existed. One hour after exercise, the RR of animals in all three groups had returned to near-normal levels, and though animals in G1 had a significantly higher RR than those in G2 and G3, the differences were small (less than 15/minute) and of

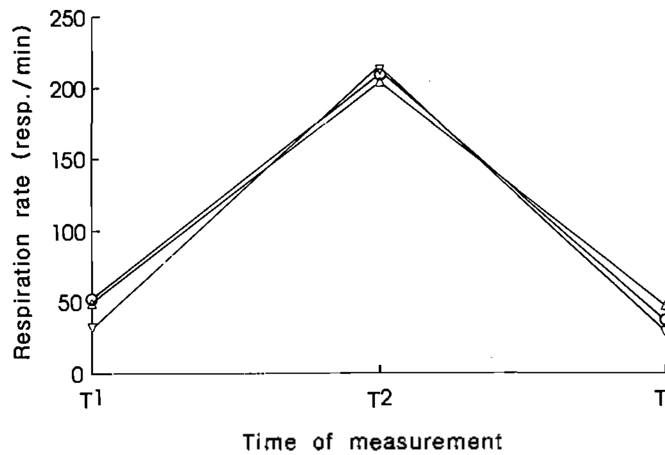

Figure 2. Effect of exercise and water restriction on respiration rate. △ : G1 (*ad libitum*); ○: G2 (1 h 20 min); □: G3 (1 h).

doubtful physiological significant.

During exercise, RR rose sharply, presumably to supply more oxygen for muscular work; and to dissipate the resultant body heat. This proposition is supported by Upadhyay and Madan (1985) who concluded that the physiological response to work (rectal temperature, respiration rate, and heart rate) is associated with increased metabolism in order to provide adequate energy to the working muscles and to dissipate the extra heat produced. However, that the later is singularly important since animals panted, a clear indication of thermal stress. Data obtained in the present experiment showed that rectal temperature and respiration rate were clearly related.

Packed red blood cell volume

Before walking commenced (D0), all groups of animals had similar PCV values. The fact that the observed values (38.2 – 39.5%) were somewhat above those reported in the literature (Altman and Dittmer, 1971) indicates that the animals used were above average in this respect. On day 2, the PCV values were significantly increased for G1 and G2, and after that values for all groups decreased significantly, especially in G1 animals (figure 3).

Experiments with both sheep (Rai et al., 1983) and cattle (Singh, 1983), have also shown that exercise and/or heat stress is associated with a decreased haematocrit (PCV), but explanations for such changes are scarce. Studies on the work performance of crossbred and Sahiwal cattle by Georgie et al. (1970) showed that while Hb concentration increased with work in the cross-breeds it decreased in the Sahiwals. In their study, differences in the pre-existing fitness of the two groups may have been

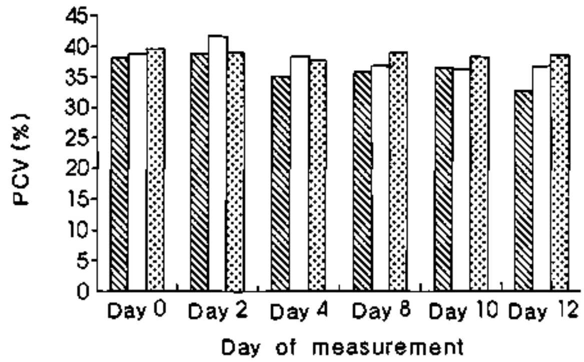

Figure 3. Effect of exercise and water restriction on PCV values. □: G1 (*ad libitum*); □: G2 (1 h 20 min); □: G3 (1 h).

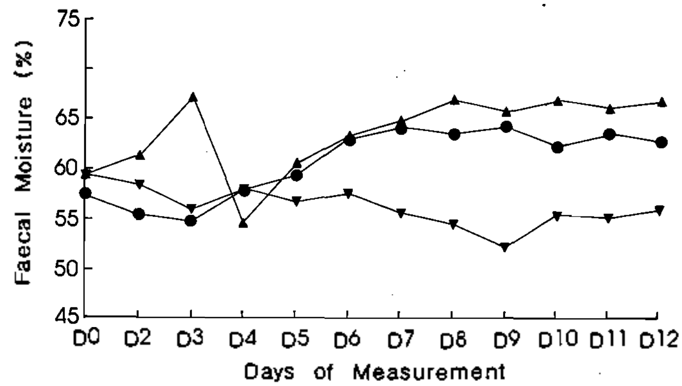

Figure 4. Effect of exercise and water restriction on faecal moisture. ▲: G1 (*ad libitum*); ●: G2 (1 h 20 min); ▼: G3 (1 h).

responsible for exercise-induced changes in Hb (and hence PCV). Reports of reduced haematocrit as a result of exercise (Karvonnen and Kunnas, 1952; Morehouse and Miller, 1967; Singh et al., 1968) lend support to the proposition that a change in blood rheology is important in exercise. A fall in Hb concentration is a natural consequence of a depression in haematocrit (Georgie et al., 1970). The red blood cell count is frequently increased in the early stages of exercise, probably because of simple haemoconcentration. During more prolonged exercise, fluid passes into the blood, and the resulting dilution of cells lowers the red blood cell count (Morehouse and Miller, 1967). Results of the present study are consistent with this propostition, the fact that the group with the greatest water consumption, G1, also experienced the greatest decrease in PCV (figure 3) suggests an effect of haemodilution when water intake is not limited. Very strenuous exercise may also cause an increased rate of destruction of red blood cells due to compression of the capillaries by muscular contraction and to increased velocity of blood flow (Morehouse and Miller, 1967), but this is unlikely to have been a factor in the present experiment in which sheep were walked at 5 km/h for one hour.

Faecal moisture

Exercise did not affect the faecal moisture content in Merino ewes, but water restriction did. Animals in G3 had faecal moisture levels (52 – 55%) significantly lower than those in G1 and G2 (62 – 66%). Up to day 4 the effect of water restriction was not obvious and faecal moisture fluctuated inconsistently, especially in G1 (figure 4). From day 4 onward the faecal moisture of animals in G3 declined and then steadiet at 52 – 55%, while faecal moisture of animals from G1 and G2 rose, plateauing from about day 7 at 62 – 65%. The decrease in faecal moisture in animals in G3 can be explained simply by the limitation imposed on water intake; it would be expected that to conserve body water sheep on restricted water intake would restrict both their respiratory (figure 1) and faecal moisture loss.

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