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Heat of warming of feed and water in goats

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ABSTRACT

Heat of warming (HW) was estimated in 18 adults barbari bucks fed on barley straw supplemented with barley grain and protein supplements. The HW values (kj/h/d) ranged from 188.69 to 211.20 in experiment 1 and 148.11 to 171.06 in experiment 2. The H W amounted to 2.9 to 4.16% of metabolizable energy intake in bucks. The HW values may be considered while assessing the energy requirements of bucks in cold season.

Key words: Feed, Goats, Heat of warming, Water

Heat of warming (HW) is the heat used by the animal to warm the feed and water it ingests to body temperature. This is usually a minor component of over all heat loss but not the one to be neglected as a steer spends about 2000 kcal to warm the feed ingested (Blaxter 1967). Sheep grazing high moisture pasture spend about 20% of daily heat production as HW (Nicol and Young 1981). Increased oxygen consumption was reported in calves drinking cool milk (Holmes 1971 b). The HW may also be significant for nutritional management of animals suffering from acute rumen impaction, milk fever and hypothyroidism which are characterized by subnormal body temperature (Blood *et al.* 1983). Upadhyaya and Karnani (2003) reported HW in buffalo and cow calves as 3.2 and 2.13 MJ/h/d, respectively, which constituted about 7 to 8% of daily metabolizable energy intake. There is a lack of information on HW in goats. The estimation of HW and its effect on ME requirements in goats have been reported in this communication.

MATERIALS AND METHODS

The HW was estimated in Barbari bucks in two different experiments described as under.

Experiment 1: Adult Barbari bucks (9) were distributed in 3 equal groups following randomised block design. The bucks were housed in a well ventilated stall and offered clean and freshwater twice a day. The barley straw (BS) was offered @ 56 to 62 g/kg $W^{0.75}$ to all the animals. Coarsely ground barley grain was offered @ 12g/kg$W^{0.75}$, while linseed-cake was given @ 5.80, 8.86 and 12.01g DM/kg$W^{0.75}$ to the animals in the groups A, B and C respectively. The experiment was initiated in the first week of December and continued up to first week of January.

Experiment 2: Adult Barbari bucks (9) were distributed in 3 equal groups as in experiment 1. The feeding and housing management of animals was also similar, however cottonseed-cake was given in place of linseed-cake @ 6.36, 11.05 and 14.09 g DM/kg$W^{0.75}$ in group A1, B1 and C1, respectively. This experiment was initiated in mid January and continued up to third week of February.

The preliminary feeding period consisted of 21 days in both the experiments followed by 6 days of metabolism trial during which animals were maintained in metabolic cages and intake of feed and water was recorded. The temperature of different feed stuffs and water was recorded by mercury thermometer as described by Upadhyaya and Karnani (2003). The rectal temperature of animals was recorded on the last day of the experiment using a clinical thermometer. The HW was calculated as per following equation:

Where HW = I (TR-TW)

I = Intake of feed and water in kg; TR, rectal temperature (°C); and TW, temperature of feed and water (°C).

The specific heat of feed was taken to be 1.0 (Blaxter *et al.* 1959). The ME was calculated as 1g TDN=3.56 kcal (Blaxter 1967) or 14.9 kj of ME. The statistical analysis of data was done according to Snedecor and Cocharan (1968).

RESULTS AND DISCUSSION

The minimum and maximum climatic temperatures (°C) for December, January and February were 7.23 and 22.66; 7.32 and 18.11, 10.11 and 24.67 respectively. The corresponding values for relative humidity (%) were 72.75, 80.95 and 61.46. The intake of dry matter, water, ME and

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Table 1. Intake of dry matter, energy and water by goats and heat of warming (experiment 1)

Groups/ attributes	A	B	C	Stat difference
Body weight (kg)	28.17±0.17	26.34±0.84	27.00±0.67	NS
DM intake (g/kgw$^{0.75}$)	53.93±1.11	52.73±2.87	58.06±1.88	NS
Water intake (ml/kgw$^{0.75}$)	105.50±5.43	124.52±4.99	125.05±25.35	NS
Metabolizable energy intake (kj/kgw$^{0.75}$)	426.79±17.41	441.18±31.53	498.59±25.32	NS
Heat of warming (kj/h/d)	188.69±9.34	210.85±28.94	211.20±59.83	NS
(kj/kgw$^{0.75}$)	16.45±0.61	18.19±0.78	18.25±3.07	NS
Heat of warming as per cent of ME intake	3.88±0.28	4.16±0.31	3.64±0.51	NS

Table 2. Intake of dry matter, energy and water by goats and heat of warming (experiment 2)

Groups/attributes	A1	B1	C1	Stat difference	C.D.
Body weight (kg)	27.25±0.59	26.84±0.34	25.89±0.09	NS	
DM intake (g/kgw$^{0.75}$)	47.33±1.39	53.15±4.48	55.58±3.07	NS	
Water intake (ml/kgW$^{0.75}$)	89.97±7.03	110.32±7.36	111.26±6.86	NS	
Metabolizable energy intake (kj/kgw$^{0.75}$)	419.95±27.64	466.36±12.10	507.52±26.23	NS	
Heat of warming (kj/h/d)	148.11±16.25	161.62±15.80	171.06±16.33	NS	
kj/kgw$^{0.75}$	12.12a±0.67	14.33b±0.41	14.92b±1.00	P<0.05	2.12
Heat of warming as per cent of ME intake	2.90±0.16	3.08±0.13	2.94±0.08	NS	

HW values in animals under experiment, 1 and 2 are presented in Tables 1 and 2 respectively. The mean values of rectal temperature of animals in experiment 1 were 39.6±0.19, 39.57±0.07 and 39.6±0.19 in groups A, B and C respectively. The corresponding values of rectal temperature in experiments 2 were 39.7±0.09, 39.5±0.07 and 39.6±0.17 in groups A1, B1 and C1 respectively. The temperature of feed stuffs in experiment 1 and 2 were as follows: barley straw 17.8 and 20.5°C; barley grain 14.0 and 19°C; water 16 and 18.8°C, respectively; linseed-cake 17°C; and cottonseed-cake 19.5°C. The mean values of HW (kj/kgW$^{0.75}$) in experiment 1 were 16.45, 18.19 and 18.25 in groups A, B and C respectively. The HW described as per cent of ME intake ranged between 3.64 to 4.16 of ME intake. The mean values of HW (kj/kgW$^{0.75}$) in experiment 2 were 12.12, 14.33 and 14.92 in groups A1, B1 and C1 respectively. The HW values in group B1 and C1 were significantly higher ($P<0.05$) than that in group A1, which may be due to high intake of water and dry matter in groups B1 and C1. The HW values as per cent of ME intake ranged between 2.90 to 3.08. The mean values of HW were relatively lower in experiment 2 than that in experiment 1, which may be due to increase in ambient temperature in February with concomitant rise in the temperature of feedstuffs and water. Blaxter *et al.* (1959) reported HW in 2 sheep fed on low feeding level as 34 Cal and 41 Cal per day, these values appear close to the HW values reported in present study. The HW required to warm the dietary cool milk to rectal temperature in young calves was reported as 47 kcal or 196.65 kj (Holmes 1971b). The possibility of substitution of heat energy required for HW from heat of microbial fermentation arising from rumen has been discussed by Nicol and Young (1981), however these workers suggested that HW may be incorporated in conventional heat loss model proposed by Monteith and Mount (1974) as critical temperature of animal increased due to heat inflow in the rumen consequent upon ingestion of cold feed.

The biochemical changes occurring in animal body due to cold stress include gluconeogenesis and glycogenolysis in liver (Webster 1976). It is likely that sudden demand of thermal energy required for warming the feed and water to body temperature is also met by these biochemical reactions. Lower weight gains have been reported in calves (Taylor and Lonsdale 1969) and pigs (Holmes 1971a) given less warm liquid feed. The HW is not mentioned in the existing feeding standards for goats (AFRC 1997, Kearl 1982, NRC 1981 and Ranjhan 1998) as a component of energy requirements of goats in cold environments. The results of this study indicate necessity of considering HW for assessing the energy requirements of goats in cold season.

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