EFFECT OF AMBIENT TEMPERATURE ON WATER CONSUMPTION IN GROWING CALVES

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Introduction

It has been reviewed that water intake was a function of dry matter ingested and the ratio for the amount of water consumed to the dry-matter intake was maintained in a fairly constant range, provided the environment were in certain conditions[3,4,7]. In hot condition, the amount of water ingested tends to increase up to certain point and then tends to decline. The dry-matter consumption declined at an accelerating rate over the range of 26.7°C[7]. This influence of the environmental temperature upon the intake of dry matter suggests that the ambient temperature has indirect effect on the consumption of water.

Under the relatively cool condition, the amount of water consumed would be little influenced by the environmental temperature. The influence of temperature on water consumption is to be greater under the hot climatic condition.

These effects of the environmental temperature on water consumption were found with the study carried out by a continuous exposure of animals to a fixed temperature. In the practical husbandry, however, livestocks are kept under fluctuating temperature conditions. The effect of the temperature on water economy of farm animals need to investigate under practical conditions. The present study purposed to determine the effect of the ambient temperature on water consumption in growing calves under the practical feeding regime.

Materials and Methods

Results obtained in the previous study[5] were analyzed on water consump-

tion of calves up to 12 weeks of age. Daily amounts of water consumed were expressed on the basis of body weight so as to eliminate the possible effect of weight differences on water consumption. The ambient temperature was daily recorded with a self-registering thermometer.

The environmental temperature was classified in four categories so as to investigate the means with which water consumption was able to be estimated at a higher accuracy. Four temperature categories were cumulative temperature for 24 hours, daily average temperature, daily maximum temperature and daily minimum temperature. The cumulative temperature was a sum of the temperature recorded at two-hour intervals from the time of a morning feeding to the next morning feeding. The average temperature was calculated by dividing the cumulative temperature with 12 observations in 24 hours. Daily maximum and minimum temperatures were those found in the period between a morning feeding and the next.

Calculations were made on coefficients of correlation and regression between water consumptions or dry-matter intake and four categories of temperatures using the methods described by SNEDECOR[6]. The regression equations were also calculated.

Results

The range of daily cumulative temperature was between about 20°C and 300°C. That of daily average temperature was about 2°C to 25°C. That of daily maximum temperature was about 4°C to 28°C. That of daily minimum temperature was about −1°C to 20°C.

Coefficients of correlations and regression equations calculated are shown in table 1.

Water consumptions on the basis of body weight significantly correlated with all of the categories of temperature ($P<.01$). Coefficients of correlation showed that there was a positive relationship between water consumptions and the environmental temperature. Regression coefficients of free water intake per kg. of body weight were obtained in a relatively constant values of about 1.3 on average, maximum and minimum temperatures.

The regression coefficient was calculated to be 0.11 between free water intake and cumulative temperature. Total water obtained per kg. of body weight also resulted to have a significant correlation with environmental temperatures ($P<.05$). Coefficients of regression showed a similar tendency to the relationships observed in free water intake. Dry-matter intake had no significant correlation with any of categories of temperatures. The ratio of free water intake to amounts of dry matter consumed had significant

TABLE 1. Relationships between water intakes and four categories of environmental temperature

Y	X: Cumulative temperature	Average temperature	Maximum temperature	Minimum temperature
FWI[1]	r=.87, P<.01	r=.40, P<.01	r=.39, P<.01	r=.40, P<.01
g./kg. of wt.	Y=.11X+8.6	Y=1.29X+9.0	Y=1.31X+7.1	Y=1.31X+11.2
FWI/DMI[2]	r=.39, P<.01	r=.39, P<.01	r=.38, P<.01	r=.38, P<.01
g./g.	Y=.006X+.57	Y=.07X+.59	Y=.07X+.45	Y=.07X+.73
TWI[3]	r=.22, P<.05	r=.22, P<.05	r=.24, P<.05	r=.18, P<.05
g./kg. of wt.	Y=.007X+94.0	Y=.87X+93.7	Y=.90X+91.4	Y=.73X+96.7
DMI	r=.108, NS[4]	r=.107, NS	r=.104, NS	r=.098, NS
g./kg. of. wt.	b=.003, NS	b=.040, NS	b=.040, NS	b=.036, NS

1) Drinking water intake, 2) Dry-matter intake, 3) Total water obtained, 4) Not significant.

TABLE 2. Equations of multiple regression for free water intake with dry-matter intake and cumulative, average, maximum and minimum temperatures

Multiple regression equation[1]	Standard partial regression ceofficients
FWI[2]=0.102 CT[3] +4.515 DMI−64.82	CT =0.350, DMI=0.477
FWI =1.221 MT[5]+4.502 DMI−64.55	MT=0.349, DMI=0.475
FWI =1.143 HT[6] +4.540 DMI−66.52	HT=0.344, DMI=0.479
FWI =1.246 LT[7] +4.561 DMI−63.61	LT =0.356, DMI=0.481

1) Test of significance showed that every overall-regressions and each of regression coefficients were significant at 1% level. 2) Free water intake, 3) Daily cumutative temperature, 4) Dry-matter intake, 5) Daily average temperature, 6) Daily maximum temperature, 7) Daily minimum temperature.

correlation with four categories of environmental temperature (P<.01). A rise of 1°C in temperatures of average, maximum and minimum increased free water intake per g. of dry-matter intake by 0.07 g. The ratio of free water consumption to the amount of dry matter consumed increased by 0.006 g. per 1°C rise in cumulative environmental temperature.

Water intake has been considered to be a function of dry-matter intake. Environmental temperature was also found to influence free water consumption. Multiple regression for free water intake was calculated with dry-matter intake and four categories of the environmental temperature. Equations obtained are shown in table 2 with each of standard partial regression coeffi-

cients.

Results presented in table 2, showed that free water intake was to be a sum of about 4.5 times of dry-matter intake and about 1.2 times of average, maximum or minimum temperatures. Daily cumulative temperature contributed by 0.102 g. per 1°C rise to free water consumption with 4.515 g. per g. of dry-matter intake. Standard partial regression coefficients indicated that the contribution of dry-matter intake to drinking water consumption exceeded over any categories of the evironmental temperature.

Discussion

Regression equations obtained between water consumptions and four categories of daily environmental temperature showed that ambient temperature significantly influenced water intakes. Coefficients of correlation show that all categories of daily ambient temperature can be used to estimate the amounts of free water durnk or total water obtained by calves. Of these categories, cumulative temperature is to be the best estimator for predicting the effect of environmental temperature or drinking water consumption.

WINCHESTER and MORRIS[7] reported that the ratio of water intake to dry-matter intake increased with an increase in the ambient temperature at an accelerating rate. Detailed examination of their resluts revealed that the rate of increase in the ratio of water intake to dry-matter intake was smaller in the temperature below 26.7°C than above it. JOHNSON *et al.*[2] observed higher drinking water consumption at the temperature of 26.7°C in calves given milk for 6 months than at 10°C. Non lactating European cattle increased water consumption as the environmental temperature rose from 10°C to 35°C. The rate of increment of water consumption again indicated that the increment rate was smaller in the temperature below 26.7°C than above it[8]. JOHNSON *et al.*[1] studied effects of the temperature and humidity on water consumption in lactating Holstein cows and found no significant differences in water consumption between the temperatures of 18°C and of 29.4°C with different humidity. Amounts of water consumed by lactating cows showed a relatively constant level up to the temperature-humidity index of 79 compared with the value under the condition of 18°C, 50% relative humidity. The results obtained for growing calves in the present study agreed with the results reported so far for adult cattle.

When the associative influence with dry-matter intake on water consumption was examined, the effect of the temperature was found to be smaller than that of dry-matter intake. JOHNSON *et al.*[1] observed a declined water

consumption possibly due to a decrease in dry-matter intake in lactating cows at higher temperature above 30°C. YOUSEF *et al.*[8] also stated that the decline in water consumption for lactating European cows at 32°C or above was presumably associated with their decline in feed consumption and in milk production. Thus, the dry-matter intake appeared to govern water consumption for cattle under hot climatic condition.

The results of the present study show that dry-matter intake is more contributive to water consumption than four categories of the temperature in growing calves. Calves destined to grow at a certain rate consumed dry matter irrespective of the ambient temperature in the range recorded in the present study. Under the condition with the fluctuating ambient temperature, dry-matter intake may not be much influenced in growing calves. Thus, dry-matter intake could have been involved with a major importance among many factors affecting water consumption in growing calves, although the effect of ambient temperature is unable to be neglected as an important factor influencing water consumption.

Summary

Water consumption of calves up to 12 weeks of age was analyzed to determine the effect of ambient temperature on amounts of water consumed. The temperature was classified in four categories which were cumulative temperature for 24 hours, and daily average, daily maximum and daily minimum temperatures.

Drinking water consumptions on the basis of body weight significantly correlated with all of temperature categories ($P<.01$). All categories of ambient temperature were considered to be useful for the estimation of drinking water consumption. Of those, cumulative temperature is to be the best estimator. The ratio of amounts of water drunk to that of dry matter consumed increased by 0.006 g. per 1°C rise in cumulative temperature and by 0.07 g. in average, maximum and minimum temperatures. Multiple regression analyses revealed that amounts of dry matter ingested was more contributive to the estimation of drinking water intake than any categories of the ambient temperature in the range recorded in the present study.

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