WATER DRINKING BEHAVIOUR OF STEERS FED EITHER FRESH CUT FORAGE OR FIRST CUT HAY

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Summary

To study the effect of moisture content of the diet on drinking behaviour and the amount of water drunk, observations were made on 8 Holstein steers fed either fresh cut forage or first cut hay. The observations were made in a barn with a mean temperature of about 13°C. Drinking occurred mainly within 3 hours after feeding for the steers fed hay, while those fed soilage drank casually. Frequency of drinking (F) was related to the dry-matter concentration (DMC, %) of herbage: F = 0.47 (±0.09) DMC − 6.5, SE = ±0.4, r = 0.86, $P < 0.01$. Intake of drinking water for each 100 kg of live weight (IDW/100 kg) for steers fed soilage was related to the dry-matter concentration: IDW/100 kg = 0.55 (±0.06) DMC − 8.7, SE = ±0.3, r = 0.94, $P < 0.01$. The intake of water in each drinking period for animals fed fresh forage was curvilinearly related to the drinking frequency; for the hay-fed steers there was a negative linear relationship. When the drinking frequency for steers fed the fresh forage increased to the same as that observed for the hay, water intake in each drinking period was the same as found for the hay-fed steers.

(Key Words: Drinking Behaviour, Forage Dry-Matter Content, Water Intake, Steer)

Introduction

It has been generally recognized that with animals fed dry diets the water drinking behaviour follows the ingestive behaviour (Mimura and Morita, 1984). With grazing animals water is drunk on zero to four occasions each day (Hancock, 1953), and the drinking behaviour is apparently depending upon the kind of forage ingested.

Water supply may be abundant in some regions where animal production has been developed, but there are many areas with limited water resources. In such areas, the timing and the amount of water required could be important in efficient production. To obtain more information on drinking water requirement of animals, drinking behaviour of growing steers was studied when fed fresh forage or hay plus a small amount of concentrates.

Materials and Methods

Eight Holstein steers (14 to 16 mo. of age) were randomly divided into two groups of 4 and fed first-cut orchardgrass-red clover hay (hay group) or fresh cut forage (fresh forage group). The fresh forage was regrowth harvested every other day from the field that was used to produce the first-cut hay. Steers were individually fed 2 kg of commercial formula feed (corn, 30%, wheat bran, 18%, soybean meal, 14%, grain screening pellet and others, 31%) as a concentrate and the first-cut hay with a surplus amount of daily intake. They were fed twice a day a half of daily concentrate allowance at 9:00 in the morning and at 5:00 in the evening. As for hay, the amount in 10% surplus of daily intake during the preliminary period was divided into two portions and was offered at the same time of concentrate feeding. Thus, steers had a free access to the first-cut hay throughout the measurement period.

The fresh grass, first-cut hay and concentrate contained 155, 92 and 182 g crude protein/kg DM and 273, 378 and 90 g crude fibre/kg DM, respectively. The mean dry-matter concentration of the fresh forage was 243 g/kg. Uneaten forage was collected daily. The measurement period started at

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the middle of September and lasted 21 days with a 7-day preliminary period to lessen the effect of fluctuation of ambient temperature on water intake since the temperature in the period from September to October in Hokkaido shows the least daily fluctuation in the year. The quantity of forage fed and weighbacks were daily recorded for each steer. Moisture contents of feed and weighbacks were measured daily. Ambient temperature in the barn was recorded using automatic recording hygro-thermometer. Statistical analyses were made with the methods described by Steel and Torrie (1960) and by Campbell (1974).

The quantity of water drunk each day was recorded immediately before morning feeding using a drinking bowl equipped with a water meter. Drinking behaviour of steers was observed on 17th, 19th and 21st days of the experimental period. The time and amounts of water drunk in each drinking period was recorded for 24 hours for individual steers in both groups. Steers were weighed at the beginning and at the end of the experimental period.

Results

Ambient temperature

Ambient temperature in the barn averaged 13.2 (s.d. ± 1.10), 13.5 (± 1.40) and 13.4 (± 0.98) °C for the observation days on 17th, 19th and 21st days of the experimental period, respectively. There was no statistically significant difference among mean ambient temperature of day-17, -19 and -21. There were small temperature fluctuations on the observation day.

Water drinking behaviour

The frequency of water-drinking for 24 hours showed no statistically significant difference among the individual steers on the same observation day within the group, although a steer in hay group tended to drink water less frequently than the other members of the group. Mean number of water-drinking periods were 8.8 (s.d. ± 1.9), 7.5 (± 1.9) and 10.3 (± 3.1) for hay group and 2.3 (± 0.9), 5.3 (± 1.2) and 7.8 (± 2.1) for fresh forage group on day 17, 19 and 21, respectively. The frequency of drinking for hay group averaged 8.8 (± 2.4) with no significance between days while that for fresh forage group differed significantly between days ($P < 0.01$).

The observations of drinking behaviour for the hay group were pooled and the patterns of drinking behaviour for 24 hours were analyzed using

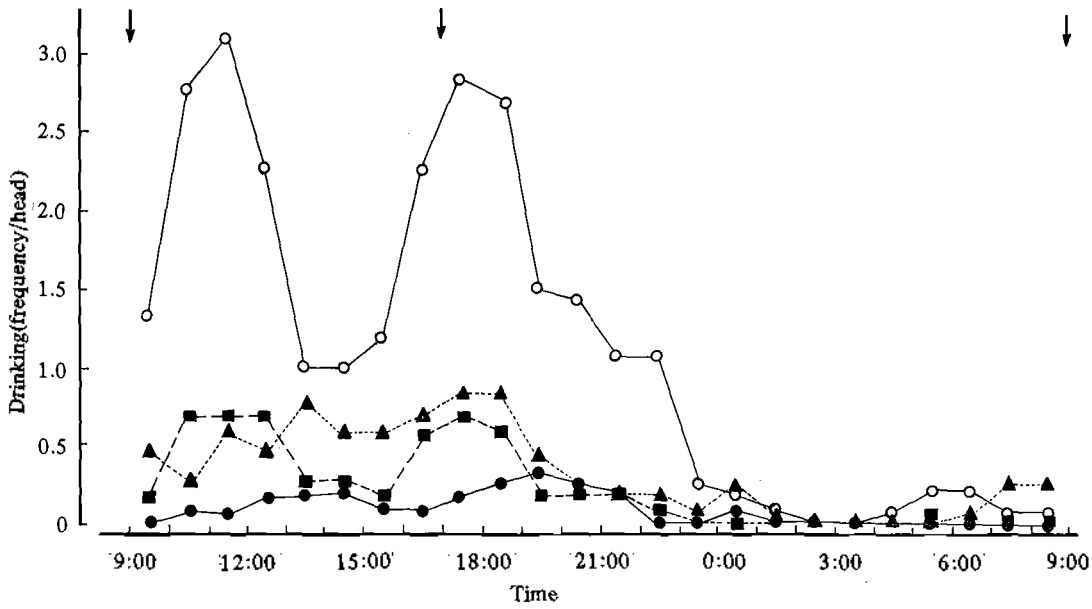

Figure 1. Diurnal drinking pattern of steers fed hay (○, pooled for 3 days) or fresh forage on day 17 (●), day 19(■) and day 21 (▲). Arrows show the time at feeding.

the moving average method (Asahida and Mimura, 1967) with the 3-hour intervals as shown in figure 1. With this analysis, drinking behaviour of steers fed a hay diet concentrated on the 3 hours from 10:00, that is one hour after morning feeding to 13:00 and those from 16:00, that is one hour before evening feeding to 19:00. Drinking rarely occurred between 23:00 and 9:00 when the steers were fed.

The frequency of water-drinking of the fresh forage group increased from 2.3 (s.d. ± 0.9) per day on day 17 to 7.8 (± 2.1) on day 21. The pattern of drinking behaviour for this group on day 17 appeared to be unrelated to feeding time (figure 1) but on days 19 and 21, the frequency tended to become similar to that for the hay group, although the peak of the drinking frequency was not so high as the hay group (figure 1). The dry matter concentrations (DMC) in fresh grass were 18.6, 25.3 and 30.2% for day 17, 19 and 21, respectively. The number of drinking periods each day (F) was positively correlated with the DMC in the forage ($r = 0.86$, $P < 0.01$). The regression analysis of F on DMC resulted in the following linear regression equation:

$F = 0.47\ (\pm 0.09)\ DMC - 6.5$, $P < 0.01$, S.E. ± 0.4, as shown in figure 2.

When the results for hay and fresh forage groups were combined, the regression was as follows (figure 2):

$F = 11 - 140\ (\pm 26)/DMC$, $r = 0.75$, $P < 0.01$, S.E. ± 0.4.

There was no correlation between the quantity of roughage dry-matter ingested and the frequency of water-drinking in both group ($P > 0.05$). Thus, water-drinking frequency appeared to be influenced by the dry-matter concentration of a diet rather than dry-matter intake.

The drinking pattern for animal fed fresh forage and hay was analyzed by the sign test. Although the values of Chi-square showed no significant coincidence for the two groups, the values drew toward the significance as the dry-matter concentration in fresh forage increased. Thus, the drinking pattern of animals fed fresh forage has a tendency to coincide with that of the hay group as DMC in forage increased.

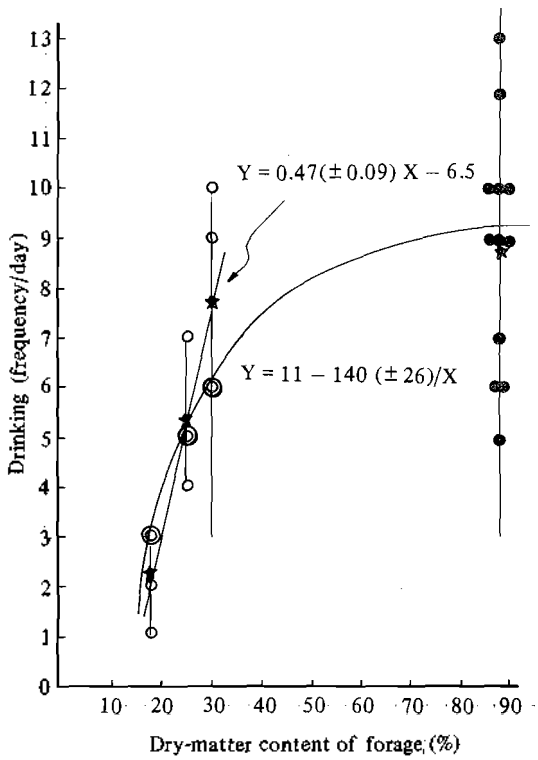

Figure 2. Relationship between drinking frequency and dry-matter content of forage for steers given hay (●) or fresh forage (○).
Solid stars with a vertical line represent the mean with standard deviation at a given dry-matter content.

Drinking water intake

Table 1 shows the mean of drinking water intake (DWI) for hay and fresh forage groups together with total water intake (TWI), dry-matter intake and live weight. Steers fed hay drank on average 39 *l*/d of water. There was no significant difference in water intake among steers or between observation days for the hay group. The mean intake of water in each drinking period (WI/F) averaged 4.8 *l* with a large coefficient of variation. There was a negative correlation between the frequency of water-drinking (F) and water intake in each drinking period ($r = -0.89$, $P < 0.01$, figure 3). Daily intake of drinking water tended to increase as the number of drinking period increased, although the correlation was not significant ($P > 0.05$).

Drinking water intake for the fresh forage group averaged 16.2 *l*/d (table 1). Significant differences in DWI were found between observation days but not among steers except on day 17.

TABLE 1. THE MEAN OF AMOUNT OF WATER DRUNK, TOTAL WATER INTAKE AND DRY-MATTER INTAKE BY STEERS FED HAY OR FRESH CUT HERBAGE WITH 2 KG OF CONCENTRATE

Group	Amount of water drunk						Total water intake		Dry-matter intake				Live weight	
	daily		per 100g		per drinking period				Roughage		Total			
	Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd	Mean	sd
	l								kg/day				kg	
Hay pooled	39.4	4.6	12.0	1.6	4.8	1.3	40.3	4.4	7.2	0.7	9.0	0.7	333	37
Fresh forage														
on day 17	4.3	3.3	1.3	1.0	1.7	0.8	34.6	5.0	6.5	0.4	8.3	0.4	–[1]	
on day 19	19.5	2.3	6.0	0.7	3.8	0.6	49.0	2.4	10.2	0.1	12.0	0.1	–	
on day 21	24.7	3.4	7.6	1.0	3.3	1.1	45.9	4.5	8.2	1.0	10.0	1.0	–	
pooled	16.2	9.5	4.9	2.9	3.0	1.2	43.2	7.4	8.4	1.6	10.2	1.6	328	26

[1] Not measured

Mean DWI on the basis of 100 kg of live weight (DWI/100 kg) was the lowest on day 17 and increased as DMC of fresh forage increased. A significant positive correlation was observed between DWI/100 kg and DMC of fresh cut herbage ($r = 0.94$, $P < 0.01$) with the regression:

DWI/100 kg = 0.55(±0.06) DMC − 8.7, S.E. ±0.3.

The mean water intake for each drinking period (WI/F) of the fresh forage group was 3.0 *l* (s.d. ±1.2) but was curvilinearly related to the number of drinking periods (F):

$WI/F = 1.44(\pm 0.32)\,F - 0.115\,(\pm 0.028)F^2 - 0.59$, $R = 0.84$, $P < 0.01$.

The maximal WI/F was calculated as 6.26 *l*. This was close to the value for the frequency of 6 drinking/day found with the hay group. Mean TWI of the fresh forage group was not significantly different from that of the hay group.

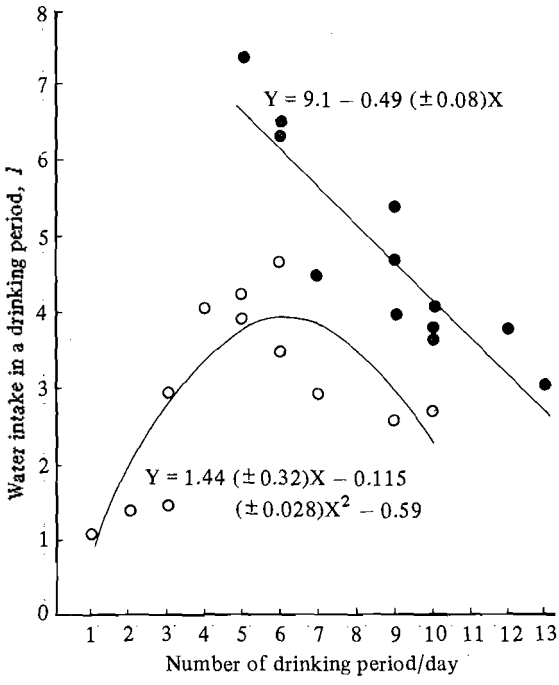

Figure 3. Relationship between water intake in each drinking period and number of drinking periods for steers given hay (●) or fresh forage (○).

Discussion

Steers fed a hay diet mainly drank water within 3 hours following feeding, while those given fresh forage had no definite pattern of the behaviour. Steers in hay group seldom drank at night or in the early morning. These observations agreed with those reported for grazing cows (MacLusky, 1959), but were different from that of lactating cows fed rations containing various forages (Castle and Thomas, 1975). Drinking by animals given the dry ration appeared to be triggered by feeding and to continue for several hours. Thus, it is possibly desirable to provide drinking water for at least 4 hours after feeding if the water requirement are to be satisfied.

Steers fed fresh forage showed a different pattern of water-drinking from day to day which was related to the dry-matter concentration in the forage.

From the equation for fresh forage animals

(figure 2), it was calculated that steers fed fresh forage reached to the mean number of drinking periods of the hay group (8.8/day) when the fresh grass contained about 33% of dry matter and would not need to drink when the DMC decreased to about 14%. Hancock (1953) indicated that genetically-determined individuality caused variations in drinking behaviour. In the present study, individual variation in drinking behaviour was not observed when the distribution of drinking was analyzed by the method of Kolmogorov-Smirnov presented by Campbell (1974). A steer in hay group, however, tended to show lower number of drinking periods than the others in the group. Thus, the individual variation may be taken into consideration. The 95% confidence interval of the mean frequency for hay group ranged from 4.1 to 13.5. The 95% confidence interval of the standard deviation was calculated to be between 1.3 and 2.4. When the number of drinking periods of the hay group was assumed to have the highest value with the largest standard deviation, more than two third of observations must have come into the range of 13.5 ± 2.4. When steers fed the fresh forage reach to its highest range, DMC in the fresh forage would contain 47.6% DMC. Thus, drinking behaviour of animals given fresh forage was inferred to approach to that of hay group when DMC increased to between 33 and 48%. Hancock (1953) reported that cattle grazed on pasture drank more frequently as DMC in herbage increased and the present study supports this conclusion. From the equation calculated for the pooled results of hay and fresh forage (figure 2), it appears that the number of drinking period increased slowly with increase in DMC above 50%. Sekine and Asahida (1987) showed that total water intake was not affected by DMC and that it was only DWI that was related to DMC. They found that animals given fresh forage drank water to make up the shortage of water supply from forage.

In conclusion, drinking behaviour and DWI of animals given fresh forage are to be influenced by DMC. The frequency of drinking and the amount of water drunk by steers appear to reach the same level as hay-fed steers when the DMC of the forage is from 33 to 48%. When DMC in fresh forage decreased to the level of 14%, steers do not appear to require drinking water, provided the environmental temperature is in the range 12 to 15°C.

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