Blood osmolality changes in sheep at satiety*

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The intention of this study was to explore blood dilution as a factor in terminating water consumption. Using 12 female sheep, 11 months old, results indicate that blood dilution from a dehydrated state to ad lib levels is not coincident with termination of water intake. The results further indicate that blood dilution as a mechanism instrumental in terminating drinking behavior cannot be generalized across all species.

It has been demonstrated that increases in blood concentration serve as an adequate stimulus for initiating drinking behavior (Hatton & Thornton, 1968; Hatton & Almlie, 1969). Until recently, it was believed that termination of such drinking behavior was dependent upon "anticipatory mechanisms" (Bellows, 1939; O'Kelly, 1963), whereby the animal anticipates restoration of a water deficit prior to the transportation and absorption of water into the circulatory system and the consequent blood dilution to ad lib levels. Hatton & Bennett (1970) published results indicating that in rats, blood dilution to ad lib levels was coincident with termination of water intake, thus limiting the generalizability of the "anticipatory mechanism" model.

The present study was initiated to investigate blood dilution further as a factor in terminating drinking behavior in sheep.

SUBJECTS

The Ss were 12 female sheep, approximately 11 months old at the beginning of the study.

PREEXPERIMENTAL PROCEDURE

While in a free drinking condition, a blood sample was collected from each animal on 4 consecutive days for use in establishing ad lib blood concentration levels. Based on weight equilibration, eight animals served as experimental Ss, while four animals served as controls. Both groups were maintained on prestudy feed schedules, with food consisting of alfalfa mixed grains. Control animals retained free water access, while a 47½-h water deprivation schedule was imposed on experimental Ss. Following 11 days on the schedule, blood samples collected from experimental Ss prior to bidaily water access showed a mean increase in plasma osmolality of 4.7%. Weight and volume of water intake for experimental Ss had also stabilized. With weight and water consumption

stable and adequate predrink blood concentration to initiate drinking behavior, adaptation to the water stress situation was considered satisfactory.

APPARATUS

Throughout the study, blood samples were drawn from the jugular vein in heparinized 10-cc syringes. Samples were centrifuged, and the plasma drawn off and analyzed osmotically by the freezing point depression technique.

Control and experimental groups were penned separately with special provisions made for enclosing experimental Ss in case of inclement weather to prevent unscheduled access to water. Water intake for experimental Ss was recorded in milliliters after each water intake period, and animal weights were recorded periodically for both groups.

PROCEDURE

Following the establishment of predrink stability of plasma osmolality for experimental Ss, a blood sampling procedure with three conditions was initiated. The conditions were predrink, postdrink, and 24 h after drinking. For each animal, a blood sample was collected immediately before access to water, within 2 min of termination of water intake, and again 24 h after the normal water access period. Volume of water intake was recorded for each animal. The complete schedule was conducted during two consecutive drinking periods.

RESULTS

Mean ad lib plasma osmolality (mean/milliosmols/kg) for experimental Ss was 308.7 M/mOsm/kg and is represented in Fig. 1 by the dashed line. The means predrink, postdrink, and 24 h after drinking were 326.2, 325.0, and 312.9 M/mOsm/kg, respectively, and are represented graphically in Fig. 1. The vertical bars in the figure represent ± 1 standard error of the means.

Analysis of variance indicated a significant effect for the stages of drinking (predrink vs postdrink vs 24 h postdrink) ($F = 25.1$, $df = 2,35$, $p < .01$), but neither the drinking

period factor ($F = 1.1$, $df = 1,35$, $p > .01$) nor the Stage by Drinking Period interaction were statistically significant ($F = 2.1$, $df = 2,35$, $p > .01$). A comparison of the blood osmolality levels using Scheffé intervals indicated that all stages of drinking differed significantly from each other ($p < .01$). Ss terminated drinking in about 2 min and consumed approximately 5 liters of water.

DISCUSSION

As reported by Hatton & Bennett (1970), blood dilution from a dehydrated state to ad lib levels is coincident with termination of drinking behavior in rats. These results suggest that in order for blood dilution to play a decisive role in terminating water intake, dilution must be at or near ad lib levels at the time water consumption ceases. In sheep, as Fig. 1 indicates, blood dilution at cessation of water intake changed slightly from predrink osmotic levels. This result was interpreted as a clear indication that blood dilution from a dehydrated state to ad lib levels is not instrumental in terminating drinking behavior in sheep.

In contrast to the interrupted drinking pattern of rats, which allows greater time for transportation and absorption of water into the circulatory system, sheep drink in one uninterrupted draft. The difference between the two species suggests that drinking patterns may be correlated with blood dilution operating as a factor in terminating drinking behavior. Blood dilution seems to be instrumental in terminating water consumption in species having an interrupted drinking pattern, but not in species having an uninterrupted drinking pattern. Thus, it appears that blood dilution, as an instrumental mechanism for terminating drinking behavior, is not generalizable across all species.

Fig. 1. Means and standard error of the mean for plasma osmolality during the different stages of drinking.

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