AVERAGE DAILY GAIN AND WATER INTAKE IN GROWING BEEF CALVES OFFERED SNOW AS A WATER SOURCE

Five calves were denied water for 112 d during winter but had access to snow as a water source (snow calves) and were compared with five calves that had continuous access to water (water calves). All calves were then given continuous access to water for a further 56 d. There was no significant difference between groups in water intake or average daily gain except at the beginning of the 56 d rewatering period when the snow calves drank more water per kg body mass than the water calves.

Key words: Calves (weaned), average daily gain, snow, water intake, water influx, tritiated water

[Gain moyen quotidien et prise d'eau chez les veaux de boucherie en croissance abreuvés uniquement avec de la neige.]
Titre abrégé: Consommation de neige par les veaux sevrés.
Cinq veaux privés d'eau pendant 112 jours durant l'hiver, pouvant toutefois consommer de la neige comme source d'eau, ont été comparés à cinq autres veaux ayant un accès continu à de l'eau. Après cette période, tous les veaux ont eu accès à un approvisionnement continu en eau pendant 56 jours supplémentaires. Aucune différence significative n'a été observée entre les deux groupes pour ce qui est de la consommation d'eau ou du gain moyen quotidien, sauf au début de la période de 56 jours durant laquelle le premier groupe a bu davantage d'eau par kilogramme de poids corporel que le deuxième groupe.

Mots clés: Veaux sevrés, gain moyen quotidien, neige, prise d'eau, apport d'eau, eau tritiée

Mature cattle (Young and Degen 1980) and sheep (Weeth et al. 1959; Butcher 1973; Degen and Young 1981) can apparently rely solely on snow to meet their water needs. However, there appears to be no published data on whether growing calves, with their high nutrient energy intake, can obtain sufficient water when only snow is available.

Beef calves are usually weaned just prior to winter. If weaned calves can use snow as a water source without detrimental effects, then the necessity of providing heated (liquid) water may be avoided. This knowledge could be incorporated into normal management practiced or used during a winter failure in the animal watering system. In the present study we measured the average daily gain and water intake of growing beef calves with access to snow as the only water source and compared their performances with calves that had continuous access to heated water during winter.

Ten recently weaned calves, six males and four females, were used in the study. Their dams were 3- to 4-yr-old cows of predominantly Charolais and Angus breeding. The calves were kept with their mothers on pasture until they were weaned at a mean age of 179 d and mean body mass of 188±47 kg. They were then kept as a group in a feedlot for 2 mo before they were divided into two groups that were matched for sex, age and body mass.

Each group was placed in a feedlot pen with the feed trough in an open front shed. One of the pens had access to a small adjacent snow-covered field. No pasture was available in this field. The calves with access to this field (snow calves) were denied water for 112 d from 9 Dec. to 9 Apr.; the other calves (water calves) had continuous access to water (10°C) from a heated bowl. Water was then made available to all calves and measurements were continued for an additional 56 d.

Throughout this study, calves within a pen were group fed 20.0 kg of a concentrate

mixture (13.9% protein) and 10.0 kg of bromegrass hay (12.1% protein) daily. The calves were weighed at the start of the study and at 2-wk intervals thereafter.

Total body water volume and total water influx of four calves in each group were estimated on three occasions as were water drunk and snow consumed. Measurements were done starting at the following times: (a) 84 d after the onset of water denial to the snow calves, i.e. when they were readily consuming snow (period 1); (b) 1–4 d after the snow calves were re-offered water (period 2) and (c) 28 d after snow calves were reoffered water (period 3).

Tritiated water was used to measure tritiated water space, an estimate of total body water volume, and total water influx, an estimate of total water intake. Water drunk and snow intake were estimated from total water influx minus estimated preformed and metabolic water from feed. All measurements followed Young and Degen (1980). Means between calf groups were compared using a Mann-Whitney U test (Sokal and Rohlf 1973) and $P<0.05$ was chosen as the minimum level of significance to be accepted. Values throughout are presented as means ± standard deviations (SD).

Daily air temperatures ranged from −32°C +14°C during the winter and from −4°C to +28°C during the spring.

The initial body mass of the snow and water calves were 206±43 and 201±54 kg and they gained, respectively, 62±19 and 76±25 kg during the 112 d while the snow calves were denied drinking water. While this 19% difference in gain is not statistically significant, biologically it could be meaningful and significant for a larger group of calves. During the subsequent 56 d of the study when all calves had access to water the body mass gains were 44±8 and 49±16 kg, again favoring, but not a statistically significant advantage for the calves with continuous access to water.

There was no difference throughout the study in tritiated water space between the treatment groups (Table 1). When water was denied to the snow calves (Period 1), daily snow intake averaged 52.1 mL kg^{-1} body mass for the snow calves while the water calves drank 59.2 mL kg^{-1}. Shortly after water was re-offered to the snow calves (Period 2), water intake increased by 57% over their snow intake, whereas the water intake by the water calves was increased by only 11% during this time. During Period 2, the water intake by the snow calves was significantly higher (24%) than that of the water calves (Table 1). In Period 3, with water available to all calves, the two groups drank similar volumes of water.

Differences in feeding behavior between the two groups of calves were noted. When denied

Table 1 Body mass, tritiated water space, water influx and water intake by calves with access to snow as a water source (snow calves, $n=4$) or with continuous access to water (water calves, $n=4$)

	Body mass (kg)	Water space (%)†	Water influx (mL kg^{-1} d^{-1})	Water intake‡ (mL kg^{-1} d^{-1})
Period 1 (after 84 d on snow)				
Snow calves	269±60	71.1±2.3	61.7± 6.0	52.1± 0.1
Water calves	285±62	71.5±5.7	68.4± 6.1	59.2± 5.3
Period 2 (immediately after reintroduction to water)				
Snow calves	277±61	70.7±2.4	91.1±10.2	81.8± 9.2
Water calves	301±61	72.9±4.2	74.4± 5.8	65.7± 5.1
			*	*
Period 3 (28 d after reintroduction to water)				
Snow calves	304±66	70.9±2.3	106.4± 1.7	98.0±10.1
Water calves	327±66	71.4±1.7	100.0± 0.8	92.0± 9.9

†Percent of body mass.
‡Water intake also refers to snow consumed and water drank.
*Significant ($P<0.05$) treatment difference, all other treatment differences were not significant

water, the snow calves ate their food more slowly than did the water calves. They ate intermittently, alternating feeding periods with bouts of snow ingestion.

Feral animals in temperate and arctic regions often rely on snow as their primary water source during the winter. In fact, when given a choice, reindeer apparently preferred snow over water (Luick 1977). This is unlike the findings with beef cows which, when given the same choice, preferred heated water (Young and Degen 1980). However, a number of domestic animals can survive on snow as their primary water source as has been reported in horses (Dietrich and Holleman 1973), cattle (Young and Degen 1980) and sheep (Weeth et al. 1959; Butcher 1973).

Lactating ewes, with their relatively high water requirements were also able to meet their requirements when offered only snow as a water source although they did reduce their water intake (Degen and Young 1981). In the present study, growing calves, with their relatively high food intake and water requirements, were able to grow and obtain sufficient water from snow. However, there was evidence that the snow calves had a somewhat reduced water intake when only snow was offered. This was based on the large increase in water influx (apparent recovery response) when water was reintroduced to them following a long period of relying only on snow. Their water intake was not only much higher than that measured when they were receiving snow, but also considerably higher than the water intake of the water calves. This could have been due to an accumulated deficit of water or perhaps due to the novelty of having access to heated water again.

Although the feeding behavior of the snow calves was different from that of the water calves, their feed intake was not depressed. Actually, the intermittent feed and snow consumption behavior by these calves benefitted them. Degen and Young (1984) have shown that consuming large amounts of snow in one bout resulted in rapidly reduced rumen and rectal temperatures in cattle and to recover body temperatures, the animals increased their metabolic rate and shivered. Eating small amounts of snow per bout, as was done in the present study, minimized decreases in rumen and rectal temperatures and reduced cold stress (Degen and Young 1984).

Snow consumed by the calves was melted and raised to body temperature. Cameron and Luick (1972) reported that reindeer reduced their water intake when consuming snow, and these authors suggested that this would be beneficial to the animals as less metabolic heat would be required to melt the snow and raise it to body temperature. However, Butcher (1973) suggested that this may not be the case since the heat increment of feeding should be more than adequate to melt the snow and bring it to body temperature. Butcher's views were supported by evidence from horses where no metabolic differences were observed between horses given snow and those given water (Dietrich and Holleman 1973). It would appear that growing calves with their relatively high energy intake and consequent high heat increment of feeding should also not require additional energy when consuming snow.

We thank J. A. Francis, K. A. Plumb and C. A. Breakey for technical assistance. The study was supported in part by grants from the Agricultural Research Council of Alberta and the Natural Sciences and Engineering Research Council of Canada.

Butcher, J. E. 1973. Snow as the only source of water for sheep. Pages 205–209 *in* H. F. Maryland, ed. Proceedings of Symposium on Water-Animal Relations. University of Idaho Press, Kimberly, Idaho.

Cameron, R. D. and Luick, J. R. 1972. Seasonal changes in total body water, extracellular fluid and blood volume in grazing reindeer. Can. J. Zool. **50**: 107–116.

Degen, A. A. and Young, B. A. 1981. Response of lactating ewes to snow as a source of water. Can. J. Anim. Sci. **61**: 73–79.

Degen, A. A. and Young, B. A. 1984. Effects of ingestion of warm, cold and frozen water on heat balance in cattle. Can. J. Anim. Sci. **64**: 73–80.

Dietrich, R. A. and Holleman, D. F. 1973. Hematology, biochemistry, and physiology of environmentally stressed horses. Can. J. Zool. **51**: 867–873.

Luick, J. R. 1977. Preference of reindeer for various physical and chemical forms of water. Pages 66–88 *in* Industrial development in Alaska and its effects on the nutritional and physiological status of arctic animals — Progress Report. Institute of Arctic Biology, University of Alaska, Fairbanks, Alaska.

Sokal, R. R. and Rohlf, F. J. 1973. Introduction to biostatistics. W. H. Freeman, San Francisco, Calif.

Weeth, H. J., Torell, C. R. and Cassard, D. W. 1959. Effects of simulated snowbound stress condition on ewes. J. Anim. Sci. **18**: 694–700.

Young, B. A. and Degen, A. A. 1980. Ingestion of snow by cattle. J. Anim. Sci. 51: 811–815.

A. A. DEGEN[1] and B. A. YOUNG.
Department of Animal Science, University of Alberta, Edmonton, Alberta, Canada T6G 2P5. *Received 20 Sept. 1989, accepted 22 Jan. 1990.*

[1]Permanent address (A.A.D.): Isan Centre for Comparative Medicine and Desert Animal Research, Jacob Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Beer Sheva, Israel, 84105.