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Expanded abstract

Milk composition and production from hand-milked muskoxen

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Muskox calves fed milk replacer seldom achieve growth rates comparable to those raised naturally. Growth rates in our herd are about approximately 25 % slower when calves are fed a commercial lamb milk replacer (347 g/d), compared to rates achieved when calves suckle their dam (423 g/d), (Chaplin, 1984; Chaplin and Stevens 1989). Diarrhoea has also been a common problem. Frisby *et al.* (1984) reported similar difficulties. To better evaluate the nutritional needs of the young calf and to compare what calves receive naturally, milk composition and volume were evaluated in two captive lactating muskox by hand milking. At present muskox milk has only been analysed from samples taken from killed animals or small spot samples from captive animals (Frisby *et al.* 1984; Jacobson and McGilliard 1984; Parker *et al.* 1990). Since milk composition changes within a single milking, as well as throughout a lactation for most mammalian species (Mepham 1987 a), incomplete or single milkings can give misleading information.

Use of existing milk replacers in feeding muskox neonates has not been totally successful due to the fact these replacers are designed specifically for calves, lambs or other domesticated livestock. Perrin (1958) lists the composition of ovine milk as approximately 9.0 % fat, 5.3 % protein and 5.2 % lactose, whereas the composition of muskox milk is reported to range in fat from 11.0 to 15.5 %, in protein from 5.3 % to 15.6 % and in lactose from 2.9 % to 3.6 % (Frisby *et al.* 1984; Jacobsen, McGillard 1984). Because of this variation, the following evaluation was undertaken.

Two females were trained to tolerate hand milking beginning shortly after parturition. By 30 days after calving, both cows and calves were accustomed to the following procedure: Upon arrival in the morning each cow was placed in the milking stall, fed 400 grams of a concentrate pellet (50 % oats, 38 % brome-alfalfa hay, 4 % molasses and 8 % mineral) and hand-milked until dry. The calf was separated at this point. Following four hours of separation the cow was returned to the stall, fed and again, completely milked. The volume of milk secreted was recorded and a sample was taken for immediate pH measurement and further analysis. The remaining milk was fed by bottle to the calf. Both the dam and calf were returned to a brome grass where they remained until the next morning when the procedure was repeated.

The milk samples were analysed for fat, protein and lactose by the provincial dairy laboratory in Regina, Saskatchewan. The component

Table 1. Composition of muskox milk.

Component	Mean ± SE	Range	Cow*	Sheep**
Fat (%)	9.45 ± 0.20	6.18–12.88	3.5–5.5	9.0
Protein (%)	7.33 ± 0.07	5.91– 9.00	3.1–3.9	5.3
Lactose (%)	4.35 ± 0.04	3.44– 5.03	4.7–5.0	5.2
pH	6.39 ± 0.13	6.25– 6.54		
Osmolarity (mmol/kg)	313.0 ± 2.1	293–337		
Sodium (mmol/L)	39.1 ± 1.6	31–57		
Potassium (mmol/L)	34.5 ± 0.7	30–40		
Chloride (mmol/L)	19.5 ± 0.7	14–30		
Urea (mmol/L)	25.0 ± 0.8	17–31		
Creatinine (umol/L)	197.6 ± 24.8	28–354		
Volume (ml/4hr)m	161 ± 8.4	94–280		

* Altman, P. L. and Dittmer, D. S. eds. (1961)
** Perrin, D. (1958).

analysis (fat, protein and lactose) was completed using an infrared milk analyzer (Milko-Scan 605 from A/S N. Foss Electric, Denmark). Electrolytes were analysed by ion-selective electrodes (Radiometer KNA 1 analyser), urea and creatinine by the Coulter DACOS chemistry analyzer and osmolarity by vapor pressure.

The compostion of milk collected between days 30 and 65 after calving is shown in Table 1. In total 52 samples were collected from the two animals, 28 from one and 24 from the second. No obvious differences existed between the two animals so the results were averaged. In general the variation within the data indicates consistency in composition during this lactation period. Fat and protein values are very similar to those listed for sheep and generally higher than those reported for cattle. Protein values were similar to those reported for muskoxen by Parker *et al.* (1990). Lactose levels are higher than generally reported (Frisby *et al.* 1984; Jacobson and McGillard 1984). The analysis of pH, osmolarity, urea, creatinine and electrolytes has not been previously reported.

The average volume of milk produced during the 4 hour calf removal averaged 161 ml (Table 1). Extrapolation of these values to a 24 hr production indicates average daily production could range between 564 and 1680 ml. Tiplady and White (1989) have estimated daily milk intake by calves between birth and 80 or 100 days of age at 722–2389 ml using a double isotope technique. The volume of milk removed from our cows immediately before the 4 hour separation averaged 371 ml but ranged up to 960 ml. This finding indicates a substantial amount of residual milk was being held in the gland which could influence total daily production.

When the present analysis is compared to a commercial source of lamb milk replacer marked differences are noted (Table 2) with fat, protein osmolarity and chlorine. It appears growth rates are being depressed in replacer fed calves because of the reduced intake of both fat and protein. The osmolarity and chlorine differences are of no consequence. The lactose level in muskox milk appears to be similar to that reported in bovine milk. Lactose is therefore not the likely cause of diarrhea in muskox calves fed a bovine-based lamb milk replacer but only when fed at the recommended level of 20 % or lower. The majority of diarrhea cases occuring in our herd have been caused by an E. coli infection in the very young calf and by the rota- and coronaviruses in the older calf. Increasing the solid content of the replacer in table 2 to 25 % results in a mixture containing fat levels which are only 58 % of normal muskox milk, protein levels which are 63 % but lactose levels which are significantly higher at 147 %. These levels of lactose could account for

Table 2. Variation in the composition of a lamb milk replacer* compared to average muskox milk.

Mixture	Fat %	Protein %	Lactose %	pH	Osm mmol/kg	Na	K mmol/L	Cl
Muskox milk	9.4	7.3	4.35	6.39	313	39	34	20
16.7 % solids	3.9	3.3	4.59	6.76	324	39	30	27
20 % solids**	4.8	4.0	5.61	6.74	387	44	35	31
25 % solids	5.5	4.6	6.43	6.68	478	52	43	36

* Wet Nurse, lamb milk replacer. Prairie Microtech Inc. Regina, Sk. Canada. Contains: 30 % crude fat, 24 % crude protein from bovine milk sources.
** Recommended mixture (1 part powder to 2.5 parts water).

the diarrhoea reported in the literature (Frisby *et al.* 1984). Improvements to these replacers could be made by increasing the concentration of fat and protein but decreasing the lactose content. The quality of fat in the replacers has not been examined but needs consideration in future studies.

References

Altman, P. L and **Dittmer, D. S.** (eds.) 1961. Blood and other body fluids. – *Federation of American Society of Experimental Biology, Washington.*

Chaplin, R. K. 1984. Nutrition, growth and digestibility in captive Muskox calves. – *Biological Papers of the University of Alaska Special Report* No. 4: 195 (abstr.).

Chaplin, R. K. 1989. Growth rates of captive Banks Island Muskoxen. – *Canadian Journal of Zoology* 67: A54–A55.

Frisby, K., White, R. G. and **Sammons, B.** 1984. Food conversion efficiency and growth rates of hand-reared muskox calves. – *Biological Papers of the University of Alaska Special Report* No. 4: 196–202.

Mepham, T. B. 1987. *Physiology of lactation.* – Open University Press. pp. 30–50.

Jacobson, N. L. and **McGillard, A. D.** 1984. The mammary gland and lactation. – *In:* Swenson, M. J. (ed.) *Dukes' Physiology of Domestic Animals.* Tenth ed. Cornell University Press, N. Y., USA. pp. 863–880.

Parker, K. L., White, R. G., Gillingham, M. P. and **Holleman, D. F.** 1990. Comparison of energy metabolism in relation to daily activity and milk comsumption by caribou and muskox neonates. – *Canadian Journal of Zoology* 68: 106–114.

Perrin, D. R. 1958. The chemical composition of the colostrum and milk of the ewe. – *Journal of Dairy Research* 25: 70–74.

Tiplady, B. A. and **White, R. G.** 1989. Nursing behavior of muskoxen and its relationship to milk intake. – *Canadian Journal of Zoology* 67: A56–A57.

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