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COMPOSITION OF PREPARTUM MAMMARY SECRETIONS OF TWO BOWHEAD WHALES (*BALAENA MYSTICETUS* L.)

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ABSTRACT: Mammary secretions from two bowhead whale (*Balaena mysticetus* L.) females carrying near-term fetuses were analyzed for dry matter, ash, protein, fat, carbohydrate and energy content. Protein values ranged from 75.9% to 97.3% of dry matter. Fat ranged from 0.6% to 9.1% of dry matter. A protein corresponding to beta-lactoglobulin on gel filtration chromatography was the predominant whey protein. Neutralizing antibodies to nine caliciviruses were detected in one sample. Composition of these two samples differs from previous reports for cetacean milk, perhaps due to the stage of lactation.

Key words: Bowhead whale, *Balaena mysticetus*, cetacean, milk, colostrum, calicivirus.

INTRODUCTION

The bowhead whale (*Balaena mysticetus* L.) is a large baleen whale inhabiting the arctic seas along the pack ice margins (Reeves and Leatherwood, 1985). Migrations of the Bering-Chukchi-Beaufort Seas stock of bowhead whales bring them close to the northern and northwestern Alaska (USA) shore, where they have been subject to subsistence hunting by coastal Alaskan Eskimos for ≥2,000 years (Marquette and Bostoce, 1980). Since the late 1970's major efforts have been directed at estimating population size so as to provide a firm guide for setting levels of subsistence harvest. The population is estimated at between 6,400 and 9,200 (mode 7,500) and increasing (Zeh et al., 1991; International Whaling Commission, 1992). Examination and sampling of dead animals have provided the basis for morphological, microbiological, and toxicological studies (Haldiman et al., 1985; Byrne et al., 1985; Tarpley et al., 1987; Shotts et al., 1990). Mammary secretions from two females carrying near-term fetuses were examined with the objective of identifying the nutritional and immunological components of bowhead whale milk which could affect neonatal survival of calves. At this stage of lactation the mammary secretions would be more properly termed colostrum or pre-colostrum; however, for the sake of clarity they will be referred to as milk throughout this paper.

MATERIALS AND METHODS

Milk was collected from two bowhead whales killed near Barrow, Alaska (71°17′N, 156°46′W). Whale 87B5, taken on 15 June 1987, was 15.7 m long and contained a 405 cm fetus. Whale 89B2, taken on 15 May 1989, was 14.7 m long and contained a 401 cm male fetus weighing 1,045 kg. In both cases large quantities of milk flowed spontaneously from the teats when the whales were pulled onto the ice; no milking or incising of the mammary glands was necessary for collection. The milk of both whales was viscous, bitter, clear and straw-colored. The milk was collected by free catch in polyethylene bottles and frozen at −20 C until shipped on dry ice to cooperating laboratories in June 1989.

Dry matter (DM), ash, fat, protein and energy content of the samples were determined for each animal by the methods of Horwitz (1980) at the National Zoological Park Nutrition Laboratory, Washington, D.C.; carbohydrates were estimated by subtracting ash, protein and fats from total DM. Duplicate readings were made for each value. Whey fraction proteins from animal 89B2 (the only one from which an adequate sample volume was obtained) were separated by gel filtration chromatography (Pervais and Brew, 1986) at the University of Miami, Department of Biochemistry and Molecular Biology, Miami, Florida (USA); only qualitative analyses were performed.

Milk from animal 89B2 was screened against a panel of orthomyxoviruses (A/Whale/ME/328/84 [H13N2], A/Gull/MD/704/77 [H13N6], A/Seal/MA/1/80 [H7N7], A/Gull/MD/1824/78 [H13N9]) in hemagglutination-inhibition and neuraminidase-inhibition assays (Palmer et al., 1975), at the School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin (USA). It also was screened by tissue culture virus neutralization (Monto and Bryan, 1974; Smith et al., 1976) against panels of marine caliciviruses and vesicular exanthema of swine viruses (San Miguel Sea Lion Viruses [SMSV] 1 through 13, Vesicular Exanthema of Swine Viruses [VESV] A through K and 1934B, dolphin calicivirus, walrus calicivirus and mink calicivirus) at the Plum Island Foreign Animal Disease Diagnostic Laboratory, Greenport, New York (USA) and the Calicivirus Research Laboratory, College of Veterinary Medicine, Oregon State University, Corvallis, Oregon (USA).

RESULTS

Based on mean (±SE), samples were comparable in DM (26.1 ± 0.067% for 87B5, 28.5 ± 0.025% for 89B2), and were high in protein (75.9 ± 0.21% of DM for 87B5, 97.3 ± 1.7% of DM for 89B2) and low in fat (9.1 ± 0.7% of DM for 87B5, 0.6% [single value] of DM for 89B2). Other milk composition values for 87B5 and 89B2, respectively, were as follows: ash 4.6 ± 0.08% of DM and 2.3 ± 0.04% of DM, estimated carbohydrates 12.5% of DM and 0% of DM, energy content 5502.7 ± 188.8 calories/g DM and 5273.8 ± 9.4 calories/g DM. Using acid precipitation of the samples, there was very little casein to separate from the whey fraction of protein. There were two main peaks of whey proteins from 89B2 corresponding to beta-lactoglobulin (estimated 90% of total whey) and lysozyme (estimated 10% of total whey). A very faint band corresponding to immunoglobulins also was discernible.

Milk from 89B2 was negative for antibodies to all orthomyxovirus types tested. Antibiody titers of 1:10 were found for SMSV 1, 4, and 8; and titers of <1:10 were detected for SMSV 9 and 10; mink calicivirus; VESV B, C and 1934B.

DISCUSSION

Milk composition has been determined for about 14 of an estimated 84 cetacean species based primarily on whaling kills and beached animals (Oftedal, 1984). Precise stage of lactation in these cases usually is unknown (Oftedal, 1984), except for some small cetaceans kept in public aquaria (Pervais and Brew, 1985); however, it is roughly inferred as late lactation when an embryo (as opposed to near term fetus) is present in utero (Dosako et al., 1987), or when a nearly grown calf is present at time of capture (Shaw, 1971). Bowhead whale milk has not previously been analyzed at any stage of lactation. Although some might exclude these samples from consideration as lactational based on semantic grounds because the calves were not yet suckling, the phenomena of mammary gland enlargement ("bagging up") and prepartum secretions ("waxing") are well known signs of impending parturition and represent an important, if generally overlooked, stage of the lactation cycle.

Reported cetacean milk samples, presumably from nursing whales, usually are high in DM (30 to 60%) and fat content (65 to 89% of DM) (Oftedal, 1984), in contrast to the low fat contents of these bowhead samples. The gross texture, taste, color, and high protein and low fat content of these bowhead mammary secretions were more similar to bovine colostrum (Johnson, 1974) than to reported cetacean milk samples (Oftedal, 1984). This is not surprising given the very early stage of lactation these samples represent. However, the high protein levels found in these bowhead samples did not correspond to high immunoglobulin levels as reported for bovine colostrum (Swenson, 1977; Miller, 1979). There was only a trace of immunoglobulins present in the 89B2 sample; beta-lactoglobulin probably was the predominant protein. Beta-lactoglobulin has been reported in ruminant, porcine, equine, canine, Florida manatee (*Trichechus manatus latirostris*), and bottlenose dolphin (*Tursiops truncatus*) milk (Pervais and Brew, 1986), as well as Stejneger's beaked whale (*Mesoplodon stejnegeri*) milk (Ullrey et al., 1984). It may aid intestinal absorption of vitamin A (Pervais and Brew, 1985) in animals where placental transfer of vitamin A is inefficient (Swenson, 1977).

The chemical compositions of the two milk samples were relatively similar. The differences may reflect different stages of lactation: composition of bovine mammary secretions changes most rapidly within the first 5 days postpartum (Johnson, 1974) and it is reasonable to assume that similar, if not more rapid, changes would occur in the mammary gland as secretory activity increases immediately prepartum. Estimation of carbohydrates by subtraction, which is less precise than direct determination, may contribute somewhat to the observed differences in carbohydrates (12.7% vs. 0% DM).

Neutralizing antibodies have been detected in bowhead whale serum against five caliciviruses: SMSV 5, 8 and 10, and VESV J and K (Smith et al., 1987). Type specific serum antibodies to various caliciviruses have been detected in other cetaceans (Smith et al., 1989; Akers et al., 1974; Smith et al., 1983); influenza viruses (orthomyxoviruses) have been isolated from or suspected in some additional cetaceans (Ridgway, 1979; Hinshaw et al., 1986). Because of the early stage of lactation and the gross similarities of the bowhead samples to bovine colostrum, I thought they might yield antibody titers to known marine viral antigens. In light of the unexpectedly low immunoglobulin levels (in comparison to bovine colostrum) found in the 89B2 sample, the titers detected against the various caliciviruses may be more significant than they appear initially. Arguing conservatively that the 1:10 titers represent prior exposure to the indicated caliciviruses, two caliciviruses (SMSV 1 and 4) are added to the list of those for which neutralizing antibodies have been found in bowhead whales (Smith et al., 1987). If all detectable titers are specific, SMSV 9, VESV B, VESV C, VESV 1934B, and mink calicivirus also would be additions to the list; this is the first evidence for an oceanic presence for VESV B and VESV 1934B (Smith et al., 1989).

Conclusions concerning the implications for neonatal bowhead whale survival based only on one or two prepartum milk samples are highly speculative. However, I propose that the initial meal of a bowhead whale calf may be designed to overcome placental obstacles in the transfer of vitamin A and immune globulins with activity against some known marine viral pathogens, and that the high calorie and high fat meals required for long term survival in the arctic aquatic environment may be of secondary importance. Opportunities to obtain optimal samples to corroborate this conjecture will be exceedingly rare.

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