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A COMPARISON OF THE MINERAL COMPOSITION OF MILK OF DOMESTIC AND CAPTIVE WILD EQUIDS (*EQUUS PRZEWALSKI, E. ZEBRA, E. BURCHELLI, E. CABALLUS, E. ASSINUS*)

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Abstract—1. Milk samples were obtained in early and/or late lactation from Przewalski horses, Hartmann's zebras, Grant's zebras, domestic horses, ponies and a mule mare made pregnant by embryo transfer.

2. Samples were compared for their content of total solids, ash, calcium, phosphorus, magnesium, sodium, potassium, copper, zinc and iron.

3. Milk from the Przewalski horses, Hartmann's zebra and the domestic horse had similar mineral composition and the content of minerals was higher in early than in late lactation.

4. Milk from the domestic mule contained the lowest concentration of calcium, phosphorus and zinc but the highest concentration of magnesium, sodium and potassium.

5. Milk from the Grant's zebras contained more sodium than potassium, unlike milk from Przewalski horses, Hartmann's zebras or domestic horses in which there was more potassium than sodium.

INTRODUCTION

It is often assumed that the milk of wild equids is similar in composition to that of the domestic horse. However, reviews of the composition of mare's milk by Neseni *et al.* (1958) and Oftedal (1981) contain few references to the milk of wild equids. In particular, there is little knowledge of the mineral composition of wild equid milk. Such information is needed to understand the nutrition of wild equids and their young and for developing formulas for hand raising orphan young.

MATERIALS AND METHODS

Milk samples were obtained from lactating, captive wild equids when the animals were restrained or tranquilized for medical procedures at the San Diego Wild Animal Park and at the National Zoological Park. Samples of 20–60 ml were obtained by hand milking. Early lactation milk was obtained from a Przewalski horse (*Equus przewalski*) at 6 days post partum and from a Hartmann's mountain zebra (*Equus zebra hartmannae*) at 5 and 12 days post partum. Late lactation milk samples were taken at about 85–250 days post partum from 5 Przewalski horses, 6 Hartmann's mountain zebras, and 3 Grant's zebras (*Equus burchelli boehmi*). Milk was also obtained in early lactation from a mule mare (*Equus caballus* × *Equus assinus*) that had foaled after receiving a horse embryo transplant (Davis *et al.*, 1985). Milk was also taken from 5 domestic thoroughbred mares and from 5 Shetland pony mares (*Equus caballus*) from 6 to 120 days of lactation. Foals were prevented from nursing for about 1 hr. The mare was then given 20 IU of oxytocin and one side of the mammary gland evacuated by hand milking. Sample size from the mule mare and the horse mares averaged 500 ml and averaged 120 ml from the pony mares. Details of the procedures for obtaining mare's milk is given by Oftedal *et al.* (1983).

Milk was stored at −20°C until analyzed. Total solids concentration was determined after drying 5 g of milk at 100°C for 5 hr. These samples were then ashed at 550°C overnight in a muffle furnace and the ash taken up in 3 N HCl. Magnesium, copper and zinc were determined by flame atomic absorption spectrophotometry. Calcium was determined by the same method in the presence of lanthanum chloride. Iron was estimated by flameless atomic absorption spectrophotometry using a graphite furnace. Sodium and potassium were measured by flame emission spectrophotometry and phosphorus by stannous chloride hydrazine reduction of phosphomolybdic acid.

RESULTS AND DISCUSSION

Milk taken in early lactation (6–14 days) from the Przewalski mares, Hartmann's zebra and domestic horse mares contained a higher content of total solids, ash, calcium, phosphorus, magnesium and potassium than late lactation milk from these species (Table 1). Early lactation milk samples from the mule mare and the Shetland pony mares contained the lowest content of total solids and ash. In addition, early lactation milk taken from the mule mare contained the lowest concentration of calcium, phosphorus and zinc and more closely resembled late lactation milk obtained from the other equids rather than early milk. On the other hand, the mule milk had a higher content of magnesium, sodium and potassium than milk from the other species.

Late lactation milk from the Przewalski mares, Hartmann's zebra and domestic horse mares had

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Table 1. Mineral composition of milk of various species of equids

Species	Animals	Observations	Total solids	Ash	Ca	P	Mg	Na	K	Cu	Zn	Fe
			%		μg/g whole milk							
Early lactation												
Przewalski horse	1	1	11.6	0.58	1380	790	104	220	590	0.42	4.1	1.3
Hartmann's zebra	1	2	11.3	0.50	1100	800	120	290	590	1.13	2.4	1.1
Domestic mule	1	1	10.1	0.48	762	530	150	335	845	0.37	1.1	0.7
Domestic horse	5	15	11.6	0.58	1327	884	102	198	655	0.64	2.7	0.37
			0.50	0.05	120	68	12	73	112	0.23	0.49	0.12
Domestic pony	2	2	9.6	0.48	1036	600	70	189	483	0.26	1.8	—
Late lactation												
Przewalski horse	5	14	10.3	0.33	804	419	62	137	344	0.23	1.9	1.1
			0.65	0.045	148	62	12	35	112	0.078	0.56	0.65
Hartmann's zebra	6	7	10.0	0.32	840	550	80	200	422	0.26	1.9	3.6
			0.23	0.038	176	76	20	22	56	0.10	0.32	2.4
Grant's zebra	3	3	10.7	0.35	690	490	93	277	187	1.0	2.9	2.2
			1.28	0.053	75	46	24	15	45	0.34	0.95	1.2
Domestic horse	5	25	10.2	0.36	811	566	53	140	410	0.25	1.9	0.27
			0.45	0.04	111	45	9	38	76	0.10	0.39	0.08
Domestic pony	5	26	9.4	0.36	857	418	77	127	250	0.37	1.7	—
			0.73	0.056	131	57	49	37	93	0.11	0.55	

Values are means ± SE. The latter are shown in small figures.

similar concentrations of total solids, ash, calcium, phosphorus, magnesium, sodium, potassium, copper and zinc. The total solids content of domestic pony mare milk was lower than that of other equids. Domestic horse, mule, pony, Przewalski horse and Hartmann's zebra milk taken in early or late lactation had 2–3 times as much potassium as sodium. The opposite was found in milk from the Grant's zebra which contained 1.5 times as much sodium as potassium. Milk from the captive wild equids contained more iron than milk from the domestic equids.

The values that we present here agree with the findings of Ullrey *et al.* (1966) and Bouwman and van der Schee (1978) for total solids, ash and macromineral composition of the milk of domestic mares and with the findings of Ely *et al.* (1972) for the micromineral composition of mare's milk. Our values for the total solids of pony milk agree with those of Lukas *et al.* (1972) but are about 10% lower than the values reported by Linton (1931) and by Pagan (1982). However, Pagan noted that the total solids of pony milk was influenced by energy intake and by the pony mare's body size. Smaller mares produced milk with lower total solid content.

There is very little information on the mineral composition of milk from equids other than horses and those that we report here. Anantakrishnan (1941) reported from India that ass's milk contained 7.8–9.1% total solids, 0.40% ash, 810 μg Ca/g and 590 μg P/g. Similar values for total solids and ash of ass's milk are given by Winkley (1930), Davis (1939) and Ben Shaul (1962). These results suggest that ass's milk contains less total solids but a greater concentration of minerals (ash) than milk from other equids. King's (1965) report of the composition of milk of a Grevy's zebra taken 3 months post partum suggest that the milk of this species may resemble ass's milk. Grevy's zebra milk contained 8.1% total solids, 0.35% ash, 680 μg Ca and 100 μg Mg, 350 μg Na and 720 μg K/g of whole milk. Ben Shaul (1962) who compiled a list of analyses of milk of wild animals gives the total solids and ash content of zebra milk (species not given) as 13.8% and 0.7%, respectively. These findings are considerably higher than ours but are similar to mare's milk at partum before the foal has nursed. Masek (1938) reported the total solids and ash content of a sample of milk from a Przewalski horse to be 10.5% and 0.35%, respectively.

The data presented here show that the milk of equids taken as a group has certain similarities such as a relatively low content of total solids. The data also indicate that there are specific similarities between certain equine species. For example, the mineral composition of late lactation milk of Przewalski horse, Hartmann's zebra and the domestic horse appears to be similar. Moreover, data from the literature suggest that ass's milk and Grevy's zebra milk may have a similar mineral composition (Anantarkrishnan, 1941 and King, 1965). Although differences exist in the composition of milk of various species of equid, there is no reason to think that one milk replacer based on analyses of domestic equine milk would not be adequate for all equines.

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REFERENCES

Anantakrishnan C. P. (1941) Studies on ass's milk. *J. Dairy Res.* **12**, 119–130.

Ben Shaul D. M. (1962) The composition of the milk of wild animals, In *International Survey of Hand-Rearing Techniques and Animal Milk Analyses* V. (Edited by Lyall-Watson). From *International Zoo Yearbook* **4**, 333–342.

Bouwman H. and van der Schee W. (1978) Composition and production of milk from Dutch warmblooded saddle horse mares. *Z. Tierphysiol, Tierernähr. Futtermittelk.* **40**, 39–53.

Davis C. J., Antczak D. F. and Allen W. R. (1985) Reproduction in mules: Embryo transfer using sterile recipients. *Eq. Vet. J.* **3**, 63–67.

Davis W. L. (1939) *The Chemistry of Milk*. Van Nostrand, New York.

Ely W. T., Covert R. L. and Ullrey D. E. (1972) Iron, zinc and copper in mare's milk. *J. Animal Sci.* **35,** 1104 (Abstract).

King J. M. (1965) A field guide to the reproduction of the Grant's zebra and Grevy's zebra. *East African Wildlife J.* **3,** 99–117.

Linton R. G. (1931) The composition of mare's milk. *J. Agric. Sci.* **21,** 669–688.

Lukas V. K., Albert W. W. Owens F. N. and Peters A. (1972) Lactation of Shetland mares. *J. Animal Sci.* **34,** 350.

Masek J. (1938) Milk from the wild horse Przewalski. *Chem. Obzov.* **13,** 137–139. Cited in *Chem. Abst.* **33,** 1379, (1939).

Neseni R., Flade E., Heidler G. and Steger H. (1958) Milchleistung und Milchzusammansetzung von Stuten in Verlauf der Laktation. *Tierzucht* **1,** 91–129.

Oftedal O. T. (1981) Milk protein and energy intakes of suckling mammalian young: A comparative study. Ph.D. Thesis, Cornell University, Ithaca, NY.

Oftedal O. T., Hintz H. F. and Schryver H. F. (1983) Lactation in the horse: Milk composition and intake by foals. *J. Nutr.* **113,** 2096–2106.

Pagan J. D. (1982) The digestible energy requirements of lactating pony mares. M. S. Thesis, Cornell University, Ithaca, NY.

Ullrey D. E., Struthers R. D., Hendricks D. G. and Brent B. E. (1966) Composition of mare's milk. *J. Animal Sci.* **25,** 217–222.

Winkley W. (1930) *Handbuck der Milchwirtschaft*, Vol. 1, p. 22. Springer, Vienna.