COMPARISON OF PROXIMATE COMPOSITION OF DOMESTIC CAT (*FELIS CATUS*), CLOUDED LEOPARD (*NEOFELIS NEBULOSA*), SNOW LEOPARD (*UNCIA UNCIA*), AFRICAN LION (*PANTHERA LEO*), AND SUMATRAN TIGER (*PANTHERA TIGRIS SUMATRAE*) MATERNAL MILK WITH EXOTIC CAT HAND-REARING FORMULAE

Katie L. Murtough, BS,[1]* Michael L. Power, PhD,[1, 2] Mike Maslanka, MS[1]

[1]Nutrition Laboratory, Smithsonian Conservation Biology Institute, National Zoological Park, Washington DC
[2]Research Department, American College of Obstetricians and Gynecologists, Washington DC

Introduction

The ability to produce milk is a trait unique to mammalian mothers. Milk acts as an external pathway of communication between mother and offspring, continuing the vital exchange of nutrients that was previously facilitated in utero by the placenta. The composition of maternal milk directly impacts the development trajectory of a nursing offspring as any milk constituent deficiencies could result in developmental pathologies such as nutritional and inadequate or inappropriate growth.[2] Thus it is important to recognize that even amongst closely related species, differences in lactation strategies often produce differences in milk composition.

Animals born in captivity sometimes require nutritional intervention if maternal milk is not an option. In such a situation, the knowledge of that species' milk composition is integral in producing comparable milk replacer formulae. The domestic cat (*Felis catus*), a well-studied species in the commercial industry, is typically used as a model for exotic felids.[1] Commercial hand-rearing formulae developed for the domestic cat are therefore commonly employed for captive exotic felids. However, little is known about the actual maternal milk composition of exotic felids and how it compares to the composition of hand-rearing formulae.

The aims of this study are (1) to compare proximate composition of milks of five felids, the domestic cat (*Felis catus*), clouded leopard (*Neofelis nebulosa*), snow leopard (*Uncia uncia*), African lion (*Panthera leo*), and Sumatran tiger (*Panthera tigris sumatrae*) to establish if there exist species-specific differences in felid maternal milk composition, (2) to conduct proximate analyses on commercial hand-rearing formulae commonly used by zoological institutions for clouded leopards, snow leopards, African lions, and Sumatran tigers, (3) to compare the maternal milk compositions of the before-mentioned felids against the compositions of the selected hand-rearing formulae, and (4) to provide exotic felid hand-rearing formulae recommendations to the zoological community.

Methods

The maternal milk samples used in this study were part of the Smithsonian National Zoological Park's Milk Repository. These milks were comprised of 14 wild African lion samples collected from 14 individuals representing days 11 through 131 post-partum, 3 captive clouded leopard samples from 2 individuals days 1 through 2 post-partum, 1 captive snow leopard colostrum sample, and 1 captive Sumatran tiger colostrum sample. Averaged domestic cat (N=11) maternal milk data reported in this study are from Jacobsen, DePeters, Rogers and Taylor, 2004 (Table 1).[6] Maternal milks and commercial hand-rearing formulae were assayed for dry matter, crude protein, fat, sugar, and ash using verified methods employed at the Smithsonian National Zoological Park's Nutrition Lab.

As part of this study a survey was distributed through the Nutritional Advisory Group forum asking zoo professionals to provide their exotic felid hand-rearing formulae and recipes. Specific hand-rearing recipes will be selected from the survey responses and subsequently replicated and analyzed in the Smithsonian National Zoological Park's Nutrition Lab. Proximate analyses on commonly used commercial formulae, KMR® (Kitten Milk Replacer) liquid and powder and Zoological Milk Matrix 33/40®, have already been completed and are illustrated in Table 2.

Results and Discussion

Our preliminary results for exotic felid maternal milk, illustrated in Table 1, indicate consistently high crude protein and fat levels regardless of stage of lactation. Our proximate analyses of KMR® liquid formula agree with those of Edwards and Hawes, 1997 (Table 2).[3] From the domestic and exotic felid maternal milk (Table 1) and KMR® liquid formula (Table 2) we note differences in the average fat content of felid milk to that of KMR® liquid formula as well as a higher crude protein values in felid milk versus the liquid formula. For this reason, powder formulae may be a more preferable option as the ratio of powder to water can be more readily adjusted to correlate with the dry matter composition of maternal milk.

Fat and protein content of milk is associated with body growth rates for developing offspring[5] and disparities in these nutrients between maternal milk and liquid or powder hand-rearing formulae could account for the slower growth rates sometimes observed in hand-reared felids.[4] When using commercial formulae and or developing unique recipes it is important to the offspring's development that the normal maternal milk composition for that species be well understood in order to decrease the likelihood of nutritional deficiencies. It is our hope that these exotic felid maternal milk data provide a solid foundation from which successful hand-rearing methods can continue to evolve.

Literature cited

1. Bell KM et al. (2011). Evaluation of two milk replacers fed to hand-reared cheetah cubs (*Acinonyx jubatus*): nutrient composition, apparent total tract digestibility, and comparison to maternal cheetah milk. *Zoo Biology*. 30:412-426.
2. Cooley PL. (2001). Phacoemulsification in a clouded leopard (*Neofelis nebulosa*). *Veterinary Ophthalmology*. 4, 2:113-117.
3. Edwards MS, Hawes J. (1997). An overview of small felid hand-rearing techniques and a case study for Mexican margay (*Leopardus wiedii glaucula*) at the Zoological Society of San Diego. *Int. Zoo Yb*. 35:90-94.
4. Grant K. (2005). Hand-rearing cheetah (*Acinonyx jubatus*) cubs: milk formulas. *Animal Keeper's Forum*. 7, 8:294-302.

5. Hinde K, Milligan LA. (2011). Primate milk: proximate mechanisms and ultimate perspective. *Evolutionary Anthropology*. 20:9-23.
6. Jacobsen KL et al. (2004). Influences of stage of lactation, teat position and sequential milk sampling on the composition of domestic cat milk (*Felis catus*). *J. Anim. Physiol. A. Anim. Nutr*. 88:46-58.

Table 1. As-fed basis comparison between the maternal milk composition of the domestic cat, clouded leopard, snow leopard, African lion, and Sumatran tiger. Nutrient data expressed as a percent of total milk.

Nutrient	Domestic Cat[1]	Clouded Leopard*	Snow Leopard*	African Lion*	Sumatran Tiger*
Dry Matter	27.9	25.3	24.0	23.6	27.7
Protein	8.7	15.1	14.7	12.0	13.4
Fat	12.7	6.8	4.6	5.6	10.2
Sugar	4.2	2.2	2.9	3.2	2.0
Ash	1.3	0.67	0.65	0.97	0.88

[1] Data reported in Jacobsen et al. (2004).
*Denotes data generated by the Smithsonian National Zoological Park's Nutrition Lab

Table 2. As-fed basis comparison between commercial hand-rearing formulae commonly used for exotic felid hand-rearing. Nutrient data expressed as a percent of total milk.

Nutrient	KMR® Liquid[1]	KMR® Liquid*	KMR® Powder[2]*	Milk Matrix 33/40® Powder[3]*
Dry Matter	19.3	18.5	28.9	32.3
Protein	7.7	7.6	13.3	12.1
Fat	4.7	4.7	7.7	11.3
Sugar	4.7	2.2	5.1	4.5
Ash	1.18	0.67	1.2	1.82

[1]Data reported in Edwards and Hawes (1997)
[2] KMR® Powder : Water (1:1)
[3]Zoologic Milk Matrix 33/40® : Water (1:2)
*Denotes data generated by the Smithsonian National Zoological Park's Nutrition Lab