

## FEED INTAKE, DIET UTILIZATION, AND COMPOSITION OF BROWSES CONSUMED BY THE SUMATRAN RHINO (*Dicerorhinus sumatrensis*) IN A NORTH AMERICAN ZOO

Ellen S. Dierenfeld, Ph.D, CNS<sup>1</sup>, Robert E. C. Wildman, PhD<sup>2</sup>, and Steve Romo<sup>3</sup>

<sup>1</sup>Department of Nutrition, Wildlife Conservation Society, Bronx, NY 10460; <sup>2</sup>Dietetics Program, University of Southwestern Louisiana, Lafayette, LA 70504; <sup>3</sup>Cincinnati Zoo & Botanical Garden, Cincinnati, OH 45220

Similar to other browsing rhinos in North American facilities, health of the Sumatran or "hairy" rhinoceros (*Dicerorhinus sumatrensis*) in captivity appears strongly linked to dietary husbandry.<sup>1</sup> Stool consistency problems, gastric torsion, and metabolic imbalances have been reported (M. Campbell, Sumatran Rhino Veterinary Advisor, personal communication), possibly due to inappropriate captive diets. After prolonged diet refinement to improve stool consistency, recommended feeding management included high-fiber herbivore pellets, mixed grass/legume hay, and available browses such that diets more closely duplicated natural forage composition.<sup>2</sup> This study was conducted to evaluate the chemical composition and utilization of diets fed to captive Sumatran rhinos in North America in an effort to better define diet suitability for improved captive dietary management and nutrition of the species.

Three consecutive 5-day feeding trials (15 days, broken into three 5-day analytical periods) were conducted on three (2.1) Sumatran rhinos housed individually indoors (January, 1997) at the Cincinnati Zoo. Normal zoo routines were not significantly altered during the trials. Body weight, total wet fecal mass, and dietary intake were measured daily on each animal. Diet ingredients and amounts fed are displayed in Table 1. Representative samples of all foods and feces were obtained and subjected to chemical analyses using standardized techniques. Dry matter intake (DMI) for Sumatran rhinos in this trial ranged from 0.64 to 1.13% of body mass. Rhinos consumed produce first followed (in order) by browse, pellets and hay. Produce and pellets were consistently and completely consumed, whereas some hay and browse remained for each rhino on various days. Produce contributed only 5% to 9% of DMI, whereas pellets made up 10% to 17% of DMI in these trials. Browse contributed by far the majority of nutrients to the diets in this study -- 62% to 83% of DMI. Rhinos ate between 50 and 70% of browse offered, in a proportion of 2/3 leaf to 1/3 twig. Hay contributed 14% of one female's diet compared with 2 to 7% for the male and other female, respectively. Total nutrient composition of the diets, weighted by percentage intakes for each individual rhino, are presented in Table 2, along with comparisons of recommended dietary nutrients for horses.<sup>3</sup> Digestion coefficients are found in Table 3. Within-animal differences were not found among trial periods, but differences among individuals were seen.

The two female rhinos in this study ate somewhat less dry matter than reported from other studies with this species (expected approximately 1% of body mass).<sup>4</sup> While good body condition was maintained throughout the trials in all animals, the rhinos displayed clear individual food preferences which resulted in differences in the nutrient composition of diets consumed (Table 2) as well as their utilization (Table 3).

The DM digestibility (DMD) of diets consumed by the Sumatran rhinos in Cincinnati (52%) was lower than that reported for Sumatran rhinos fed native browses (65%, leaves only; Michael, unpublished report). Given the composition of native food plants eaten, excessively digestible diets are not considered appropriate for browsing rhinoceros species in captivity. The high proportion of browse in the current diet likely contributed to the DMD coefficients. Lignification of cell wall constituents lowers digestibility, as lignin is defined as a chemically unavailable fiber fraction. The overall diets consumed by these rhinos were about 31% lignified (acid lignin as a proportion of NDF), which compares favorably to the average lignification index of the browses offered (32%) as well as native browses eaten by Sumatran rhinos (27%) in Indonesia.<sup>2</sup> The Cincinnati Zoo currently maintains the only Sumatran rhinos in captivity in North America and is one of only a few facilities to maintain this species globally. The inclusion of a high proportion of subtropical browse in the diets appears to contribute to the successful maintenance of this species at Cincinnati. Nonetheless, possible nutritional imbalances were identified from this detailed study. The browses offered, and particularly the preferred species, *F. benjamina*, appear low in available protein (crude protein minus AD-CP) compared with both native Indonesian browses and equine nutrient requirements. Thus overall diets consumed by Sumatran rhinos in the Cincinnati Zoo appeared marginal in protein and Zn content, and possibly low in Cu, but must be extrapolated with caution as the consumption of trace mineral salt supplements, available free-choice, was not quantified.

## Literature Cited

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Table 1. Diets offered to Sumatran rhinoceros (*Dicerorhinus sumatrensis*) during feeding trials at the Cincinnati Zoo, Cincinnati, OH, USA, 1997.

Feeding	Individual	Diet Component	Amount
AM Diet:	All Rhinos	<i>Ficus benjamina</i> (FL origin)	1/3 box
		Orchard grass/alfalfa mix hay	1 flake
		Bananas with peel	7 bananas
		Apples	7 apples
		Vitamin E supplement <sup>1</sup>	3000 I.U.
PM Diet:	Male	<i>Ficus benjamina</i> (FL origin)	1 box
		<i>Ficus</i> spp. (CA origin)	1 box
		Orchard grass/alfalfa mix hay	2 flakes
		Herbivore pellets <sup>2</sup>	1.8 kg
		Bananas with peel	8 bananas
		Apples	8 apples
	Female 1	<i>Ficus benjamina</i> (FL origin)	1/3 box
		<i>Ficus</i> spp. (CA origin)	1 box
		Orchard grass/alfalfa mix hay	2 flakes
		Herbivore pellets <sup>2</sup>	1.8 kg
		Bananas with peel	8 bananas
	Female 2	<i>Ficus benjamina</i> (FL origin)	2/3 box
		<i>Ficus</i> spp. (CA origin)	1 box
		Orchard grass/alfalfa mix hay	2 flakes
		Herbivore pellets <sup>2</sup>	1.8 kg
Bananas with peel		8 bananas	
	Apples	8 apples	

<sup>1</sup>Emcelle vitamin E, Stuart Products, Bedford, TX, USA

<sup>2</sup>Mazuri ADF-16 large pellets, PMI, St. Louis, MO, USA

Table 2. Chemical composition of diets consumed by Sumatran rhinos (*Dicerorhinus Sumatrensis*) in three 5-day feeding trials at the Cincinnati Zoo, 1997. All nutrients except water expressed on a dry matter basis.

Nutrient	Male	Female 1	Female 2	Horse Reqt. <sup>1</sup>
Water, %	49.1	41.7	44.3	n.a.
Crude Protein, %	9.0	9.9	9.7	8.0 - 13.0
AD-CP, %	2.5	2.1	2.2	n.a.
Crude Fat, %	0.6+	1.3+	1.2+	n.a.
NDF, %	44.1	42.5	41.7	n.a.
ADF, %	38.7	35.1	35.1	n.a.
Acid lignin, %	15.1	12.4	13.0	n.a.
Ash, %	12.0	11.0	11.1	n.a.
Ca, %	2.6	2.1	2.2	0.3 - 0.4
K, %	1.2	1.5	1.4	0.3 - 0.4
Mg, %	0.3	0.3	0.3	0.1
Na, %	0.14	0.15	0.15	0.15
P, %	0.2	0.3	0.2	0.2 - 0.3
Cu, mg/kg	6.9	8.3	8.2	10
Fe, mg/kg	103.6	124.7	124.2	50
Mn, mg/kg	42.2	67.7	64.0	40
Mo, mg/kg	1.6	2.1	1.9	n.a.
Se, mg/kg	0.11	0.13	0.13	0.1
Zn, mg/kg	28.4	37.6	37.9	40

<sup>1</sup>Reqt. for maintenance and reproduction, National Research Council, 1989.

Abbreviations: NDF = neutral detergent fiber, ADF = acid detergent fiber, AD-CP = acid detergent crude protein.

n.a. = not available

Table 3. Digestion coefficients calculated for Sumatran rhinos (*Dicerorhinus sumatrensis*) from three 5-day feeding trials at the Cincinnati Zoo, 1997. Expressed on a dry matter basis.

Nutrient	Male	Female 1	Female 2
Dry Matter, %	52.90	53.36	50.56
Crude Protein, % apparent	35.31	43.18	48.66
Crude Protein, % true	81.44	90.79	89.69
Metabolic Fecal N, %	0.66	0.76	0.64
NDF, %	36.49	27.51	21.92
HC, %	68.35	25.74	43.49
ADF, %	32.04	27.89	17.89
Cellulose, %	37.45	28.80	16.40
Acid lignin, %	20.42	26.21	23.58

Abbreviations: NDF = neutral detergent fiber, HC = hemicellulose, ADF = acid detergent fiber