FEED INTAKE AND ANALYSIS OF BROWSE FED TO SUMATRAN RHINOCEROS (*DICERORHINUS SUMATRENSIS*) AT THE CINCINNATI ZOO AND BOTANICAL GARDEN

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Abstract

Even though Sumatran rhinoceros (*Dicerorhinus sumatrensis*) have been exhibited at 4 zoos in the U.S. for about 20 years, the diet is not well defined. Currently, the animals at Cincinnati Zoo & Botanical Garden (CZBG) appear in good health and condition with successful reproduction consuming a diet of the following ingredient proportions: 9-18% produce, 76-83% ficus spp., 3-5% ZNN (Zoo Nutrition Network) herbivore, and 2-4% orchard grass/alfalfa hay as fed. The animals at CZBG consume their diet well but it is quite expensive to feed. Analyses of diets offered and consumed were compared to suggested nutrient levels for captive herbivores and horses indicating a few nutrients were below recommendations. Increasing the nutritionally complete pellet and hay may provide a diet meeting the suggested nutrient levels.

Introduction

CZBG has exhibited the Sumatran rhinoceros since 1989. In the past 6 years CZBG has successfully produced 3 calves. Currently, CZBG is the only zoo to exhibit this species in the U.S. The diet consists mainly of different species of ficus, most recently grown in San Diego California and purchased from San Diego Zoo, with a small quantity of a nutritionally complete pellet, mixed legume/grass hay, and a limited quantity of produce. The diet was analyzed in 1997 using estimates from some ingredient amounts.[2] Considering it is not unusual for diets to drift over time, an updated analyses of all ingredients offered and consumed was warranted. Based on current health and reproduction it was suggested. In addition, a desire for a lower cost diet was communicated considering the cost of shipping in ficus fresh. Reducing the quantity of ficus offered with a corresponding increase in nutritionally complete pellet and hay was suggested. Baseline data was collected before any changes were to be made.

Methods

A seven day diet intake was completed on 1.2 Sumatran rhinoceros (ages ~26, ~19 and 3 respectively) held individually in February of 2007. Food items offered were weighed and orts were measured (Table 1). Additionally animals were weighed daily. Samples of the 2 species of ficus fed during the 7 day collection were collected from 5 boxes as whole plant (combination of leaves, stems/twigs), leaves, and stems/twigs pooled together and frozen at -20°F. Once frozen these samples were sent to Dairy One, Ithaca, NY for analysis of dry matter, ash, protein, fat, fiber constituents (acid detergent fiber (ADF), neutral detergent fiber (NDF), and lignin), and minerals (calcium, phosphorus, magnesium, potassium, sodium, iron). The nutritionally complete pellet and hay were sampled and analyzed by Dairy One, Ithaca, NY for the same nutrients. For the nutrient analysis the leaf to twig ratio for the 2 ficus species offered and not

consumed was based on Dierenfeld et al.[3] The nutrient content of the complete diet was calculated using Zootrition™ (Table 2).

Results and Discussion

Overall, the diet was consumed well by 1.2 Sumatran rhinoceros (Table 1). All animals maintained body weight over the diet consumption period. Dry matter consumption as a percent of body weight was, 2.2, 1.5, and 2.4 respectively, for the adult male, adult female, and 3 year old. The food item not completely consumed was the ficus. As fed the ficus makes up a significant portion of the diet (between 77-85% of the diet offered as fed and 76-83% of the diet consumed) (Table 1). It is not clear as to the exact mechanism the browse plays in the diet nor is it clear if the quantity that was offered is needed for adequate nutrition. In the time the Sumatran rhinoceros have been in captivity in U.S. zoos, a variety of different nutritionally complete diets and hay has been offered with varied browse quantities.[3] The diets at CZBG have not been well documented nor well quantified. The current diet with a large percentage of browse offered, as fed, was formed over the years but the exact quantity of browse that should be offered to maintain good consumption, gastrointestinal health, and body condition is unclear. Thus base line data was obtained prior to making any changes to the diet.

When the nutrient analyses of diets offered and consumed were compared to target nutrients (both multiple herbivore species of the same body type and digestive physiology and horse requirements) vitamin D and thiamin were below target levels.[4,5] The animals have access outside most of the year (typically 10 months) so vitamin D requirement should be met with biosynthesis. However, if the nutritionally complete pellet and mixed grass hay were increased 3-3.5 times in the diet the thiamin would meet the target levels. The vitamin A was 4 times the target levels but that was attributed to the beta carotene in the vegetables consumed. Additionally, the iron was 2-4 times higher than the target level due to the nutritionally complete pellet, mixed grass hay, and ficus.

The ficus species sampled were compared to values published by Dierenfeld in 2000[3] (Table 3). However, Dierenfeld et al. did not report analysis for the whole plant as sampled. The analysis from 2007 for leaves and stems/twigs showed very similar values to that harvested in the late 1990's.[3]

Now that baseline data was collected and analyzed recommendations are being considered to increase the nutritionally complete pellet and mixed grass hay while reducing the ficus.

LITERATURE CITED

1. Campbell, M.K. 2007. Personal Communication.
2. Dierenfeld, E.S., R.E.C. Wildman, and S. Romo. 1999. Feed Intake, Diet Utilization, and Composition of Browses Consumed by the Sumatran Rhino (Dicerorhinus sumatrensis) in a North American Zoo. Proc. AZA NAG Third Conference on Zoo and Wildlife Nutrition. Columbus, OH.

3. Dierenfeld, E.S., R.E.C. Wildman, and S. Romo. 2000. Feed Intake, Diet Utilization, and Composition of Browses Consumed by the Sumatran Rhino (Dicerorhinus sumatrensis) in a North American Zoo. Zoo Biology 19:169-180.
4. Lintzenich and Ward 1997, Hay and pellet ratios: considerations in feeding ungulates, NAG fact sheet 006, www.nagonline.net.
5. National Research Council. 2007. Nutrient Requirement of Horses, 6th revised ed. Washington, DC: National Academy Press.

Table 1. Seven day diet average intake for 1.2 Sumatran rhinoceros (*Dicerorhinus sumatrensis*) as fed

1.0 Ipuh			
Food Item	Offered, kg	Consumed, kg	Consumed, %
Banana	2.69	2.69	100
Apple	2.82	2.82	100
Carrot	0.58	0.58	100
Sweet Potato	0.61	0.61	100
Vitamin E[1]	3.9 g	3.9 g	100
Ficus spp. [2]	40.17	35.83	89.4
ZNN Grain[3]	2.32	2.14	92.1
Hay[4]	1.34	0.88	64.3
Total	50.57	45.58	90.3
0.1 Emi			
Food Item	Offered, kg	Consumed, kg	Consumed, %
Banana	2.64	2.64	100
Apple	2.81	2.81	100
Carrot	0.47	0.47	100
Sweet Potato	0.61	0.61	100
Vitamin E[1]	3.8 g	3.8 g	100
Ficus spp.[2]	30.26	28.22	93.3
ZNN Grain[3]	1.23	1.23	100
Hay[4]	1.30	1.24	95.0
Total	39.36	37.25	94.7
0.1 Suci			
Food Item	Offered, kg	Consumed, kg	Consumed, %
Banana	1.55	1.55	100
Apple	1.19	1.19	100
Carrot	0.51	0.51	100
Sweet Potato	0.53	0.53	100
Vitamin E[1]	2.0 g	2.0 g	100
Ficus spp.[2]	41.23	34.49	83.7
ZNN Grain[3]	1.91	1.91	100
Hay[4]	1.47	1.47	100
Total	48.42	41.68	86.1

[1]Vitamin E supplement was Emcelle Tocopherol made by Stuart Products Inc., Bedford, TX.
[2]Ficus species were *rubiginosa* and *microcarpa* harvested by the San Diego Zoo in San Diego California and shipped to Cincinnati, OH.
[3]Zoo Nutrition Network (ZNN) grain is proprietary formula made for CZBG by Purina Mills, LLC. Richmond, IN.
[4]Hay was a mixture of orchard grass and alfalfa.

Table 2. Nutrient analysis of diets offered and consumed by 1.2 Sumatran rhinoceros (*Dicerorhinus sumatrensis*) on a dry matter basis

	Ipuh		Emi		Suci		Target	Target
Nutrient	offered	consumed	offered	consumed	offered	consumed	Nutrients[a]	Nutrients –Horse[b]
Protein, %	10.4	10.0	10.1	9.9	10.6	10.5	15.54-19.98	5.99-17.04
Fat %	2.6	2.7	2.6	2.6	2.7	2.7	-	-
Vitamin A, IU/g	17.4	19.0	20.1	21.2	15.0	17.4	1.11-3.85	0.84-3.33
Vitamin D, IU/g	**0.16**	**0.16**	**0.11**	**0.11**	**0.13**	**0.15**	0.22-0.55	0.37-0.68
Vitamin E, mg/kg	152	153	140	141	92.3	108	120-350	33.9-100.9
Thiamin, mg/kg	1.5	1.5	**1.1**	**1.2**	**1.2**	1.4	2.22-4.99	1.4-6.9
Riboflavin, mg/kg	2.2	2.3	1.7	1.8	1.8	2.1	2.22	0.93-2.7
Calcium, %	1.4	1.3	1.4	1.3	1.5	1.4	0.22-0.72	0.22-0.65
Phosphorus, %	0.23	0.42	0.21	0.40	0.22	0.43	0.16-0.38	0.16-0.42
Magnesium, %	0.22	0.23	0.22	0.22	0.22	0.23	0.077-0.11	0.04-0.14
Potassium, %	2.1	1.9	2.1	1.9	2.2	1.9	0.29-0.42	0.12-0.59
Sodium, %	0.14	0.16	0.13	0.14	0.14	0.15	0.099-0.29	0.05-0.46
Iron, mg/kg	130	140	121	132	130	143	39-49	23.3-69.3
Zinc, mg/kg	33.2	35.9	28.2	31.1	31.4	35.5	39.9	18.7-55.5
Copper, mg/kg	9.9	8.9	8.5	8.5	8.9	9.0	9.99	4.7-13.8
Manganese, mg/kg	31.3	34.1	30.1	34.9	30.9	38.1	39.9	18.7-55.5
Selenium, mg/kg	0.07	0.07	0.05	0.05	0.06	0.07	0.099	0.05-0.14
Iodine, mg/kg	0.26	0.27	0.18	0.19	0.22	0.25	0.099-0.59	0.17-0.49

[a] Lintzenich and Ward 1997.[4]

[b]Horse NRC 2007 for 600 kg and 900 kg horse assuming 2% body mass consumption converted to 100% dry matter diet.[5]

Table 3. Chemical composition of *ficus rubiginosa* and *microcarpa* browse harvested in San Diego California on a dry matter basis

	F. *rubiginosa*			F. *microcarpa*		
Nutrient	Whole	Leaves	Stems	Whole	Leaves	Stems
Moisture, % as-fed	68.4	67.3	69.7	66.4	68.8	62.2
Protein, %	9.8	12.5	8.2	8.7	9.8	4.7
Acid Detergent Fiber, %	40.4	27.9	47.1	35.6	26.5	52.0
Neutral Detergent Fiber, %	51.9	39.6	59.3	44.9	35.7	63.3
Lignin, %	14.7	15.4	14.2	13.9	9.7	13.4
Fat %	3.5	4.9	2.2	2.5	2.7	1.6
Ash, %	7.7	11.4	7.6	10.2	12.7	6.3
Calcium, %	0.98	1.35	0.84	2.3	2.9	1.1
Phosphorus, %	0.12	0.11	0.16	0.19	0.13	0.21
Magnesium, %	0.28	0.34	0.22	0.18	0.19	0.18
Potassium, %	2.1	1.6	2.3	2.4	2.6	1.9
Sodium, %	0.25	0.36	0.19	0.02	0.02	0.02
Iron, mg/kg	165	243	105	68	77	69
Zinc, mg/kg	18	30	20	18	15	18
Copper, mg/kg	6	5	6	10	6	11
Manganese, mg/kg	19	33	18	9	18	7