CASE STUDY: ELIMINATION DIET FOR A FEMALE ORANGUTAN (*PONGO PYGMAEUS ABELII*) WITH DIGESTIVE PROBLEMS AT THE TORONTO ZOO

Michelle E. Shaw, MS, Ceridwyn J. Rich, MS*

Toronto Zoo, 361A Old Finch Ave., Scarborough, ON M1B 5K7 Canada

Background

Ramai (ISIS #20164) is a female Sumatran orangutan (*Pongo pygmaeus abelii*) who was born at the Toronto Zoo on 4 October 1985. She was parent-reared, and currently weighs approximately 62 kg.

Ramai has had a history of loose stool and skin problems. A fecal scoring chart was developed to illustrate the range of fecal consistency observed in orangutans at the Toronto Zoo (Figure 1). This tool was based on all collection animals to standardize keeper observations. In the past two to three years, the condition of her stool has degraded from grade 3 to explosive grade 5 fecals (Figure 1). It is not known whether the dry, itchy skin and hair loss she experiences is related to allergies, stress, and/or diet.

There have been several nutrition-related attempts at improving Ramai's fecal scores in the past, none of which have been successful. Trials have included the addition of psyllium to the diet (2003), high-fiber (bran & psyllium) muffins (2004), a water restriction diet (2005), due to Ramai's tendency to drink excessive amounts of water, a removal of citrus fruits from the diet (2005), a pancreatic enzyme supplement (Viokase-V powder, Fort Dodge Animal Health, 800 5th St. NW, Fort Dodge, IA, 50501, U.S.A.; 2006), and prebiotics (2007).

The orangutan diet used at the Toronto Zoo is currently based on the recommendations listed in the Association of Zoos and Aquariums Species Survival Plan (AZA-SSP) Orangutan Husbandry Manual with approximately 50% of the diet (dry matter basis) offered as nutritionally complete primate biscuits, and 50% offered as produce, with an emphasis on vegetables rather than fruit.[6] However, the Toronto Zoo orangutans, based on their activity and intake levels, seem to require only 50% of the total recommended amounts listed in the manual. For example, the manual recommends 2200 kcal ME/day for an average 62 kg female. A 62 kg female at the Toronto Zoo seems to require only 1100 kcal ME/day to maintain her body weight (Table 1). On an as-fed basis, this diet includes 13% primate biscuit, 5% Toronto Zoo primate gelatin diet, 66% vegetables, and 16% fruit.

An elimination diet is a useful tool to help determine the sensitivity an individual has to certain foods, and involves eliminating those foods which are suspected to provoke a reaction.[7] A radical elimination diet was designed for Ramai to determine whether certain food items were responsible for ongoing digestive problems. The elimination diet involved a restriction phase, when produce items were eliminated from the diet, and a challenge phase, during which produce was gradually reintroduced, to establish if certain food items resulted in a negative fecal reaction.

Case Report: Elimination Diet

Restriction Phase

The first phase of the elimination diet was to restrict feed to one banana (150 grams) and one kilogram of primate biscuits (Mazuri Leaf-Eater Primate Diet 5M02, PMI Nutrition International, LLC, Brentwood, MO 63144, U.S.A.), daily, and to remove all other items (including any enrichment items) from the diet for a period of one month. Water was available ad libitum throughout the entire diet trial. Ramai was housed on her own throughout the trial so that she did not have access to other food items offered to the rest of the group. This phase began on 6 May 2006. Within a week, Ramai's average fecal score improved from a grade 5 to a grade 3.

Challenge Phase

The second phase of the elimination diet, the challenge phase, involved reintroducing each produce item, one at a time. Keepers monitored Ramai for any adverse reactions (grade 4 and/or grade 5 fecals immediately following the challenge, or any behaviors to indicate symptoms of a reaction such as sleepiness, joint pain, headaches, or mood changes).[5,7] Fecal scores and observations were recorded by keeping staff daily. This phase began on 8 June 2006.

Two items of similar composition were introduced on each challenge day (one in the morning and one in the afternoon). Previous anecdotal evidence from the keepers indicated that items containing higher sugar content (i.e., fruit) resulted in poor fecal consistency. Therefore challenge items were offered according to sugar content in the following order: leafy greens (hypothesized as least reactive due to low sugar content), other vegetables, and finally fruit (hypothesized as most reactive due to high sugar content). Vegetable items were offered in 300g quantities, and fruit items were offered in 160g quantities; this is double the amount that would normally be received (Table 1). After eating the morning challenge item, Ramai was closely monitored for two hours. If Ramai did react to any food item, she would only be offered primate biscuits for a minimum of 24 hours, and would not receive another item until her system was cleared of that reaction. If no adverse reactions were noted during this time, primate biscuits and banana were fed, and the second test item would be offered in the afternoon. As before, Ramai was monitored for any reactions within two hours of receiving the second challenge item.

Each challenge day was separated by a rest day, when only primate biscuits and a banana were fed, to monitor any possible delayed hypersensitivity reactions and ensure any residual effects from previous challenge items were not confounding the observations. If Ramai was still unreactive after the rest day, then the food items tested on the previous day were considered to be non-reactive. If a reaction did occur, then more rest days were required until her system was cleared of that reaction, after which time new challenge items would be tested.

It could not be determined with certainty whether some adverse reactions were caused by environmental stress (e.g., fire alarms, group dynamics, differences in keeper husbandry) or residual effects from a previous challenge item. Those items were re-tested at the end of the challenge phase.

Modified Diet

After all produce items were tested, only those items that did not show a significant reaction were added back into Ramai's diet rotation (Table 2). Ramai began receiving the modified diet in December 2006.

Discussion

Ramai had a positive pregnancy test on 15 June 2006. In August 2006, keepers consistently reported grade 4 and 5 fecals, even when Ramai was returned to a restricted diet of primate biscuits and banana for long periods. It was suspected that hormonal and physical changes due to pregnancy were responsible for this decline in fecal condition. It was inconclusive as to whether the fecal condition was due to challenge items, pregnancy, stress, or a combination of the above. Therefore, the challenge phase of the elimination diet was discontinued when Ramai was 4 months into her pregnancy (3 October 2006). At this time, only training and enrichment items had not been tested. Brown rice was introduced into the diet on 13 December 2006 after several weeks of particularly explosive diarrhea. Interestingly, her skin condition improved during the pregnancy, but then deteriorated after giving birth.

Ramai gave birth on 15 December 2006. Ramai did not produce fecals for six days following parturition, although she was behaving normally and eating well otherwise. Ramai did not return to baseline fecal consistency (grade 3), but it was decided to begin feeding her modified diet (Table 2) on 25 December 2006 rather than continue with the challenge phase.

By late January, fecal consistency was alternating between bouts of grade 2 and 3 fecals, and periods of grade 5 fecals. This is still a considerable improvement over the fecal records from the two years prior to the elimination diet trial.

Although great apes in captivity tend to receive a large number of training/enrichment items, such as peanut butter, honey, etc., only items on Ramai's modified diet are now available for her training and enrichment sessions. We hope to gradually introduce some of these items back into her diet.

It is thought that Ramai's digestive troubles are multi-factorial, with a combination of food sensitivity and stress playing major roles. Further studies will examine hormonal and seasonal patterns in fecal consistency. A commercial enzyme-linked immunosorbent assay is currently available for domestic dogs,[4] pigs,[3] and rodents[3] and has been utilized to document food hypersensitivity issues in the black rhinoceros (*Diceros bicornis*),[2] Asian elephant (*Elephas maximus*),[1] and Bengal tiger (*Panthera tigris tigris*).[1] An assay for use in great apes is currently being developed. Although these assays are not considered exclusively definitive, in conjunction with clinical signs and elimination diet observations, they may help to diagnose the source of Ramai's food sensitivities.

Acknowledgements

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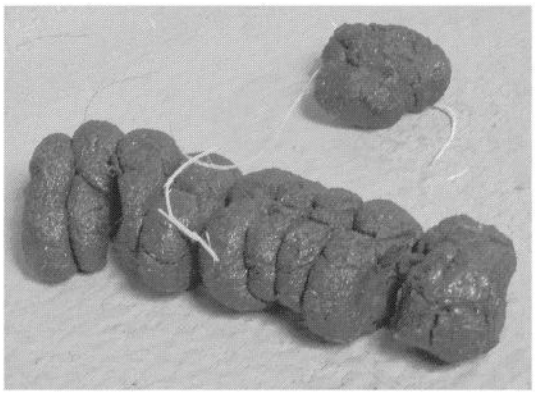
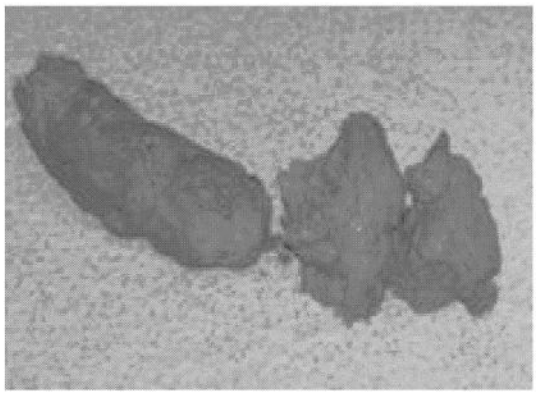
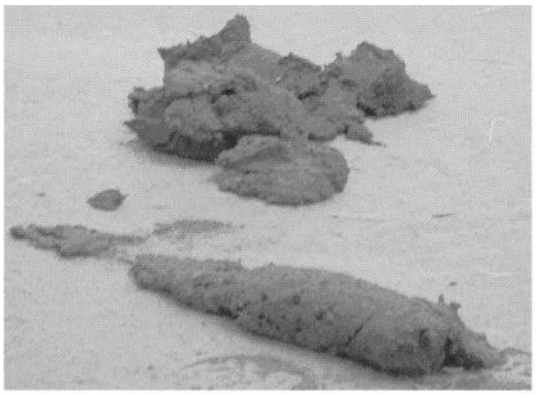


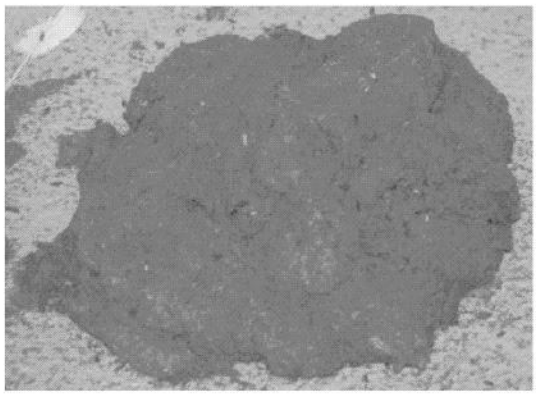
Grade 1: Well formed, solid and dry



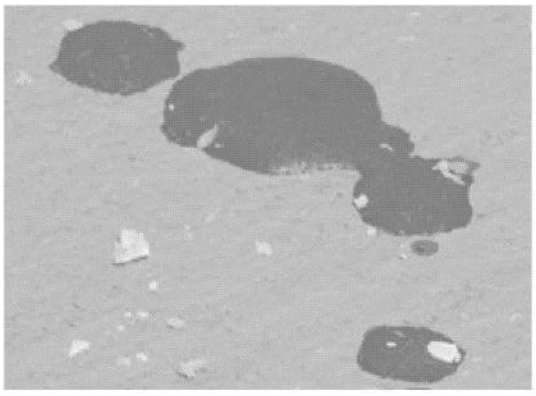
Grade 2: Well formed, solid and firm



Grade 3: Formed, moist and soft



Grade 4: Smooth and soft



Grade 5: Diarrhea

Figure 1. Toronto Zoo orangutan (*Pongo pygmaeus abelii*) fecal scoring chart.

Table 1. The current diet for an average 62 kilogram orangutan (*Pongo pygmaeus abelii*) at the Toronto Zoo.

	Fruit (75 gram per item*)								**Forage Items (150 gram per item)**										**Other Vegetables (150 gram per item*)**												
	Apple	Banana	Cantaloupe	Grapes	Honeydew	Mango	Pear	Tomato	Bok choy	Broccoli	Cabbage	Celery	Dandelion	Escarole	Kale	Nappa	Romaine**	Spinach	Beet	Carrot	Cauliflower	Corn	Cucumber	Eggplant	Green beans	Green pepper	Onion	Potato	Turnip	Yam	Zucchini
MONDAY		x		x		x	x					x				x	2			x	x				x			x			
TUESDAY	x		x			x		x	x	x					x	x				x								x	x	x
WEDNESDAY		x		x	x		x				x						2	x			x			x	x			x			
THURSDAY		2		x		x				x		x	x		x							x	x			x			x	
FRIDAY	x			x			x	x	x							x	x	x	x		x				x		x				
SATURDAY		x			x	x	x			x					x		2			x					x				x	x	
SUNDAY	x	x	x	x							x			x	x		x		x				x			x				x	

*fruit and other vegetables are offered individually; forage items are offered on exhibit.
** banana and romaine quantities are doubled on some days

Other food items offered daily include the Mazuri Leaf-Eater Primate Biscuit (230g), Toronto Zoo primate gelatin diet (100g), and Toronto Zoo fiber (bran, psyllium) muffins (60g). Items given as enrichment or for training include applesauce, honey, jam, fruit juice, peanut butter, pumpkin purée, and salad dressing.

Table 2. Modified diet fed to one adult female orangutan (*Pongo pygmaeus abeilii*) at the Toronto Zoo.

	225 gram per item											
	Bok choy	Celery	Kale	Nappa	Romaine	Spinach	Carrot	Cauliflower	Cucumber	Eggplant	Turnip	Parsnip
MONDAY		x		x	x		x					
TUESDAY	x		x	x							x	
WEDNESDAY					x	x		x		x		
THURSDAY		x	x						x			x
FRIDAY	x			x		x		x				
SATURDAY			x		x		x				x	
SUNDAY						x			x	x		x

Two whole bananas (300g), two cups cooked brown rice (350g), and 250g Mazuri Leaf-Eater Primate Biscuit are also fed daily.

Note: Enrichment and training items, Toronto Zoo primate gelatin diet, and muffins are being withheld until they can be properly tested.