

# Orangutan Nutrition

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To compile information on the feeding of captive orangutans, a diet survey was sent to institutions that had contributed medical records for an earlier report on orangutan management (Dierenfeld 1990). Based on analyses of the survey data, recommendations for diet changes are given.

## Literature Review

Feeding behaviors have been documented for orangutans from several field sites (MacKinnon 1974; Rodman 1977; Rijksen 1978; Sugardjito and Nurhuda 1981; Galdikas 1988), but neither digestive physiology nor nutritional requirements have been investigated in any detail.

Extensive field studies in Sumatra (Rijksen 1978) and Borneo (MacKinnon 1974; Rodman 1977; Galdikas 1988) have shown orangutans to be highly opportunistic feeders, consuming greater than 100 (Rijksen 1978) to over 300 (Galdikas 1988) plant species in a given location. Foods eaten are found in the middle to higher strata, with trees comprising about 80-90% of food sources. Ground feeding is relatively less common, and is particularly rare in females and young animals. Orangutans eat 1 to 25 different foods per day, with females consuming an average of 9.6, and males 7.1 items daily (Galdikas 1988).

Regardless of the habitat sampled (hilly, mountainous, or swampy lowland), orangutans spent approximately 60% of foraging time consuming ripe and unripe fruits; thus, they are considered predominantly frugivorous. The variety of fruits eaten (>90 species, Rijksen 1978; >150 species, Galdikas 1988) ranged from the heavily spined durian fruit (*Durio* sp.) to tiny figs (*Ficus* sp.). In Rijksen's study, over 50% of fruits were figs. Large figs were absent from Galdikas' study area; fruits and other portions of three other trees, *Gironniera nervosa*, *Xanthophyllum rufum*, and *Tetramerista giabra*, were the most important food sources.

During some months, fruit was not the major diet component in Tanjung Putting (Galdikas 1988); as a diet category, fruit was negatively correlated with bark and leaves. Twenty-five to 40% of foraging time was spent consuming immature and mature leaves. Other plant parts eaten regularly included flowers, buds, shoots, pseudobulbs, epiphytic roots, vines, creepers, and fungi. Seed did not constitute a large part of the diet in any of the field studies; although they were consumed and passed, few were chewed by orangutans.

Insect foraging (termites, ants, bees, gall wasps, crickets, caterpillars, and bushcrickets) comprised 4-14% of the activity budgets as reported by Galdikas and Rijksen, respectively. Adult males spent more time eating ground dwelling termites than did females or young animals (Galdikas 1988).

Miscellaneous dietary items listed were earth, decaying wood, spider webs, and bird eggs. A single sighting of vertebrate meat eating has been reported (Sugardjito and Nurhuda 1981).

Seasonal, sexual, and locality differences in food choices by orangutans have been reported. Physiological and/or chemical factors underlying these observations have not been investigated, and such differences may simply reflect availability. Combined with behavioral observations, nutrient analyses of major food items consumed by free-ranging orangutans may provide guidelines for the development of optimal captive diets.

Table 1 contains limited chemical analyses of selected plants eaten by free-ranging orangutans, collected between October and December 1980 in Tanjung Putting Reserve (Hamilton 1982). A distinction was made between total crude protein and available protein to account for binding by various tannins detected in the plants. Young leaves that were consumed generally had more available protein than young leaves that were ignored (not shown in Table 1), but cell wall content was similar in species consumed and those ignored. Overall, these foods appear to be relatively low in available protein and high in cell-wall constituents

(fiber), particularly when compared with non-human primate diet recommendations (National Research Council 1978).

**Table 1**  
**Composition Of Plants Eaten By Free-Ranging Orangutans (Hamilton, 1982).**

Species	Plant Part	Percent (%) in Dry Matter		
		CP <sup>a</sup>	Avail CP	NDF
Ficus sp. <sup>1,2</sup>	Fruit	4.6-7.3		37.3
Gironniera nervosa	Fruit	12.7	5.1	77.0
Sarcotheca diversifolia	Fruit	7.1	4.6	28.5
Eugenia lineata	Fruit peel	4.2	2.6	20.3
Eugenia sp.	Fruit peel	3.6	0.4	86.4
vine sp.	Fruit peel	14.4	12.7	31.4
Dillenia sp.	Flower	25.2	16.6	48.0
Xanthophyllum sp.	Flower	22.2	18.7	50.3
Artocarpus sp.	Young leaf	13.2	6.2	45.8
Baccaurea sumatrana	Young leaf	12.5	11.1	28.7
Dialium sp.	Young leaf	15.9	9.4	54.9
Gironniera nervosa	Young leaf	17.6	3.7	83.7
Xanthophyllum sp.	Young leaf	16.6	12.4	68.7

<sup>a</sup> CP = Crude Protein; Avail CP = available crude protein;  
NDF = neutral detergent fiber (total cell wall constituents)

<sup>1</sup> Leighton 1973

<sup>2</sup> Milton et al. 1980

### The Diet Survey

In 1995, the Wildlife Conservation Park, Bronx, New York, conducted a diet survey for this chapter. The diet survey form (Figure 1) was modeled after that used by the American Association of Zookeepers. Results were received from 24 zoos, and indicated a wide diversity in captive-orangutan diets. Over 50 distinct food items were listed. Eleven of the responding zoos (46%) offered 11 to 15 different food items daily, three (13%) offered greater than 15 items daily, and the rest (42%) offered 10 or fewer items each day. In general, zoos fed two meals daily, with various treat items (more than 20 different items were listed as treats) offered midday or occasionally. Although most zoos reported successful breeding on current diets, which have been used from 2 to 30 years, a few were in the process of diet modification.

Survey respondents attributed very few health problems to diet. Problems attributed to diet included periodontal disease (n=1 institution), gastrointestinal disorders (constipation, n=2; diarrhea, n=1), and obesity (n=6; 25% of the response).

**Figure 1**  
**Orangutan Diet Survey Form (Wells et al. 1990)**

- 1) Institution
- 2) How long has this diet been in use?
- 3) Have the animals successfully reproduced on this diet?
- 4) Have any medical problems attributed to diet occurred in your collection? If yes, please describe.
- 5) Diet and Instructions for Preparation: Please be specific in describing food items and amounts fed. Include brand names where applicable. Avoid vague terms such as "scoop" or "handful". We must be able to convert each item into grams to perform the analysis. If it is possible for you to provide the weight, in grams, of each ingredient in your diet, it would be most appreciated. Please see attached sample form.

*Note:* If there is more than one orangutan diet (for example composition of juvenile diet differs from adult) please use a separate copy of this form.

AM Diet  
Amount                      Item                      Total weight in grams

PM Diet  
Amount                      Item                      Total weight in grams

# Adults fed above diet?              (Ages \_\_\_ to \_\_\_ years) Sex?

# Juveniles fed above diet?              (Ages \_\_\_ to \_\_\_ years) Sex?

- 6) Notes and remarks: Include such information as time of feeding, how food is presented, palatability, if food is fresh, frozen, canned, etc.
- 7) Special considerations: Is the diet altered during pregnancy or lactation? Are there any seasonal alterations? Are there any medical considerations, which affect the diet, etc.?
- 8) Date:
- 9) Your Name:
- 10) May we contact you if we have any questions?
- 11) Your phone number:

Fruits comprised the bulk offered to orangutans at most zoos, averaging about 45% (range 4 to 86%) by weight on an as-fed basis. These consisted primarily of oranges, apples, bananas, and grapes, but a number of other fruits (e.g. pears, peaches, pineapple, grapefruit, raisins, figs, dates, prunes, coconut, and tomatoes) were also fed. Root vegetables (e.g. carrots, yams, onions, and potatoes) comprised the second-largest category of food offered in zoos, 16% of the diet as fed (range 5 to 30%). Other vegetables counted in this category included zucchini, cucumbers, and cauliflower.

Commercial primate feeds (both dry and canned) varied from 2 to 41% of the diet as fed, averaging about 16%. Several products were represented, from high-protein (about 32% crude protein on a dry basis) to high-fiber biscuits (about 25% neutral detergent fiber). Green produce comprised 11% of the diet as fed, ranging widely from 2 to 71%. Numerous items were offered, including kale, lettuce (presumably iceberg), romaine, collards, spinach, alfalfa cubes, cabbage, broccoli, and celery. Fresh browse was only mentioned as a daily diet component in two facilities; browse was offered one to two times per week in some zoos and was considered an occasional treat in others. Bamboo was supplied by two zoos; no other browse was reported by species.

Animal products (e.g. meat, eggs, milk, yogurt, cottage cheese) made up 1 to 19% of the diet (average 5.4%) in 12 institutions (50% of the survey sample) feeding these items. Seeds and grains (e.g. corn, sunflower seeds, peanuts, rice, safflower seeds, breads) completed the diets, averaging 4% of the total (as-fed basis).

Only three institutions reported dietary changes during pregnancy or lactation. One increased the overall amounts of food, one added more juice and milk during lactation, and one supplemented the female with calcium.

**Table 2**  
**Average Calculated Macro-nutrient Composition Of Diets Fed To Orangutans In North American Zoos (N=24) And Comparison To Dietary Requirements Of Old World Primates**

	Energy (kcal/g)	Crude Protein	Crude Fat	NDF	Ca	Phos	D	E (IU/g)
	% of dry matter							
Orangutan (range)	3.6 (3.2-4.3)	16.3 (6.1-26.0)	5.6 (2.9-9.8)	12.7 (7.5-22.7)	0.6 (0.2-1.0)	0.4 (0.2-0.7)	3.3 (0.4-6.4)	122 (24-332)
O.W. Primate <sup>1</sup>	Unk	16.7	Unk	Unk	0.6	0.4	2.2	Unk

<sup>1</sup>National Research Council 1978.

Surveys that included amounts fed (actual or easily estimated from units supplied) were subjected to computer analysis of nutrient content using the Animal Nutritionist software package (N-Squared Computing, Silerton, OR). The concentrations of energy, protein, fat, neutral detergent fiber, calcium, phosphorus, and vitamins D3 and E calculated from these diets are shown in Table 2, which also contains the nutrient requirements established for Old World primates (NRC 1978).

### **Evaluating Nutritional Needs of the Orangutan**

According to Kleiber, caloric needs of orangutans can be estimated from the general equation  $140 \text{ kcal} \cdot (\text{body mass})^{0.75}$  (Robbins 1983). For captive animals ranging in size from 40 kg (adult female) to 75 kg (adult male), energy needs for maintenance would theoretically be met with 2227 to 3568 kcal metabolizable energy per day (ME/day) (Walker 1978). Zoo diets analyzed from the survey supplied 723 to 6733 kcal/day/individual, with an average of approximately 2650 kcal (n=9). No apparent links with reproductive success or animal health were evident from calories fed; the zoo feeding the least total calories per day also reported obesity as a problem.

It must be understood, however, that diets analyzed were those offered, not necessarily consumed in total, thus calories ingested may have been different from those calculated. Also, the size of the individual(s) fed was unknown, so estimates are very crude. Overfeeding to reduce competition in group feeding situations must also be considered. Nonetheless, it appears that energy needs are being met by the diets fed. In cases of obese orangutans (even with low caloric intake), the source of those calories may need to be investigated in more detail. Wells et al. (1990) surveyed 41 zoos holding orangutans in North America and found approximately 2% of the population (6 of 249) suffered from diabetes. However, dietary management of diabetes mellitus in orangutans is not well documented (Toddes and Donoghue, in press). Obesity and diabetes (non-insulin dependent) have been found to be metabolically interrelated in humans, and may be linked to diabetes in orangutans, among which obesity has been documented in 25% of surveyed zoos (Dierenfeld 1990). If obesity is a risk factor for diabetes mellitus, then weight control should be a primary consideration in the nutritional management of the captive orangutan. Diets high in fiber, and low in fat and simple sugars, along with enhanced daily activity may assist in management of this potential health problem.

In comparing values for the reported diets with established nutrient values for Old World primates (the only model currently available) in Table 2, it is clear that diets, in general, closely meet nutritional needs for those components listed. However, the variability in diet composition (see ranges) among zoos needs to be addressed. Compared with diets of free-ranging orangutans (see Table 1), zoo diets provide adequate available protein, but very low fiber levels.

### **Recommendations for Diet Alteration**

As a result of studies from the field and these limited captive-diet analyses, dietary changes may be indicated at some institutions. In particular, there appears to be little need to supply animal products (including eggs) to orangutans. Orangutans do not eat meat as a regular diet item; insectivory is reported from field studies, but likely fulfills a minor portion of nutrient needs. The high protein levels (50-60%) reported in chemical analyses of invertebrates can be misleading (Redford and Dorea 1984). The chitinous exoskeleton contains unavailable nitrogen, which, if not accounted for, artificially elevates reported protein content. Chitin, as a complex polysaccharide, may provide an additional source of dietary fiber for the orangutans consuming them, but this has not been explored. Invertebrates should possibly be offered to captive orangutans as a treat/occupational diet item in very limited quantities.

More important, dietary fiber levels for captive orangutans may need to be increased. This can be accomplished in several ways: 1) offer all fruits raw and unpeeled; fiber is often localized in the peels; 2) replace soft fruits (bananas, grapes, citrus fruits), which contain low fiber levels, with hard fruits and vegetables, such as apples, pears, yams, potatoes, squash, or cucumbers, which contain relatively more fiber (carrots are not as fibrous); 3) increase green produce in the diet, and/or add browse daily; and 4) use

high-fiber, commercial-primate biscuits. Fiber levels in some common foods used in orangutan levels are listed in Table 3 for comparison.

**Table 3**  
**Fiber Content Of Produce Items Fed To Zoo Orangutans <sup>A</sup>**

<b>Fruits and Vegetables</b>	<b>Total Cell Wall (NDF) % in dry matter</b>
Apples	7.6
Beet Root	11.8
Broccoli	18.4
Cabbage	14.2
Carrots	9.2
Cauliflower	16.0
Celery	14.4
Collard Greens	18.6
Corn, Kernel, Sweet	7.9
Cucumber, peeled	12.7
Cucumber, skin	35.5
Kale	16.5
Lettuce, romaine	17.3
Onions	7.6
Oranges, peeled	3.7
Potatoes, peeled	2.5
Potatoes, skin	12.9
Spinach	17.6
Turnip Greens	19.4
Zucchini Squash	12.5

<sup>A</sup> NDF determined by P.J. Van Soest, unpublished.

**Table 4**  
**New York Zoological Park's Primate Browse List (Koontz et al. 1987)**

<b>Common Name</b>	<b>Scientific Name</b>
Crabapple	Malus sp.
Silver maple	Acer saccharinum
Sugar maple	Acer saccharum
Alder	Alnus sp.
Mangrove (Florida import)	Avicennia germinans
Hackberry	Celtis occidentalis
American Beech	Fagus grandifolia
Weeping Fig	Ficus benjamina
Forsythia	Forsythia sp.
Kentucky coffee tree	Gymnocladus dioicus
Alfalfa	Medicago sativa
White mulberry	Morus alba
Golden bamboo	Phyllostachys aurea
White poplar	Populus alba
Black locust	Robinia pseudoacacia
Weeping willow	Salix babylonica
Fragrant honeysuckle	Viburnum sp.
Grape	Vitis vinifera
Banana (exhibit plant)	Musa acuminata
Torch ginger (exhibit plant)	Phaeoamerica sp.

Fruits are an important diet component for both free-ranging and captive orangutans, and may provide valuable behavioral stimulation. It is likely that the domesticated fruits fed in zoos contain more simple sugars and less fiber, but similar available protein levels, than fruits obtained in natural habitats. A variety of fresh fruits should be offered, with choice dictated by local or seasonal availability and with price a major consideration. Fruit should not exceed 25% of the total weight of the diet and may even contribute much less, providing approximately 5% of the dry matter.

As mentioned earlier, greens represent a minor proportion of most of the reported orangutan diets (11% as fed). However, the fruits consumed as a primary diet component by free-ranging orangutans appear nutritionally similar to leafy green vegetables cultivated for human consumption, and may even duplicate the nutrient levels of many browse plants. Greens, in the form of locally available browse plants (see Table 4 for list of examples), or dark green, leafy produce (not iceberg lettuce) should be offered in amounts up to 40-50% (as fed basis) of the total diet. Perhaps palatable forage plants could be incorporated into exhibits to allow foraging activity. Increased greens would also provide natural sources of dietary fiber, protein, calcium, B vitamins,  $\beta$ -carotene, and  $\alpha$ -tocopherol.

Nutritionally balanced, commercial dry biscuits (preferably high-fiber; at least 20% NDF on a dry basis) should be fed at a minimum of 15% of the diet weight (as fed), which would provide about 50% of the calories. High-protein primate biscuits do not appear to be necessary to meet the nutritional needs of orangutans. As this diet category provides the majority of micronutrients (particularly vitamins and minerals), one must assure adequate consumption of biscuits by all individuals.

Root vegetables, again, raw and unpeeled (there is no reason to cook vegetables for these animals, as their digestive tracts are able to handle complex carbohydrates), should be included at about 15% of total weight of the diet (as fed). Cooking, however, can enhance variety and presentation occasionally. The diet survey revealed little use of the wide variety of foods available in this category. Beets, parsnips, turnips, pumpkins, and several tropical tubers might be accepted, but choice should be based upon seasonal and local availability, with palatability and cost the underlying factors.

Seeds (including nuts) and seed products should be considered treat or occupational items only and should not comprise a large portion of the daily diet as they are relatively high in fat (sometimes up to 50%), low in fiber, and imbalanced in calcium:phosphorus. They might best be used scattered throughout an exhibit to encourage foraging.

Any supplemental vitamins should be added based upon calculated need, not prophylaxis. With a diet based heavily on green forages and balanced commercial products, additional supplementation would appear unnecessary. Overfeeding during pregnancy should also be avoided; increased amounts (in balanced proportions) may be offered during the last trimester and lactation.

Orangutans are opportunistic, rather generalistic herbivores. Although variety is desirable, diets need not be excessively complex. A goal of 6 to 10 diet items daily may be realistic (for example 2 fruits, 2 yellow/orange vegetables, 3 to 4 greens, and high-fiber biscuits). Some seasonal variation (apart from that based on produce availability) in the diets of captive orangutans may be warranted, particularly in temperate climates where animals are held indoors in winter months and receive less exercise. In those instances, amounts should be limited to reduce obesity.

## Summary

1. The free-ranging orangutan is highly herbivorous; most zoo diets are quite variable but contain levels of animal products (meat and dairy products in particular) not reflected in natural diets
2. Computer analysis of diets fed to captive orangutans indicate adequate calories, protein, calcium phosphorous, and vitamins D and E as compared to nutritional requirements for Old World primates. From limited field information, diets appear to lack adequate levels of plant fiber.

3. Diet revisions, including using animal products and seeds as treats only, replacing low-fiber fruits and commercial products with higher-fiber counterparts, and increasing green produce/forages are suggested to reduce dietary fat and increase fiber.
4. A suggested diet for captive orangutans includes (by weight, as-fed basis): at least 50% green produce/browse, no more than 25% fruit, about 15% yellow/orange vegetables, and at least 15% dry, high-fiber, commercial primate biscuits.

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