DIETS FOR CALLITRICHIDS—MANAGEMENT GUIDELINES

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Meeting the nutritional needs of Callitrichids is essential if they are to survive and reproduce in captivity. It is appropriate to offer animals in captivity a diet that best matches their nutritional requirements. Any efforts to develop appropriate dietary guidelines must consider the following:

1) information from feeding-ecology data,
2) information from published nutrient-requirement data (which often includes laboratory primate requirements),
3) foods available to zoos, and
4) the animals' food preferences.

In this chapter, we will provide a general overview for feeding callitrichids. Several SSPs are establishing or have published husbandry manuals for individual species that include species-specific nutritional and feeding recommendations. Please refer to those documents for additional and, sometimes, more specific nutritional information and feeding guidelines.

FEEDING ECOLOGY

Information on feeding ecology of callitrichids varies substantially. Much more qualitative data are available on the types of foods consumed in the wild than quantitative data detailing the nutritional content of the foods selected. Despite this lack of quantitative information, several generalizations about callitrichid diets can be applied to captive-feeding regimens.

FOOD SELECTION

Reports indicate that, in the wild, food selection differs among callitrichid species from fruits and insects in the larger species to exudates (gums, saps, and latex) and insects in the smaller species. Their primary feeding strategies encompasses insect foraging for all (Garber 1992).

Emperor tamarins (*Saguinus imperator*) primarily are frugivorous and insectivorous. Grasshoppers are the favorite food item. The diet also may include exudates, nectar, flowers, and other plant parts. In the dry season when fruits are scarce, emperor tamarins may become intense nectar feeders (Terborgh 1983). Rosenberger (1992) noted that they may lose as much as 15% of their body weight when consuming large quantities of nectar.

Moustached (*Saguinus mystax*) and saddlebacked (*Saguinus fuscicollis*) tamarins spend up to 31% of feeding time on nectar during the dry season (Garber 1988). The diet of moustached tamarins (*S. mystax*) includes about 14% insects as determined by feeding time. Both saddlebacked (*S. mystax*) and moustached (*S. fuscicollis*) tamarins consume water and prey from bromilliads (Nickel and Heymann 1996) as do golden lion tamarins (*Leontopithecus rosalia*) (Garber 1992). Some may consume up to 38 species of insects, including insects weighing over 8.5 grams (Nickel and Heymann 1996). Moustached tamarins (*S. mystax*) also consume fruit seeds and pass these undigested (Heymann 1992).

Pygmy marmosets (*Cebuella pygmaea*) are arboreal, rarely coming to the ground. The pygmy marmoset (*C. pygmaea*) is classified as an exudate feeder and insectivore. They feed on exudates by gouging holes in the major branches of trees and the stems of vines with lower incisors (Kinzey et al. 1975; Ramirez et al. 1977). Preferred insects are grasshoppers, spiders, and butterflies. Ramirez et al (1977) noted that pygmy marmosets (*C. pygmaea*) spend 67% of their total feeding time investigating and procuring exudates and 33% of feeding time foraging for insects. Fruit, buds, flowers, and nectar also are consumed, but constitute a minor portion of the diet.

In terms of types of foods consumed (i.e., fruits, exudates, and insects), diets may vary considerably within a species as well as among species. Diet variability may be a consequence of seasonal changes in food availability and distribution. Saguinus species have been grouped as to foraging strategy. Groupings include: 1) seasonal exudates

feeding occasionally from tree trunks; 2) insects taken from bark surface and tree trunks used as platforms for terrestrial prey; 3) bark stripping for insects and small vertebrates; and 4) tree gouging year-round for exudates (Garber 1992). Interestingly, some moustached tamarins (*S. mystax*) may consume soil, presumably for mineral content (Hartmann and Hartmann 1991).

ROLE OF GUT MORPHOLOGY IN FEEDING STRATEGY

The body size of callitrichids is classified as small compared to other New World primates. Body mass generally ranges from 105 to 700 g (Garber 1992). Claw-like nails allow clinging while foraging. Garber (1992) provides a table of body mass for callitrichids.

Gastrointestinal-tract morphology of callitrichids has been associated with the extent to which a species consumes exudates, specifically gums. It is thought that, for increased digestion of gums, a more complex GI tract is beneficial. Common marmosets, which are largely exudate feeders, possess a large complex cecum with internal ribbon-like structures (Garber 1992). *C. emiliae* have a large complex cecum to help process gums (Ferrari and Martins 1992). These GI-tract structures are less developed in the golden lion tamarin (*L. rosalia*) (Garber 1992).

Dentition of callitrichids is combined into two categories: short-tusked dentition for gouging bark (marmosets), and long-tusked dentition like other primates (tamarins) (Ferrari and Martins 1992). Dentition is correlated with feeding strategy. Thus, it appears that these animals are well adapted for their specific diets.

PUBLISHED NUTRIENT REQUIREMENT DATA

A few studies have established some basic nutrient requirements for a number of callitrichid species. The National Research Council (1978) attempted to describe the nutrient requirements of nonhuman primates. Although the NRC requirements are outdated and are under revision, they remain the main source of compiled scientific information on nutrient requirements in nonhuman primates. Unfortunately, limited species were examined and only 24 nutrients are presented in the NRC publication, while primates may require considerably more (up to 47 nutrients).

ENERGY REQUIREMENTS

Energy requirements for marmosets and tamarins may be higher than for other New World primates. Morin (1980) published energy requirements at 150-160 Kcal/kg body mass/day. However, the quantity of energy needed is directly related to the digestibility of the foods consumed. The digestible energy of one artificial diet fed to a variety of callitrichids ranged from 71% to 86%. Power (1991) indicated that the change in digestible energy was correlated to body size. The smaller the body size, the less well energy was digested. The larger the body size the better energy was digested. The exception was the pygmy marmoset, which had the smallest body size but a high level of digested energy at 84%.

PROTEIN REQUIREMENTS

The NRC (1978) proposed that New World primates need a higher level of protein than their Old World counterparts. New evidence shows that this may not exactly be true for all New World primates (Oftedal 1995). However, an increased level of dietary protein should not be deleterious to healthy animals. Flurer and Zucker (1988) found that marmosets consumed their feces when fed diets less than 6% protein or when lacking in one or more amino acids. Protein requirements for small primate species are published as 3.5 g - 4.5 g/kg body mass/day of high-quality protein (NRC 1978). No study has determined the protein requirements of pregnant or lactating callitrichids. The protein requirement is linked to the array and quantity of essential amino acids, the digestibility of protein in the diet, and the presence of secondary plant compounds such as tannins. An amino acid associated with taurine is needed for proper development of young primates, but its requirement as a dietary essential is unknown (Sturman 1993).

VITAMIN AND MINERAL REQUIREMENTS

New World primates are able to use dietary vitamin D_3, while Old World primates can use both vitamin D_2 and vitamin D_3. Studies have shown that marmosets and tamarins may require higher levels of vitamin D_3 than other New World primates because of a target organ receptor resistance to the active form of the vitamin (Takahashi et al. 1985; Ausman et al. 1985). Vitamin D_3 requirement is stated as 110 IU/100 g body mass/day (Takahashi et al. 1985).

Vitamin C is a proven dietary essential in common marmosets and no less than 15 to 20 mg ascorbic acid/kg body mass is required (Flurer et al. 1987; Flurer and Zucker 1989). In one study (Flurer et al. 1987), the animals were fed 500 ppm concentration in the diet. The authors concluded that the requirement is higher than human requirements. However, when compared to common marmosets on the same diet, saddlebacked tamarins had significantly lower circulating levels than the common marmosets, intimating that there is a species difference in need (Flurer and Zucker 1987) and possibly a higher requirement in some callitrichid species (Flurer and Zucker 1989).

Zinc deficiency was noted in moustached marmosets when fed less than 150 ppm of dietary zinc. When the levels were increased by 40 ppm the deficiency symptoms were alleviated (Chadwick et al. 1979).

Nutritional deficiencies can cause a number of anemias in nonhuman primates (Wixson and Griffith 1986). A deficiency of riboflavin causes normocytic normochromic anemia. Deficiencies of vitamin B_{12} and/or folic acid can cause macrocytic anemia. Wixson and Griffith (1986) suggested that New World primates would be a good model for folate-induced anemia. Hypochromic iron deficiency can result from blood loss from bleeding or intestinal parasites. While they did not report this specific to callitrichids, callitrichids probably are susceptible to a number of anemias and other deficiency diseases if not provided a diet that meets nutritional needs.

As mentioned previously, very few studies have been undertaken to define the nutrient requirements of callitrichids. Other than the nutrients discussed above, the guidelines for New World primates are recommended for use in feeding captive callitrichids.

FOOD AVAILABILITY TO ZOOS

Knowing which types of food callitrichids consume is important when developing a captive diet, but it is more important to know the quantity of nutrients consumed. For the most part, these data are not available. Clapp and Tardif (1985) reported that a variety of foods have been offered in marmoset research colonies. Most facilities fed some type of commercial diet supplemented with insects, small vertebrates, and produce.

Protein requirements to feed adequately have been reported at 20% (dry-matter basis), but this may be above true requirement levels. Adequate fat levels have been reported at about 7% and carbohydrates at about 5.3% (both dry-matter basis). Diets now fed at laboratory colonies nearly have eliminated the problem of marmoset wasting syndrome (Clapp and Tardif 1985).

In his study to examine a captive diet in Geoffroy's marmosets, Price (1992) calculated the nutrient content of a mixed diet to assess possible nutritional problems found in the collection. Because the animals were housed singly and in groups, data were not easily applied to the adequacy of the diet. The diet met the recommended levels for New World primates (NRC 1978) and appeared adequate for other species. Price (1992) suspected protein level and some mineral levels were inadequate for these particular animals. It appears possible to maintain and breed callitrichids in captivity on a manufactured diet supplemented with other commonly fed items.

In developing a captive diet, zoos should consider which categories of foods are consumed by callitrichids in the wild and which foods from the same categories are available to institutions. They should also consider studies that indicate that the nutritional content of foods consumed by free-range primates may be considerably different from the nutritional content of foods from the same botanical classification available in captivity. Multiple reasons for this anomaly exist. Generally, fruits consumed in the wild are higher in fiber and lower in sugars than those items cultivated for human use (Calvert 1985). Also, fruits consumed by callitrichids in the wild may be primarily unripe, while those available to zoos are usually very ripe. Ripening increases the sugar level in the fruit and may help explain why fresh fruit fed in zoos can causes loose stool in callitrichids. Finally, free-ranging callitrichids consume a variety of insects and exudates, food items not commercially available to institutions. Zoos must acknowledge that, in captivity, animals are limited in dietary intake and, consequently, in nutrient intake by the foods which are offered.

FOOD PREFERENCE

As mentioned before, the foods comprising most of the diet of free-ranging animals may not be that most sought, but that most available. Differences in food choice also may be based on physiological condition. Hence, day-to-day fluctuations in food consumed may vary dramatically within species and among individuals.

Types and variety of food items offered artificially limit captive callitrichid diets. Studies with a variety of laboratory mammals have shown that an animal does not necessarily select food items based on the item's nutrient content (Price 1992). Therefore, it can safely be assumed that captive callitrichids, given a limited variety of succulent food items, will not necessarily select food items of adequacy in nutrient content. Instead, animals may select items based on sugar content, fat content and even novelty. Thus, it is important that zoos offer foods that compliment each other nutritionally.

Pennington (1993) lists the nutrient content of commonly fed food items, such as produce. Allen (1989) has published information about less commonly fed food items, such as insects. The nutritional content label on manufactured products presents the guaranteed analyses of the packaged product, but does not show levels of vitamins and minerals. Many times, manufacturers will provide these to zoos upon request. If not, the product can be chemically analyzed.

Using published research on nutritional requirements, the NRC guidelines, and data on wild-callitrichid feeding and nutrient content of food items available in zoos, it is possible to formulate appropriate diets for captive callitrichids.

FORMULATION OF APPROPRIATE DIETS

Zoos must be flexible when formulating diets for captive callitrichids. They must take into account animal preferences, weight, exercise, physical condition, environment, behavioral considerations, and food availability. Therefore, it is more appropriate here for the authors to offer guidelines for nutrient content and food categories rather than recommending specific food items in set quantities. Guidelines allow for flexibility in diet formulation while assuring a nutritious diet is consumed.

Nutrients presented in the next section provide only target levels and food items are presented as food groups. The entire diet (as well as the animals' enclosure) should be viewed as potential enrichment and, as long as the target nutrient levels are met within the diet consumed, food presentation can be altered to accommodate behavioral and enrichment needs.

Consider the feeding strategy in offering the diet. Feeding tubes, fashioned like bromeliads, or "flaky" substrates can simulate picking and bark-gouging. Gums, while limited, can provide substantial activity (Kelly 1993). Take care that all ingested food items are considered as diet contributors.

CALLITRICHID MANAGEMENT GUIDELINES—DIET RECOMMENDATIONS

FOOD AND WATER

Food—Adults

Schedule

1. Animals should be fed at least twice per day. The interval between morning and afternoon feeding should fall between 4.5 to 6.5 hours. Since marmosets spend much time foraging, feeding times may be scattered throughout the day.
2. The morning (or activity period) feeding should consist of more food than the afternoon or evening (inactivity period) feeding, though the same categories of foods should be offered. If possible, food should be available throughout the day and scattered to encourage foraging.

Nutrient Content

If consumed in its entirety, the proper diet contains the nutrients listed in Table 1 on a dry-matter basis (based on calculated analysis). These should be considered target nutrient levels until more specific nutrient levels are defined (adapted from published literature and New World monkey NRC requirements). Levels are expressed in quantity per unit of diet.

TABLE 1. TARGET NUTRIENT LEVELS

Nutrient	Concentration in diet*	Nutrient	Concentration in diet*
Energy (kcal/g)	**	Choline (mg/kg)	—
Crude protein (%)	**	Biotin (mg/kg)	0.1
Fat (%)	—	Vitamin C (mg/kg)	500 or more
Fiber (%)	—	Calcium (%)	0.6
Linoleic acid (%)	1	Phosphorous (%)	0.4
Vitamin A (IU/g)	14	Magnesium (%)	0.2
Vitamin D (IU/g)	2.2 or less	Potassium (%)	0.9
Vitamin E (mg/kg)	56	Sodium (%)	0.3
Thiamin (mg/kg)	5.6	Iron (mg/kg)	200 or less (80-200)
Riboflavin (mg/kg)	5.6	Zinc (mg/kg)	11.1
Niacin (mg/kg)	55.6	Copper (mg/kg)	1.5
Pyridoxine (mg/kg)	2.8	Manganese (mg/kg)	44.4
Folacin (mg/kg)	0.2	Selenium (mg/kg)	—
Vitamin B12 (mg/kg)	0.6	Iodine (mg/kg)	2***
Pantothenic acid (mg/kg)	16.7		

See explanations on previous pages for justification of nutrient levels.
* Probable requirements for New World primates. Depending on the interpretation of the NRC (1978), the requirements for magnesium, iron, and manganese may be overestimated.
**The requirements for these nutrients are higher for marmosets and tamarins than for other New World primates. Energy required is 150-160 Kcal/Kg body mass/day (d) (Morin 1980); protein for small primate species is 3.5- 4.5 g/Kg body mass/day of high-quality protein (NRC 1978); vitamin D3 required is 110 IU/d/100 g body mass (Takahashi et al. 1985).
***NRC may have overestimated the quantity needed. For most other animals the requirement is about 0.1.
—No NRC requirement stated for this nutrient. This does not mean there is no requirement, just that studies have not been performed. For selenium, the level in many mammals is about 0.1 ppm.

Daily Diet

Food Items

Zoos can achieve the nutrient levels outlined above by offering a diet consisting of the food items listed in Table 2. **Note**: food items or food groups are expressed as percentages, by weight, of total diet fed. Percentages were derived from free-ranging data and food-item, nutrient-content information.

For flexibility, three diets are represented. Each meets or exceeds the target nutrient levels outlined above. Food groups are presented in Appendix A. It is assumed that the

insects fed are crickets and mealworms. Mealworms contain substantially more fat and energy than crickets, therefore, a higher percentage of crickets to mealworms should be used for overweight animals. Invertebrates must be fed an 8% calcium diet for at least 4 days prior to being fed to the animals (Ward and Crissey 1997).

The vegetables and starches offered should be cooked (steamed or microwaved) to enhance digestibility. Nectar, if the animals consume nectar in the wild, may be fed (diluted 50:50 with water) and mixed with the diet. This is not in addition to the diet. Fruit must be decreased by weight as nectar is offered. If, for logistical or cost reasons, the use of insects must be decreased, increase the nutritionally complete portion of the diet (by weight).

TABLE 2. SAMPLE DIETS

DIET #1

FOODS	% IN DIET (by WEIGHT as fed)
Commercial Marmoset Diet	70
Fruit	10
Vegetables	5
Starches	5
Insects	8

Nutrient Content of Diet #1

The commercial marmoset diet that compliments the diet above is one with the following specifications. This particular product is a canned product (hence the higher moisture content). With the use of this product, the diet must contain a source of vitamin C. (This can be obtained from the fruit, if a good source is used.) This product contains the following nutrients as stated on the label and/or in the informational literature:

Crude Protein	minimum %	9.30	Ash	maximum %	2.50
Crude Fat	minimum %	3.20	Calcium	minimum %	0.33
Crude Fiber	maximum %	0.80	Phosphorous	minimum %	0.24
Moisture	maximum %	60.00	Vitamin D3	min IU/g	9.90

DIET #2

FOODS	% IN DIET (by WEIGHT as fed)
Commercial Primate Diet	50
Fruit	12
Vegetables	10
Starches	10
Insects	18

Nutrient Content of Diet #2

The commercial primate diet that compliments the diet above is one with the following specifications. This product contains the following nutrients as stated on the label and/or in the informational literature:

Crude Protein	minimum %	25.0
Crude Fat	minimum %	5.0
Crude Fiber	maximum %	4.0
Moisture	maximum %	10.0
Ash	maximum %	6.1
Calcium	minimum %	1.0
Phosphorous	minimum %	0.6
Vitamin D3	IU/g	6.6

DIET #3

FOODS	% IN DIET (by WEIGHT as fed)
Commercial Primate Diet A	47
Commercial Marmoset Diet B	10
Water	3
Fruit	10
Vegetables	10
Starches	10
Insects	10

Nutrient Content of Diet #3a

The commercial primate diet that compliments the diet above is one with the following specifications. This product contains the following nutrients as stated on the label and/or in the informational literature:

Crude Protein	minimum %	25	Ash	maximum %	6.1
Crude Fat	minimum %	5	Calcium	minimum %	1
Crude Fiber	maximum %	4	Phosphorous	minimum %	0.6
Moisture	maximum %	10	Vitamin D3	IU/g	6.6

Nutrient Content of Diet #3b

The commercial marmoset diet that compliments the diet above is one with the following specifications. This is a powdered product formulated to be mixed with water and heated to a gel. Thus water was added as part of the diet. It also is stated that it should be used with another manufactured primate diet (such as used in this example). This product contains the following nutrients as stated on the label and/or in the informational literature:

Crude Protein	minimum %	33	Ash	maximum %	5
Crude Fat	minimum %	14	Calcium	minimum %	0.85
Crude Fiber	maximum %	6	Phosphorous	minimum %	0.67
Moisture	maximum %	2 or 0	Vitamin D3	IU/g	30

Quantity of food per day

How much to feed per day may be difficult to determine. Optimally, quality of food should be based on accurate measurements of the animal's body mass (or body weight). Charting an animal's body mass over time will provide an indication of optimum weight and normal fluctuations for that individual. This information can be extremely valuable as a predictor of possible problems associated with weight changes, including disease.

An average, active adult animal will consume approximately 5% of body weight per day (dry-matter basis); or somewhere between 16 to 24% of body weight on an as-fed basis (depending on the moisture content of the diet). However, this depends on exercise and physiological state. If the animal is lactating, intake increases to 1.5 times usual. If the animal is in a period of decreased activity, it will consume less. In a large colony of animals where there is high competition or animals of differing age/sex groupings, or where there is the possibility of pest infestation, the animals should be fed so that there is a small quantity of food remaining after the feeding period. However, there should not be so much food remaining as to allow sorting and rejection of food items to occur. The challenge for animals' caregivers is to assure that each animal receives its prescribed diet, especially the nutritionally complete manufactured portion.

Remember, the quantity of food to be consumed depends on the nutrient density of the diet and the digestibility of the food items. In callitrichids, the requirements for energy and protein are calculated according to the body mass of the animal. Again, monitoring body mass will help determine intake.

To convert the percentages provided in the diets in Table 2 to actual quantity of foods to feed, the following formula can be used: TOTAL g diet per day x percent food item in the diet/100

Size of food items

An individual should easily handle food items. Sizes and shapes should be varied for behavioral enrichment.

Feeding behavior
Food sharing and stealing is common within family groups and serves to teach the young about important food items. However, feeding the quantities as outlined above should circumvent the problem of an individual in a group not receiving enough food because of competition.

Food—Handreared young
Feeding regimes for handreared young are available from the studbook keeper and the Infant Diet/Care Notebook (AZA 1993, currently being updated and revised). Zoos have handreared a number of infants successfully and reintroduced them after weaning to a family group for socialization and to learn parental-care techniques.

Water—Adults
Fresh water should be available at all times. Food and water dishes should be disinfected daily to prevent bacterial build-up, especially Pseudomonas.

ADDITIONAL COMMENTS ON FOOD AND FEEDING

Certain foods (like excessive quantities of fruit) may periodically cause diarrhea in some animals. The literature for the gel diet states that loose stool may be associated with it, if fed in large quantities. Temporarily restricting affected individuals to only the nutritionally complete primate biscuit/canned diet may clear up the problem. Reducing the quantity of fruit in the diet may also produce desired results. The importance of including the nutritionally complete primate diet cannot be overemphasized; its consumption is critical to proper dietary management of these animals. The nutrient content of the diet should be reassessed if one nutritionally complete food item is substituted for another. A drop or increase in food intake must be carefully monitored and body weight should be maintained. Oral medication may be handfed to individuals in favorite food items.

IMPORTANCE OF MEASURING DIETARY INTAKE AND METHODOLOGY

Ultimately, it is the diet (food items) actually consumed by each animal that will determine its nutrient status. The diet offered must allow the animal to consume the nutrients needed. If the animal does not consume the diet or certain portions of the diet, it may not receive the nutrients it requires. Therefore, it is important to assess diet consumption periodically.

One method to determine diet consumption follows. Over a period of at least five days, keepers collect data on diet offered and consumed. Different keepers should collect data to determine variation in individual food preparation. Calculate consumption by measuring the quantity (by weight) of food items offered and subtracting the quantity of food remaining. Each keeper apportions food according to normal procedures. Weigh each item on a digital scale before adding to food pan. Orts (leftover food) are collected at the end of the feeding time or before the next feeding time and weighed. Enrichment food items are included and should be accounted for in the same manner.

Some foods dehydrate, so desiccation should be considered. Likewise, addition of water (i.e., rain or misting) should be estimated. One simple way to avoid this is to determine intake by dry matter. If a drying oven is unavailable, to determine food-weight changes, a weighed sample pan should be placed near a cage (where the animals are housed) in an area free from pests. The pan should be left for the same period of time as the diet and subjected to similar environmental conditions. The percentage of water gain or loss should be determined and a correction factor calculated. This "factor" can then be used to determine the actual quantity of diet consumed without the conflicting problem of moisture. A computer analysis (one example: Animal Nutritionist software by N-squared Inc, Silverton, OR) can be used to calculate nutrient content of the diet offered and consumed. For nutritional advice, please consult your nutritionist or obtain a name of a professional nutritionist from the AZA Nutrition Advisory Group.

Special considerations:

1. Overweight Animals—If the diet is adequate in nutrients, the diet can be decreased in total (beginning with a 5% decrease). Other options include decreasing the calorically dense food items and/or increasing the lower calorie items. The importance of monitoring body mass can not be overemphasized.

2. Seasonality—An occurrence in the wild, animals in captivity may occasionally undergo seasonal fluctuations in intake and body mass. If these are determined to be normal for the species or particular animal, changes in food offered can be made. The importance of determining animal body weight and food consumption can not be overemphasized.
3. Periodontal disease—Animals that consume primarily soft foods that do not abrade the tarter from teeth may have an increased susceptibility to dental disease. A nutritionally balanced diet is important in maintaining oral health. Also, care should be taken to periodically offer crunchy or hard foods that may help keep teeth clean.
4. Vitamin D—Tamarins require more vitamin D than other New World primates (Ausman et al. 1985; Takahash et al. 1985). The requirement for vitamin D for tamarins is 110 IU/day (d)/100 g body weight (BW) on an as-fed basis (Takahashi et al. 1985). If animals are housed indoors only, they must rely totally on diet for their vitamin D: if outdoors, they have the opportunity to convert a vitamin D precursor in the skin to vitamin D upon exposure to ultraviolet light. Much work is currently being performed with respect to vitamin D deficiency and primates housed indoors (Meehan et al. 1996).
5. Wasting disease—Protein and calories are very important to callitrichids to prevent the occurrence of protein/calorie malnutrition, which could lead to Marmoset Wasting Syndrome (Barnard et al. 1988). Research has shown that tamarins require 150-160 Kcal/Kg body mass/day (Morin 1980). The NRC (1978) recommends 3.5-4.5 g/Kg body mass/day high quality protein for small primate species.
6. Species specific concerns—Cotton-top tamarins provide a model for studying colitis and colon cancer. It is thought that this may be congenital. There also have been reports of high blood pressure and heart disease in pygmy marmosets. The relationship to diet is unknown. Taxonomically, callimicos appear slightly different than marmosets and tamarins and may handle certain nutrients such as vitamin D differently (Crissey et al. 1996). The animal manager should consult individual SSP manuals for details on species-specific differences.

APPENDIX A. FOOD CATEGORIES

Items listed in this appendix are examples with respect to availability. For additional information about food categories and exchanging one item within a food group with another, consult the American Dietetic Association (1995).

Fruit	**Veggies**	**Starches**
apples	carrots	sweet potato
bananas	green beans	white potato
grapes	cucumber	peas
oranges	green pepper	acorn squash
papayas	zucchini	cooked rice
blueberries	cauliflower	cooked pasta
strawberries	cooked/canned beans	corn
pineapple		
grapefruit		
pears		

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