

COTTON TOP TAMARIN

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VI Nutrition

Chapter Summary

- Adult animals consume on average 152 kcal/g body weight (range 112-253kcal/g body weight).
- Lactating female's caloric intake increases to 260 kcal/g body weight; thus, diets of lactating females should be adjusted to accommodate this increased energetic demand.
- Diets should address both the physical and psychological needs of the animals.

Diet Development

Developing a captive diet can be a complicated task. Barnard & Knapka (1993) have presented an extensive review on callitrichid nutrition. They suggest that the nutritional requirements for a wild animal should be based on information from four areas of study: 1) observation of the diet consumed by related species; 2) field observations of food consumption by the species being studied; 3) anatomical features of the species that influence nutritional requirements; and 4) controlled research of the nutritional requirements of the species. Because of the extensive studies on callitrichids in both the field and in the laboratory, the current knowledge of the nutritional requirements have been established using these methods.

Field Observations

In the wild cotton-top tamarins have been observed feeding primarily on fruits and insects (Hampton et al., 1966; Neyman, 1978; Savage, 1990). They have not been observed to eat leaves, nor do they gouge holes in trees to obtain sap. Tree gouging to obtain exudates has never been observed in captive or field studies of *Saguinus* or *Leontopithecus*. However, cotton-top tamarins are opportunistic feeders of sap, using holes gouged by birds, insects or rodents (Raimerez, 1985; Neyman, 1978; Savage, 1990). Cotton-top tamarins have also been observed to feed on other animals, including small birds, lizards, and eggs (Neyman, 1978; Savage, 1990).

A causal relationship has been suggested between the small body size of callitrichids and their insectivorous habitats (Temerin et al., 1984). Metabolic costs of maintenance and locomotor activity are relatively high in small primates. Given the small size of callitrichids, they have adapted to feeding on insects, a food source that is high in calories.

Gut transit times are also decreased in small-bodied as compared to large bodied primates. Milton (1984) advances a physiological explanation for this "as body size increase, metabolic costs per unit body weight decrease exponentially while gut volume remains proportionate to body mass." So, in small mammals, the size of the gut cannot process the amount of food required for their disproportionately high energetic requirements per unit body weight without decreased food transit time. Thus, the short gut transit times seen in cotton-top tamarins and other callitrichids, explain field observations that they seek out nutritionally concentrated food and rarely, if ever, eat fibrous plants that require long transit times to digest. To date, the nutrient composition of a wild cotton-top tamarin diet has not been completely determined.

Captive Diets

It is generally accepted that feeding cotton-top tamarins a commercial primate diet supplemented with various foods and nutritional supplements is sufficient to prevent deficiencies when nutritional requirements are not known. It has also been suggested that a varied dietary regime satisfies the behavioral needs of the monkeys as well (Coimbra-Filho et al., 1981; Epple, 1970; Kirkwood, 1983; Kirkwood et al., 1983; Snowdon & Savage, 1989; Tardif et al., 1988).

Documentation of cotton-top tamarins responses to diets supplemented with various foods has provided valuable information regarding the animals' taste preferences, as well as insights into their nutritional requirements. King (1978) examined dry matter, energy, protein, and fat intake collected from captive cotton-top tamarins and other callitrichids given a commercial primate diet, plant products (vegetables and fruits), and animal products (eggs, milk, insects, etc.). Daily voluntary dry matter intake was 52 g/kg body weight. This consisted of approximately 16% primate diet, 77% plant products, and 7% animal products. The protein intake consisted of approximately 38% primate diet, 42% plant products, and 27% animal products. Fat intake was 13.6% of the total calories. The sources of dietary fat consisted of approximately 15% primate diet, 55% plant products, and 30% animal products.

Benirschke and Richart (1963) fed a colony of callitrichids a variety of fruits, nuts, and animal protein food sources. They found that sweetened milk, fresh eggs, and insects were readily consumed while vegetables, fish, meat, or cooked food was avoided. The monkeys maintained constant body weight and had normal hair coats while on this diet. In general, these studies suggest that callitrichids fed diets based on plant products, insects, and animal products had a nutritional requirement for an animal protein source and had a preference for fruits and insects.

Various diets have been developed that are composed primarily of a commercially prepared diet appropriate for callitrichids and supplemented with fresh fruits, vegetables, and insects, and animal products. However, problems have resulted when using supplemented diets. There are numerous reports indicating that tamarins develop preferences to fruit, which resulted in decrease consumption of the more nutritious foods (see Bamard & Knapka, 1993 for a complete review; Kirkwood, 1983; Kirkwood et al., 1983). In studies by Kirkwood and his colleagues (1983), cotton-top tamarins who were fed a diet comprised of one-fourth apple, one-fourth banana, one-eighth orange, and *ad lib* monkey pellets for 5 years, had a high incidence of diarrhea. The tamarins ate the fruit prior to and in preference to the monkey pellets. When a change in the diet was made to include one-fifth of an egg per monkey daily and fruit was reduced by one half, there was an increased consumption of the commercial diet, resulting in a 50% increase in protein intake. A decrease in the occurrence of chronic diarrhea was observed and an increase in body weight, new hair growth on alopecic monkeys and an increase incidence of triplet births was also noted.

Vitamin and Mineral Requirements

There is little published information regarding the vitamin and mineral requirements of cotton-top tamarins. Most commercial callitrichid diets contain Vitamin D₃. However, care should be taken if you plan to administer Vitamin D₃ since fat soluble vitamins are toxic at high concentrations. Bamard & Knapka(1993)list the following values for reference.

		Source
Vitamin D ₃	2000 IU/kg body weight or a daily intake of 33 IU per 400 g body weight	Flurer & Zucker, 1987
Retinol	171 g/kg body weight	King, 1978
Cholecalciferol	2.8 g/kg body weight	King, 1978
Calcium	206 mg/kg body weight	King, 1978
Phosphorous	194 mg/kg body weight	King, 1978

Protein and Energy Requirements

Protein and energy requirements of smaller species are greater on a per unit body weight basis than those of larger species (Clarke et al., 1977). Pregnancy, lactation, and growth

increase energy requirements. There have been several studies examining energy and protein consumption in adult cotton-top tamarins.

Daily intake of	130 kcal/kg body weight	Kirkwood et
metabolized energy (ME)		al.,1983
	152 kcal/kg body weight	Kirkwood &
		Underwood, 1984
al.,1981	160 kcal/kg body weight	Escajadillo et
	225 kcal/kg body weight	Flurer et al., 1983
	189-219 kcal/kg body weight	Tardif et al., 1988
Daily intake of protein	.6 g protein/kg body weight	Kirkwood et al., 1983
	9.75 g protein/kg body weight	Flurer et al., 1983

It should be noted that the overall caloric density of the diet may affect protein requirements. According to Bamard and Knapka (1993), a high caloric density partially offsets protein needs, and this is likely to account for the extreme difference between the values in Kirkwood et al., (1983) and Flurer et al., (1983) studies. Clapp and Tardif (1985) and Escajadillo et al., (1981) report success in maintaining cotton-top tamarin with an average dietary protein content of 20% and 22.5% respectively.

Of the three dietary energy sources (protein, carbohydrate, fat) the least necessary for cotton-top tamarin health is fat. Escajadillo et al., (1981) and Clapp and Tardif (1985) report an average of 8.9% and 9.2% fat content respectively is sufficient for cotton-top tamarins in captivity.

While comparatively little discussion is included in the literature about the carbohydrate content of the diet, it is the largest single component and provides the bulk of the energy readily accessible to the animal. Studies examining carbohydrate content suggest values that range from 47.2-81.4% (Clapp & Tardif, 1985; Escajadillo et al., 1981; Flurer et al., 1983).

Fiber content in the diet of callitrichids is a subject of considerable discussion. The percent of "undigestible" fiber in a number of diets studied ranged from 1.5-10% (Flurer

et al., 1983). Protein digestibility began to decrease as fiber content exceeded 4% (Flurer et al., 1983).

Krombach et al., (1984) found that chitin (specifically shrimp meal), used as a fiber source, is at least partially digestible by callitrichids. How this is accomplished is not exactly clear, but may either be the result of microbial action in the gut or of chitinolytic enzymes produced by the monkeys (Barnard & Knapka, 1993). Although not clinically proven, the latter possibility points to insects (with their chitinous exoskeletons) as an even more important nutritional component than previously thought.

Kirkwood and Underwood (1984) examined the food intake of cotton-top tamarins at various stages of the life cycle. They determined that the energy intake required for maintaining adult cotton-top tamarins was approximately 152 kcal/kg body weight/day with a range of 112-253 kcal/kg body weight/day. The mean intake for pregnant females in the last 7 weeks of pregnancy was approximately 139 kcal/kg body weight/day, which was not significantly different from that of non-pregnant monkeys. However, during lactation the daily caloric intake increased significantly to 260 kcal/kg body weight/day. It was suggested that the ME provided by the breast milk was 17.8 kcal/day. Thus, this suggests that captive diets must be modified to accommodate the high energetic demands of lactation.

Suggested Diet

ZuPreem Marmoset (Hill's) diet is basically a nutritious diet for cotton-top tamarins. Additional items in conjunction with ZuPreem Marmoset diet however, will allow for a complete diet that addresses not only the physical but psychological needs of the tamarins. Cotton-top tamarins have been observed to consume between 30-40 g/kg/day (Escajadillo et al., 1981; Flurer et al., 1983).

Rather than provide a listing of each institutions diet, we have provided sample diets that meet the current nutritional standards for callitrichids. The diets of the Brookfield Zoo and Central Park Wildlife Center have been prepared by their respective nutritionists and represent a completely well balanced diet for cotton-top tamarins.

Brookfield Zoo Cotton-top Tamarin Diet (per animal)

Diet provides approximately 184 kcal/kg/day

Divide this amount into two feedings.

<u>Item</u>	<u>Amount</u>
Hill's ZuPreem Canned Marmoset Diet	46 g
Frugi Fruit'	24 g

Sweet Potato	10g
Crickets	2.15 g (10, 3d/wk)
Mealworms	0.34 g (10, 3d/wk)
Marmoset Protein Supplement ²	0.06 g

1. Frugi Fruit is of 54.5% apple, 11.4% grape, 17% banana, 5.7% raisins, 5.7% currants, 5.7% blueberries)

2. Marmoset Protein Supplement consists of 16.3% spray dried egg whites, 24.5% high nitrogen casein, 40.8% soybean protein, 16% magnesium oxide, 2% iron sulfate, 0.4% manganese sulfate)

Note: The Marmoset Protein Supplement is spread over the frugi fruits

Central Park Wildlife Center Cotton-top Tamarin Diet (12er animal)

Diet provides approximately 175 kcal/kg/day

<u>Item</u>	<u>Amount</u>
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AM Diet

Hill's ZuPreem Marmoset Diet	50 g
Spectrum Primate Pro-Plus	6 g
Bird salad	25 g

PM Diet

Spectrum Primate Pro-Plus	6g
Bird Salad'	50g

One treat per day can be given, including: apple, banana, greens, orange, mealworms, or crickets.

If needed, orange juice can be used on the high fiber primate biscuit to entice animals to eat; otherwise there is no need for orange juice.

1. BIRD SALAD RECIPE (Provides: 700 kcal/kg)

Mix for 2 kg:

fruit	1000g
mixed vegetables	500g
greens	400g
avi-powder	100g
oyster shell	4g
dicalcium phosphate (powder)	2g
vitamin E powder (Rovimix)	0.1g

PREPARATION: Chop fruits and greens (kale) finely, add mixed vegetables and coat all with dry ingredients.

FRUIT: 4 apples (500g), 3 cups blueberries (350g), 1 cup grapes (150g)

VEGETABLES: frozen mixed vegetables - 4 cups (500g)

ROVINUX 40%: vitamin E supplement, Hoffmann-LaRoche, Inc.