

Chapter 4

Nutrition, Food Preparation and Feeding

Adapted from E. Dierenfeld, M. Bush, L. Phillips, R. Montali and other contributors

Cite Reference:

Dierenfeld, E.S., Bush, M., Phillips, L. and R. Montali (1994) Nutrition, Food Preparation and Feeding. In: *Management and Conservation of Captive Tigers, Panthera tigris*. R. Tilson, G. Brady, K. Traylor-Holzer and D. Armstrong, Eds. Minnesota Zoo: Apple Valley, Minnesota

DIETARY REQUIREMENTS

(from E. Dierenfeld)

Unique nutritional requirements of felids must be recognized in feeding captive tigers, including the need for high protein and fat diets, inclusion of dietary vitamin A (as retinol), arachadonic acid, taurine, and niacin. General reviews of felid nutrition (Scott 1968, MacDonald et al. 1984), a more specific review applying these data to captive tiger management (Dierenfeld 1987), and a summary of digestion studies conducted on captive tigers (Hackenberger et al. 1987) provide evidence that the domestic cat remains the best model for establishing dietary composition parameters (National Research Council 1984) for the tiger.



Bush et al. (1987) point out that exact nutritional requirements for all nutrients are not known specifically for tigers; therefore, requirements are extrapolated from data on domestic felids (NRC 1984). Diets are formulated, prepared, and fed; some meet dietary needs while others do not and result in tigers with nutritionally related medical problems (e.g., chronic disease, nutritional disorders or poor reproductive performance). Fortunately, most nutritional disorders are of only historical significance due to improved nutritional management (Slusher et al. 1965). This does not exclude other possible nutritionally related disorders observed in tigers such as hind-limb ataxia (Seal, pers. comm.).

Adult tigers are fed to maintain body condition, with general maintenance energy requirements = $140 \text{ kcal (body mass in kg)}^{.75}$ (Kleiber 1964). Thus a female averaging 123 kg requires 5170 kcal/day, whereas a 160 kg male requires 6300 kcal. Metabolizable energy (ME) requirements can be met by daily feeding 3.1 and 4.1 kg respectively, of commercial diets containing about 2.00 kcal/kg (as fed basis) daily, with a digestibility coefficient of 0.84.

Most management programs have found that tigers' appetites and body conditions improve if they are fasted one to two days a week. Either no food is fed on these days or shank or other large bones are fed. Feeding bones (femur bones, oxtails, rawhide) has an additional function in

promoting periodontal health and provides an opportunity to exhibit more natural feeding behaviors, and presumably is enriching to the animals (see **Chapter 2, Dental**). One fast day per week is recommended, which increases the meal sizes to 3.6 and 4.8 kg for Bengal tiger females and males respectively (Sumatran tigers less; Siberian tigers more).

Diet quantities should be increased 10-20% in animals housed outdoors during winter months, and decreased by the same amount during summer months when appetite drops. Increase diet to *ad libitum* during lactation.

Commercially prepared feline diets (see **Commercial Feline Diet** box) or properly supplemented carcass meat should be considered the dietary staple for tigers. Composition should closely adhere to nutrient specifications as outlined above. Recent studies with zoo felids have reported excesses of vitamin A and phytoestrogens, and deficiencies of taurine in various commercial preparations. Responsive manufacturers are correcting these potential health problems by reducing retinol to levels of approximately 15,000 IU/kg (dry basis), minimizing the addition of estrogenic plant materials, and increasing the addition of taurine, particularly in heat-processed meat products. No vitamin supplements should be necessary with properly formulated and stored commercial diets.

The advantage of the commercial diets is that they are readily available, require little or no labor in preparation, and are assumed to be formulated with a sound nutritional basis. The disadvantage is that it does not resemble a tiger's natural diet and disallows "hunting" as seen in captive tigers fed whole or partial carcasses. Some managers consider commercial feline diets very boring for the cat and unavailable to Southeast Asian zoos. For example, Indonesian zoos feed their tigers kangaroo meat and Chinese zoos feed mostly chicken. Economics determine the components of these diets as the ingredients vary with the change in cost of producing the diet. Thus, the guaranteed analysis remains the same, but the diet may vary in raw ingredients. The guaranteed analysis label does not guarantee that the ingredients of the diet are actually utilized or available for utilization by the tiger (Bush et al. 1987).

FOOD PREPARATION

(from M. Bush, L. Phillips & R Montali)

Food preparation and handling is an area of special concern. If the diet is mixed within the institutions, all ingredients should be scrupulously maintained free of contamination from chemicals, pests or microorganisms. Avoid allowing raw diets to warm to room temperature for long periods of time prior to feeding. The practice promotes the rapid growth of bacterial organisms. Frozen ingredients should be properly thawed to reduce bacterial growth and diets fed as soon as possible after mixing. Commercial diets are thawed under clean conditions, free from external contamination, and fed immediately after thawing. Some institutions actually feed the diet while still frozen allowing tigers to eat as it thaws.

The food is weighed and daily records kept as to how much is offered to each individual tiger

and how much is consumed. Determination of ration amounts is a dynamic process to meet changes in metabolic needs, such as in seasonal needs, illness, pregnancy, lactation and growth. Proper body weight to avoid obesity should be maintained by diet alterations. These changes should reflect not only energy but also vitamin and mineral needs. Records of stool consistency

A Commercial Feline Diet

(adapted from Animal Spectrum, 5801 Locust St, Lincoln, NE 68516)

This commercial feline food has been formulated to be fed as the sole ration to non-domestic carnivores, principally *Felidae*. It is a complete and balanced diet fortified with all necessary vitamins and trace minerals, as well as proper levels of calcium and phosphorus.

Ingredients

Horsemeat, horsemeat by-products, bone meal, liver, fish meal, soy grits, dried beet pulp, dried eggs, brewer's dried yeast, salt, D-activated animal sterol (source of vitamin D₃), vitamin B₁₂ supplement, vitamin E supplement, menadione, sodium bisulfite (source of vitamin K activity), riboflavin supplement, niacin, calcium pantothenate, choline chloride, thiamine, pyridoxine hydrochloride, folic acid, copper oxide, cobalt carbonate, manganous oxide, ethylene diamine dihydriodide, zinc oxide.

Guaranteed Analysis

Crude Protein:	19.0% (min.)
Crude Fat:	12.0% (min.)
Crude Fiber:	1.5% (max.)
Ash:	4.5% (max.)
Calcium:	0.6% (min.)
Phosphorus:	0.5% (min.)
Moisture:	62.0% (max.)
Vitamin A:	7,500 IU/lb. (min.)
Vitamin D ₃ :	850 IU/lb. (min.)

assist in determining if the diet is poorly digested or possibly inducing diarrhea indicative of enteric disease. The food should be offered on a non-contaminated surface. In most situations feeding is done on the enclosure floor. Feeding should optimally be off the floor or substrate, but this is not always practical as tigers often destroy bowls.

Chunk Meat Supplements

If diets are mixed within the institution they should be supplemented to provide 1% calcium (dry matter basis), particularly if bones are not consumed. This is equivalent to about 7 g Ca/kg meat; a non-phosphorus containing supplement such as CaCO₃ (40% Ca) should be used. For this particular example, 17.5 g of CaCO₃ (per kg meat) would be added. If meat is lean and/or well-trimmed, vitamins A and E may need to be supplemented at recommended levels. Do not supplement with vitamin A if liver is consumed in any amount. Vitamin E may be necessary in diets based on meats containing polyunsaturated fats (any non-ruminant), at levels providing 50-

150 IU/kg dry matter. One reviewer suggests that meat on the bone or whole carcasses can also be supplemented with a good powdered supplement used in conjunction with cod liver oil, even for females with cubs (D. Richardson).

Whole prey items should be small enough, or fed at appropriate intervals, to permit consumption

How Much Does A Wild Tiger Eat?

Over much of the tiger's broad geographic range, wild pig, wild cattle and several species of deer are their major prey. All prey are forest or grassland ungulates that range in size from small hog deer at 30 kg (65 lbs), to sambar (180 kg/400 lbs), up to large gaur at over 900 kg (2,000 lbs). Schaller (1969) assumed a requirement of 5.4 to 6.8 kg per Bengal tiger per day on a long-term basis. Sankhala (1977) suggested about 10-12 kg of meat per day, while Sunquist (1981) suggested 5-6 kg for a tigress and 6-7 kg for a tiger per day. Tamang's (1979) study of Bengal tigers and prey populations pointed out that free-ranging tigers consume a daily requirement of 7 kg. To obtain this food a tiger would need to kill 18 sambar, or 111 hog deer, or 68 chital per year (based on the assumption the only 70% of prey is considered edible).

Typically, wild tigers gorge themselves on fresh kills. As the carcass is eaten (after several days), daily food consumption decrease, followed by a few days during which tigers eat practically nothing. Thus, the average amount of food consumed over the entire period is closer to what a zoo tiger eats on an

in total. Although little information concerning the contribution of gut contents in prey items to overall nutrition of predators is available, complete rather than selective consumption of prey species is recommended to prevent previously documented nutrient imbalances, e.g., rickets in carnivores fed only muscle or organ meat; hypervitaminosis A from excessive liver.

FEEDING BEHAVIOR

Lindburg (1988) presented excellent arguments for the augmentation of prey items to animal exhibits to enhance natural behaviors, as well as health effects previously discussed. While zoos cannot recreate a completely natural existence, there are points at which nature's ways can guide management in improving the quality of life for zoo animals. Equating an adequate diet with good nutrition leads to dietary substitutions which ignore non-nutritive requirements. These requirements include substitute activities, oral health in relation to food texture, and the psychological aspects of feeding. While psychological well-being remains an elusive concept regarding "pleasure" in feeding, the difficulties encountered in its measurement do not render it unimportant. Until more refined techniques for assessing the mental state of animals in feeding are developed, we may be guided by the fact that the behaviors commonly associated with feeding in nature lead to the conclusion that much of their pleasure centers around food.

Markowitz (1982) described an elaborate system of behavioral enrichment installed to promote displays of hunting and jumping ability of the tiger. Certainly obesity due to lack of activity in captivity is a major problem for zoo carnivores, including tigers. Both of the above suggestions require commitment in terms of labor and/or capital investment, but may prove valuable.

The primary goal from an animal health perspective is to provide a good diet formulation based on sound nutritional concepts and quality sources of dietary components. Other contributors have pointed out the value of attempting to meet the environmental and behavioral needs of captive tigers. One of the ways to meet these needs is to devise a weekly diet that would provide commercially prepared diets, bones and whole or partial carcasses. Care must be taken that animals euthanized with barbiturates are not fed, as this is the most common type of poisoning in large captive felids. Felids feeding on such carcasses may show varying signs from mild ataxia to general anesthesia that may last for days. The liver from such carcasses are especially high in barbiturate levels and cause more severe signs (Bush et al. 1987). In addition, communication between the source of the diets, the veterinary and nutrition staff, and the keepers will allow monitoring of health status, early evidence of nutritional deficiencies, or potential toxic problems. Only then can dietary inadequacies be assessed.

REFERENCES

- Bush, M.; Phillips, L.G.; Montali, R.J. Clinical management of captive tigers. In *TIGERS OF THE WORLD*. R.L. Tilson and U.S. Seal, eds. Noyes Publications: Park Ridge, NJ, Pp. 171-99, 1987.
- Dierenfeld, E.S. Nutritional considerations in captive tiger management. In *TIGERS OF THE WORLD*. R.L. Tilson and U.S. Seal, eds. Noyes Publications: Park Ridge, NJ, Pp.149-60, 1987.
- Hackenberger, M.K.; Atkinson, J.L.; Niemuller, C.; Florkiewicz, R.F. Digestibility and metabolizable energy of diets for captive tigers. In *TIGERS OF THE WORLD*. R.L. Tilson and U.S. Seal, eds. Noyes Publ.: Park Ridge, NJ, Pp. 161-66, 1987.
- Kleiber, M. *THE FIRE OF LIFE*. Wiley: New York, 1964.
- Lindburg, D.G. Improving the feeding of captive felines through application of field data. *ZOO BIOLOGY*. 7:211-18, 1988.
- MacDonald, M.L.; Rogers, Q.R.; Morris, J.G. Nutrition of the domestic cat, a mammalian carnivore. *ANN. REV. NUTR.* 4:521-62, 1984.
- Markowitz, H. *BEHAVIORAL ENRICHMENT IN THE ZOO*. Nostrand Reinhold Co.: New York, 1982.
- National Research Council. *NUTRIENT REQUIREMENTS OF CATS*. National Academy of Sciences: Washington, DC, 1984.
- Sankhala, K.S. *TIGER! THE STORY OF THE INDIAN TIGER*. Simon and Schuster: New York, 1977.

Schaller, G. THE DEER AND THE TIGER. University of Chicago Press: Chicago, 1969.

Scott, P.P. The special features of nutrition of cats, with observations on wild felidae nutrition in the London Zoo. SYMPOSIUM OF THE ZOOLOGICAL SOCIETY. London. 21:21-36, 1968.

Slusher, R.; Bistner, S.I.; Kirchner, C. Nutritional secondary hyper-parathyroidism in a tiger. JOURNAL OF THE AMERICAN VETERINARY MEDICAL ASSOCIATION. 147:1109-1115, 1965.

Sunquist, M.E. The social organization of tigers (*Panthera tigris*) in Royal Chitwan National Park, Nepal. SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY, 336: 1-98, 1981.

Tamang, K.M. Population characteristics of the tiger and its prey. Ph.D. Thesis, Michigan State University, East Lansing, 1979.