The Association of American Feed Control Officials Dog and Cat Food Nutrient Profiles: Substantiation of Nutritional Adequacy of Complete and Balanced Pet Foods in the United States [1,2]

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ABSTRACT The Association of American Feed Control Official (AAFCO) formed the Canine (1990–1991) and Feline (1991–1992) Nutrition Expert Subcommittees to update the requirements for substantiation of "complete and balanced" claims for pet foods sold in the United States. There are two means by which a company may substantiate nutritional adequacy for a dog or cat food. The first means is by formulating the food so that nutrient levels fall within the ranges as established in the AAFCO Dog and Cat Food Nutrient Profiles. These profiles replace the National Research Council recommendations as the recognized authority in the United States as that term is applied to AAFCO regulations. Levels of nutrients are based on practical formulations of pet foods with adjustments to account for bioavailability of nutrients in commonly used ingredients. Separate profiles for adult maintenance and growth and reproduction are set, and maximum levels of some nutrients are also established. The second means of substantiation is through the conduct of feeding trials following AAFCO protocols. J. Nutr. 124: 2535S–2539S, 1994.

INDEXING KEY WORDS:

• *symposium* • *dogs* • *cats* • *nutritional requirements* • *nutrient profiles*

The Association of American Feed Control Officials (AAFCO) is an advisory body comprised of representatives from the individual states of the United States. A primary function of AAFCO is the publication of model laws, animal feed regulations and ingredient definitions, all of which a state may adopt as a part of its own feed laws and regulations. Included in the model regulations are means for substantiation of nutritional adequacy for "complete and balanced" dog and cat foods.

Means of substantiation

There are two means of substantiating the nutritional adequacy of a pet food. The first method requires the product to be formulated so that essential nutrient levels fall with the ranges as set in the AAFCO Nutrient Profiles. The second method requires a pet food manufacturer to conduct animal feeding trials in accordance with AAFCO protocols. Pet foods that successfully pass the feeding trials are exempt from the requirement to meet the profiles.

Historically, AAFCO has relied on the publications of the National Research Council (NRC) as its "recognized authority on animal nutrition" with respect to the levels of nutrients that constituted a complete and balanced dog or cat food (NRC 1974, 1978, 1985, 1986). This reliance became problematic with the most recent of the NRC publications. The 1985 and 1986 editions reflected more recent knowledge of canine and feline nutrition, but their recommendations were not in a format readily usable by AAFCO or the pet food industry. As a result, AAFCO elected to continue to use the outdated 1974 and 1978 recommendations.

In 1990, the AAFCO Canine Nutrition Expert (CNE) Subcommittee was established to address this problem. The report of the CNE Subcommittee became the AAFCO Dog Food Nutrient Profiles (Table 1) (AAFCO 1992). Compared with the 1974 NRC rec-

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TABLE 1

***AAFCO Nutrient Profiles for dog foods*[1]**

Nutrient	Units dry matter	Growth/reproduction minimum	Adult maintenance minimum	Maximum
Protein	g/kg	220	180	
Arginine	g/kg	6.2	5.1	
Histidine	g/kg	2.2	1.8	
Isoleucine	g/kg	4.5	3.7	
Leucine	g/kg	7.2	5.9	
Lysine	g/kg	7.7	6.3	
Methionine-cystine	g/kg	5.3	4.3	
Phenylalanine-tyrosine	g/kg	8.9	7.3	
Threonine	g/kg	5.8	4.8	
Tryptophan	g/kg	2.0	1.6	
Valine	g/kg	4.8	3.9	
Fat[2]	g/kg	80	50	
Linoleic acid	g/kg	10	10	
Minerals				
Calcium	g/kg	10	6	25
Phosphorus	g/kg	8	5	16
Ca/P ratio		1:1	1:1	2:1
Potassium	g/kg	6	6	
Sodium	g/kg	3	0.6	
Chloride	g/kg	4.5	0.9	
Magnesium	g/kg	0.4	0.4	3
Iron[3]	mg/kg	80	80	3000
Copper	mg/kg	7.3	7.3	250
Manganese	mg/kg	5.0	5.0	
Zinc	mg/kg	120	120	1000
Iodine	mg/kg	1.5	1.5	50
Selenium	mg/kg	0.11	0.11	2
Vitamins				
Vitamin A	mg/kg	1.5	1.5	15
Vitamin D	mg/kg	0.0125	0.0125	0.125
Vitmain E	mg/kg	50	50	1000
Thiamine[4]	mg/kg	1.0	1.0	
Riboflavin	mg/kg	2.2	2.2	
Pantothenic acid	mg/kg	10	10	
Niacin	mg/kg	11.4	11.4	
Pyridoxine	mg/kg	1.0	1.0	
Folic acid	mg/kg	0.18	0.18	
Vitamin B-12	mg/kg	0.022	0.022	
Choline	mg/kg	1200	1200	

[1] Presumes an energy density of 14.6 kJ ME/g, based on the "modified Atwater" values of 14.6, 35.6 and 14.6 kJ ME/g for protein, fat and carbohydrate (nitrogen-free extract), respectively. In rations >16.7 kJ ME/g, the concentration of all other nutrients should be increased proportionately; rations <14.6 kJ ME/g should *not* be corrected for energy.

[2] Although a true requirement for fat per se has not been established, the minimum level was based on recognition of fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability and to supply an adequate energy density.

[3] Because of very poor bioavailability, iron from carbonate or oxide sources that is added to the diet should not be considered as contributing to the nutritional iron in the diet.

[4] Because processing may destroy up to 90% of the thiamin in the diet, allowances in formulation should be made to ensure the minimum nutrient level is met after processing.

ommendations, there are two separate AAFCO profiles (one for growth and reproduction and one for adult maintenance), instead of just one for all life stages. This allows dog foods formulated for the maintenance of adult dogs to contain lower amounts of some nutrients. Also, out of concern for the risk of nutrient excess, maximum limits on the amounts of calcium, phosphorus, magnesium, fat-soluble vitamins and most trace minerals in dog foods were established (Hazewinkel 1989, Hedhammer et al. 1974, NRC 1980, NRC 1987). Where specific data were lacking in dogs, data on other species were extrapolated.

The new profile for growth and reproduction raises the minimum amount of fat required. In the practical experiences of the subcommittee members, this was deemed necessary to increase the energy content to appropriate levels. Also increased in both profiles are the levels of zinc and iron (Chausow and Czarnecki-Maulden 1987, Sanecki et al. 1982). On the other hand, the levels of calcium, phosphorus and sodium chloride

TABLE 2

***AAFCO Nutrient Profiles for cat foods*[1]**

Nutrient	Units dry matter	Growth/reproduction minimum	Adult maintenance minimum	Maximum
Protein	g/kg	300	260	
Arginine	g/kg	12.5	10.4	
Histidine	g/kg	3.1	3.1	
Isoleucine	g/kg	5.2	5.2	
Leucine	g/kg	12.5	12.5	
Lysine	g/kg	12.0	8.3	
Methionine-cystine	g/kg	11.0	11.0	
Methionine	g/kg	6.2	6.2	15
Phenylalanine-tyrosine	g/kg	8.8	8.8	
Phenylalaine	g/kg	4.2	4.2	
Taurine (extruded)	g/kg	1.0	1.0	
Taurine (canned)	g/kg	2.0	2.0	
Threonine	g/kg	7.3	7.3	
Tryptophan	g/kg	2.5	1.6	
Valine	g/kg	6.2	6.2	
Fat[2]	g/kg	90	90	
Linoleic acid	g/kg	5	5	
Arachidonic acid	g/kg	0.2	0.2	
Minerals				
Calcium	g/kg	10	6	
Phosphorus	g/kg	8	5	
Potassium	g/kg	6	6	
Sodium	g/kg	2	2	
Chloride	g/kg	3	3	
Magnesium[3]	g/kg	0.8	0.4	
Iron[4]	mg/kg	80	80	
Copper	mg/kg	5	5	
Iodine	mg/kg	0.35	0.35	
Zinc	mg/kg	75	75	2000
Manganese	mg/kg	7.5	7.5	
Selenium	mg/kg	0.1	0.1	
Vitamins				
Vitamin A	mg/kg	2.7	1.5	225
Vitamin D	mg/kg	0.01875	0.0125	0.25
Vitamin E[5]	mg/kg	30	30	
Vitamin K[6]	mg/kg	0.1	0.1	
Thiamin[7]	mg/kg	5.0	5.0	
Riboflavin	mg/kg	4.0	4.0	
Pyridoxine	mg/kg	4.0	4.0	
Niacin	mg/kg	60	60	
Pantothenic acid	mg/kg	5.0	5.0	
Folic acid	mg/kg	0.8	0.8	
Biotin[8]	mg/kg	0.07	0.07	
Vitamin B-12	mg/kg	0.02	0.02	
Choline[9]	mg/kg	2400	2400	

[1] Presumes an energy density of 16.7 kJ ME/g, based on the "modified Atwater" values of 14.6, 35.6 and 14.6 kJ ME/g for protein, fat and carbohydrate (nitrogen-free extract), respectively. In rations that contain >18.8 kJ ME/g, the concentration of all other nutrients should be increased proportionately; rations <16.7 kJ ME/g should *not* be corrected for energy.

[2] Although a true requirement for fat per se has not been established, the minimum level was based on recognition of fat as a source of essential fatty acids, as a carrier of fat-soluble vitamins, to enhance palatability, and to supply an adequate energy density (NRC 1986).

[3] In general, if the mean urine pH of cats fed ad libitum is not below 6.4; the risk of struvite urolithiasis increases as the magnesium content of the diet increases.

[4] Because of very poor bioavailability, iron from carbonate or oxide sources that is added to the diet should not be considered as contributing to the level of nutritional iron in the diet.

[5] Add 10 mg vitamin E above minimum level per gram of fish oil per kilogram of diet (NRC 1986).

[6] Vitamin K does not need to be added unless diet contain >25% fish on a dry matter basis.

[7] Because processing may destroy up to 90% of the thiamin in the diet, allowances in formulation should be made to ensure the minimum nutrient level is met after processing.

[8] Biotin does not need to be added unless diet contains antimicrobial or antivitamin compounds (NRC 1986).

[9] Methionine may substitute for choline as a methyl donor at a rate of 3.75 parts for 1 part choline by weight when methionine exceeds 6.2 g/kg (NRC 1986).

(salt) are lowered compared with the 1974 NRC recommendations, especially for adult maintenance dog foods (Henrikson 1968, Jenkins and Phillips 1960, NRC 1985). In addition to setting levels for amounts of calcium and phosphorus individually, minimum and maximum ranges for the calcium-to-phosphorus ratio have been set. The new profiles also establish minimum required amounts of essential amino acids, as well as protein. Amino acid requirements were also recommended in the 1985 NRC edition but not the 1974 edition. Changes in the amounts of some of the amino acids compared with the 1985 NRC recommendations were also incorporated (Blaza et al. 1982, Czarnecki and Baker 1982, Hirakawa and Baker 1985, Hirakawa and Baker 1986).

The Feline Nutrition Expert (FNE) Subcommittee was formed in 1991 to address the same issue in cat foods and the NRC recommendations. The FNE Subcommittee updated the cat food nutrient profiles in a manner similar to that of dog foods (Table 2) (AAFCO 1993). Taurine levels were established for both extruded and canned products, with higher levels in canned foods to account for the lower availability of taurine in these products (Douglass et al. 1991). Modifications in the levels of protein, calcium, phosphorus, potassium, zinc and niacin were also made compared with the 1978 NRC recommendations (Buffington et al. 1991, NRC 1986). A minimum level of vitamin K activity in products containing high amounts of fish was established (Strieker 1991). Maximum levels of some nutrients (methionine, zinc and vitamins A and D) were also established (Fau et al. 1987, NRC 1980, NRC 1987).

In addition to establishing new nutrient profiles for cat foods, another charge of the FNE Subcommittee was to revise the AAFCO feeding trial protocols for both dog and cat foods. The number of animals were increased from six to eight per test diet. Also, more specific statistical methodology was incorporated. For a diet to pass under the new protocols, mean values of parameters in the treatment group animals may not be significantly different from mean values in the control group animals, whereas values under the old protocols had to fall within a range of "normal" values. Animals under the old protocols could show profound drops in hemoglobin values, for example, and yet if values remained in the normal range the diet would pass. This treatment effect is better detected by use of the new methods.

Many "loopholes" were also filled to better preserve data integrity. For example, under the old protocols a certain number of animals had to successfully pass the test, but the protocols did not specify how many animals could be put on test. Theoretically, an unlimited number of animals could be put on test to replace those removed for "nonnutritional reasons" until enough passed. Now, ≤25% of animals put on test may be removed.

Some new serum chemistry analyses were also added to the protocols. For example, whole blood taurine levels must be determined on all cats in the tests. Also, serum alkaline phosphatase levels must be run on animals during the maintenance trials. The latter test is intended to assure adequate calcium in the diet, whereas the previous maintenance trial would not be able to detect an adverse effect. The subcommittee recognized that this parameter was not ideal in terms of specificity or sensitivity, but weighed potential benefit against the cost and impracticality of other means (e.g., parathormone assays, bone densitometry).

Unequivocal proof of a product's nutritional adequacy for all animals under all conditions can never be achieved. However, with the changes in both the nutrient profiles and feeding trial protocols, assurances of nutritional adequacy to the consumer have been improved. Substantiation of the nutritional adequacy of a pet food based on the nutrient profiles may be less reliable than the results of feeding trials. For example, the nutrient profiles cannot assess the acceptability, palatability and other factors of a product as well as the feeding trials. Also, although formulations should be adjusted to account for nutrient levels at the time of feeding, processing losses can remain a factor. On the other hand, the validity of a feeding trial greatly depends on the competence and integrity of the conductor of the trial. Especially in the maintenance trials, subtle chronic nutrient deficiencies or excesses can be overlooked. In the future, this author envisions a hybridization of the two methods.

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