

Quality Appraisal for the Ornamental Bird, Fish, Dog, and Cat Foods Available in Bangladesh

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Abstract

*The study aimed to assess if the chemical composition of different avian, aquatic, dog, and cat foods commonly available in Chattogram, Bangladesh adheres to the recommended standards. Food samples were collected and subjected to proximate analysis for the dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE), and total ash (TA). The plant seeds used for ornamental birds exhibited substantial variability in terms of proximate components. The maximum variability was observed in case of CF contents (101.3%), followed by EE (88.3%), NFE (37.1%), CP (35.8%), TA (33.3%) and DM (2.9%) contents. The DM (94.6%) and EE (34.2%) were highest in the sunflower (*Helianthus annuus*), the CP was highest (24.9%) in the hemp (*Cannabis sativa*), the CF was highest (35.0%) in the chia (*Salvia hispanica*), the NFE was highest (83.3%) in the rice (*Oryza sativa*), and the TA was highest (6.8%) in the guji (*Guizotia abyssinica*) seeds. The mean values of the dog and cat foods revealed that DM, CP, CF, EE, NFE, and TA were 93.4, 31.0, 2.6, 10.5, 49.1, and 6.8%, respectively for different brands. The observed variations among minimum and maximum values were DM 3.0%, CP 12.7%, CF 1.5%, EE 13.8%, NFE 26.9%,*

and TA 3.2%. The proximate analysis of aquarium fish foods revealed that the mean values of DM, CP, CF, EE, NFE, and TA were 94.6, 26.7, 4.2, 5.3, 51.7, and 6.8%, respectively for different brands. The observed variations among minimum and maximum values were DM 1.9%, CP 5.2%, CF 1.5%, EE 1.6%, NFE 5.7%, and TA 1.6%. Overall, all the brands met or exceeded the minimum standards. Pets being sensitive to food allergy in addition to proximate analysis, feeding trials are recommended to ensure acceptability, palatability, and digestibility of the pet foods.

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INTRODUCTION

Pets are the animals, birds, fishes, amphibians, and reptiles which are kept to serve different purposes, i.e., fancy, fun, exhibition, company, recreation, and sometimes for personal, family, and institutional protection [1–5]. Additionally, keeping pet may influence the psychological and physiological parameters important to the health and welfare of human beings [6–9]. Dogs and cats are the most common pet animals although nowadays, people also keep other animals like

rabbits, rodents, hamsters, fancy rats, guinea pigs, pigeon, love birds, finch, cockatiel, budgerigar, java, macaw, diamond dove, grey parrot, tropical gold fish, comets, frogs, tarantulas, crabs, and some reptiles, and insects [10–12]. In Bangladesh, different types of avian and aquatic pets are the new type in addition to traditional dogs and cats. Recently, the number of households having pets is increasing day by day [13–15]. People are becoming more and more interested in rearing pets. Currently, trading of these pets is a new trend in our country and various associations are involved in this sector. Most of the pets available here are of exotic types and the foods that are used to feed them are either of plant or animal origin [16–19]. Commercial pet foods usually contain macronutrients, trace elements, and vitamins necessary to keep captive pets in good health. The management of these pets differs from the management of other domestic animals in terms of housing, feeding, reproduction, disease, and health.

Of all the factors, food is one of the vital components amongst the numerous inputs required for successful pet rearing. Different types of pet foods are used for feeding different species of pets that are commercially available. The most commonly used ingredients of the ornamental bird foods are different kinds of seeds such as sunflower, lin, canary, safflower, hemp, guji, sesame, rice, chia, varagu, and millet seeds [20–23]. These plant seeds are good sources of nutrients necessary for growth, reproduction, and health of the pet animals. Plant seeds are typically high in unsaturated fats and are considered as healthy food ingredients for birds [20]. In case of aquatic pets, food is prepared in a way intended for consumption by fishes kept in aquariums or in tanks. Approximately, 80% of the aquarists provide exclusively industrially prepared commercial foods available in flake, pellet, or tablet form for their fishes [24–27]. Fish foods contain essential fatty and amino acids for fishes. However, for dogs and cats many types and forms of commercial foods are available, i.e., dry pet foods, wet pet food, and semi-moist pet food [28, 29]. Dry pet foods are popular because they are comparatively cheap, easy to store, and convenient to administer [30, 31].

In case of choosing a commercial pet food, the most important consideration, however, is its nutrient content because the maintenance, growth, productive and reproductive performances, as well as behavior of pets are directly associated with the quality of foods provided. Unbalanced and poor quality diet invites wide range of diseases which interfere the productivity of animals severely. Accordingly, it is very important to consider the nutritional requirement of the reared pets as well as the nutritional composition of the given foods. Nowadays, the pet owners are becoming more and more conscious in selecting pet foods to ensure proper amount of nutrition to their pets to promote their long-term health and welfare [18, 21, 22]. Though pet food trade is a promising sector in Bangladesh, there are very few literatures found in assessing the quality of available commercial pet foods in relation to their price. The present study, therefore, was conducted to assess the chemical composition of different avian, aquatic, and companion pet foods commonly available in Chattogram, Bangladesh.

MATERIALS AND METHODS

Study Area

Commercially manufactured ornamental bird, fish, dog, and cat food samples were collected from the different local markets of Chattogram metropolitan area and analyzed in the Animal Nutrition Laboratory of the Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University (CVASU) from April to September, 2018.

Collection of Sample

The different food samples of each type, e.g., ornamental bird food (Figure 1), fish food, dog food and cat foods were collected from different retail shops. Around 100g of each sample was taken in a sterile zipper bag and sent to the Animal Nutrition Laboratory, CVASU for chemical analysis.

Preparation of Sample

Air dry samples were used for estimating moisture content in a hot air oven. The samples were

subjected to grinding to make a homogenous powder. Later on, it was mixed properly and exposed for sampling. Individual samples were marked and kept in air tight polythene bags and labeled properly for further analyses.



Figure 1. Plant seeds used as ornamental pet bird foods.

Analysis of Samples

Samples were subjected to proximate analysis for the dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE), and total ash (TA) followed by the procedure as described by AOAC [32].

Statistical Analysis

Data related to chemical composition of different foods were compiled by using Microsoft Excel 2016. Raw data were tested for the outliers and multicollinearity by interquartile range test and variance inflation factors. Normality of variable was examined by using a normal probability plot and equality of variances was tested by the Shapiro Wilk test. The descriptive statistics, i.e., mean, median, mode, standard error, and coefficient of variation for the DM, CP, CF, EE, NFE, and TA were calculated and one sample t-test was performed using reference value to analyze the data in Stata (Stata/SE 14.1, Stata Corp LP, 4905 Lakeway drive, College Station, TX77845, USA). For dog and

cat food, the considered reference values were DM 92.0%, CP 30.0%, CF 5.0%, EE 8.0%, NFE 50.0% and TA 6.0%. For aquarium fish food, the reference values were DM 95.0%, CP 25.0%, CF 5.0%, EE 5.0%, NFE 50.0%, and TA 5.0%. Statistical significance was accepted at $P < 0.05$ for the one sample t-test.

RESULTS

Ornamental Bird Food

The plant seeds exhibited substantial variability in terms of DM, CP, CF, EE, NFE, and TA contents (Tables 1 and 2). The maximum variability was recorded in case of CF contents (101.3%), followed by EE (88.3%), NFE (37.1%), CP (35.8%), TA (33.3%) and DM (2.9%) contents. The DM (94.6%) and EE (34.2%) were highest in the sunflower (*Helianthus annuus*), the CP was highest (24.9%) in the hemp (*Cannabis sativa*), the CF was highest (35.0%) in the chia (*Salvia hispanica*), the NFE was highest (83.3%) in the rice (*Oryza sativa*), and the TA was highest (6.8%) in the guji (*Guizotia abyssinica*) seeds.

Table 1. Chemical composition of different ornamental bird food ingredients available in the local market at Chattogram, Bangladesh.

Plant seeds	Chemical components (%) ¹					
	DM	CP	CF	EE	NFE	TA
Canary (<i>Serinus canaria</i>)	89.9	19.6	1.8	4.4	70.3	3.9
Chia (<i>Salvia hispanica</i>)	86.3	13.1	35.0	3.2	43.7	5.0
Foxtail millet (<i>Setaria italica</i>)	88.9	11.0	4.0	2.8	79.2	3.0
Guji (<i>Guizotia abyssinica</i>)	91.1	22.1	11.0	26.6	33.5	6.8
Hemp (<i>Cannabis sativa</i>)	93.1	24.9	20.6	24.6	25.5	4.4
Kodo millet (<i>Paspalum scrobiculatum</i>)	89.6	11.4	10.5	3.3	72.0	2.8
Lin (<i>Linum usitatissimum</i>)	93.6	22.6	4.5	16.7	53.0	3.2
Rice (<i>Oryza sativa</i>)	87.9	8.1	2.3	1.6	83.3	4.7
Safflower (<i>Carthamus tinctorius</i>)	92.1	14.7	9.5	19.8	53.0	3.0
Sunflower (<i>Helianthus annuus</i>)	94.6	23.6	3.5	34.2	36.1	2.6

¹DM= Dry matter; CP= Crude protein; CF= Crude fibre; EE= Ether extracts, NFE= Nitrogen free extracts; TA= Total ash.

Table 2. Statistical analysis of different ornamental bird food ingredients available in the local market at Chattogram, Bangladesh.

Parameter (%)	Minimum	Maximum	Mean	Median	SE ¹	CV%
DM	86.3	94.6	90.7	90.5	0.84	2.9
CP	8.1	24.9	17.1	17.2	1.94	35.8
CF	1.8	35.0	10.3	7.0	3.39	101.3
EE	1.6	34.2	13.7	10.6	3.83	88.3
NFE	25.5	83.3	55.0	53.0	6.40	37.1
TA	2.6	6.8	3.9	3.6	0.42	33.3

SE= Standard error; CV= Coefficient of variation

Dog and Cat Food

Results of the proximate analysis of dog and cat foods revealed that the mean values of DM, CP, CF, EE, NFE, and TA were 93.4, 31.0, 2.6, 10.5, 49.1, and 6.8%, respectively for different brands (Tables 3 and 4; Figure 2). All the brands met the minimum standards. However, DM, CF, EE, and

TA differed with the reference standards. The observed variations among minimum and maximum values were DM 3.0%, CP 12.7%, CF 1.5%, EE 13.8%, NFE 26.9%, and TA 3.2%.

Table 3. The analyzed nutrient composition of the pet foods randomly selected from the local market of Chattogram, Bangladesh.

Brands	Analyzed nutrient composition (%)					
	DM	CP	CF	EE	NFE	TA
Brand 1	93.0	34.3	3.2	21.1	33.4	8.0
Brand 2	94.5	25.2	3.2	8.5	56.3	6.8
Brand 3	95.0	33.4	1.9	8.5	49.4	6.8
Brand 4	92.0	35.5	2.2	7.3	47.0	8.0
Brand 5	94.0	35.0	3.3	8.7	48.2	4.8
Brand 6	92.0	22.8	1.9	8.8	60.3	6.2

¹DM= Dry matter; CP= Crude protein; CF= Crude fibre; EE= Ether extracts, NFE= Nitrogen free extracts; TA= Total ash

Table 4. Statistical analysis of nutrient components of different pet food.

Parameter (%)	Minimum	Maximum	Mean	SE	Sig.
DM	92.0	95.0	93.4	0.52	*
CP	22.8	35.5	31.0	2.27	NS
CF	1.8	3.3	2.6	0.28	***
EE	7.3	21.1	10.5	2.12	*
NFE	33.4	60.3	49.1	3.78	NS
TA	4.8	8.0	6.8	0.48	***

SE= Standard error; *= Significant ($p < 0.05$); ***= ($p < 0.001$).

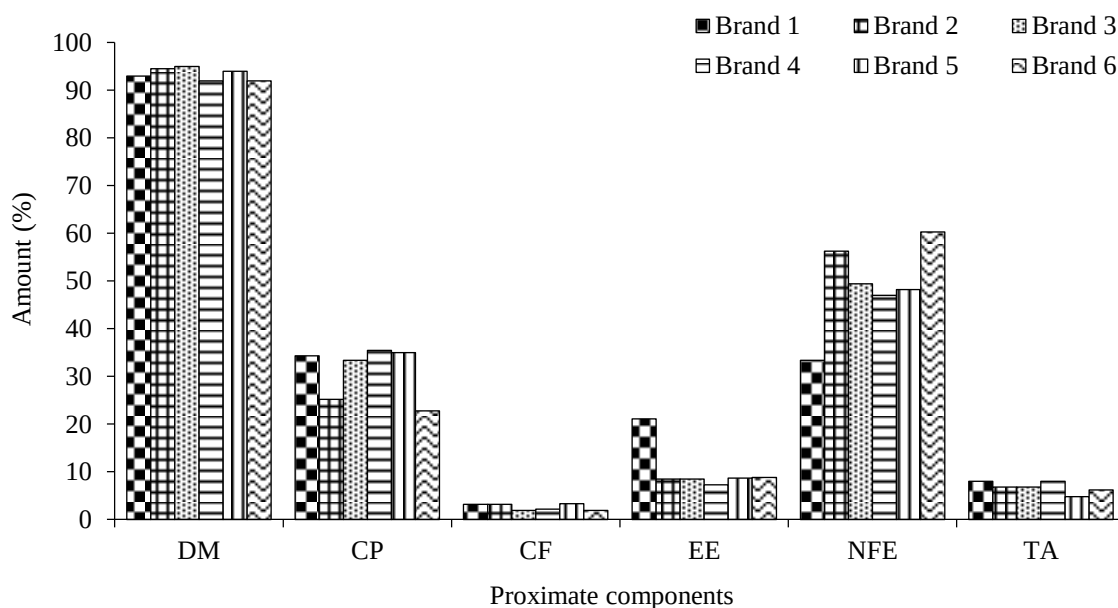


Figure 2. Nutritional comparison of the dog and cat foods.

Ornamental Fish Food

Results of the proximate analysis of dog and cat foods revealed that the mean values of DM, CP, CF, EE, NFE, and TA were 94.6, 26.7, 4.2, 5.3, 51.7, and 6.8%, respectively for different brands (Tables 5 and 6; Figure 3). All the brands met the minimum standards. However, DM, CF, EE, and

TA differed with the reference standards. The observed variations among minimum and maximum values were DM 1.9%, CP 5.2%, CF 1.5%, EE 1.6%, NFE 5.7% and TA 1.6%.

Table 5. Proximate components of the ornamental fish foods.

Sample name	Chemical composition (%)					
	DM	CP	CF	EE	NFE	TA
Optimum	95.1	28.5	3.5	5.0	55.5	7.5
Osaka 2000	93.5	27.0	4.1	5.6	56.6	6.7
Osaka green	94.2	27.8	4.0	6.0	56.3	5.9
Super nova	95.4	23.3	5.0	4.4	60.3	7.0

¹DM= Dry matter; CP= Crude protein; CF= Crude fibre; EE= Ether extracts, NFE= Nitrogen free extracts; TA= Total ash

Table 6. Statistical analysis of the proximate components of pet fish food.

Parameter	Minimum	Maximum	Mean	Median	SE	Sig.
DM	93.5	95.4	94.6	94.7	0.43	NS
CP	23.3	28.5	26.7	27.4	1.16	NS
CF	3.5	5.0	4.2	4.1	0.31	NS
EE	4.4	6.0	5.3	5.3	0.35	NS
NFE	50.0	55.7	51.7	50.6	1.34	**
TA	5.9	7.5	6.8	6.9	0.34	*

SE= Standard error; *= Significant ($p < 0.05$); ***= ($p < 0.001$).

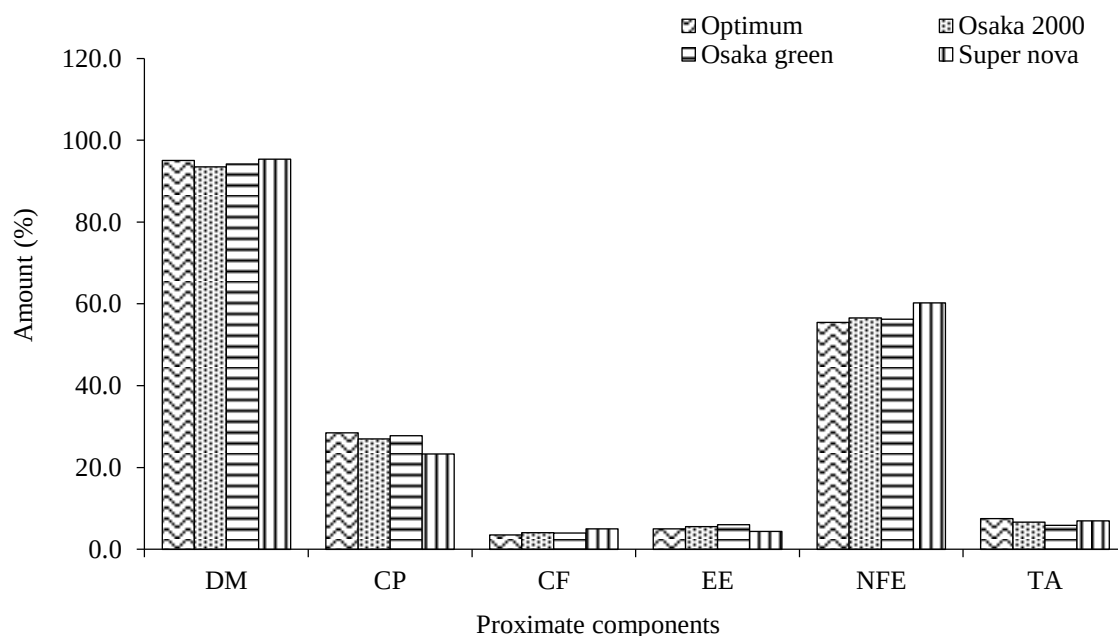


Figure 3. Nutritional comparison of the ornamental aquarium foods.

DISCUSSION

Ornamental Bird Foods

Pet birds' diet formulation is influenced by the species, age, sex, genetics, season of the year, housing, activity, and whether the birds are laying eggs, raising young, molting, or recovering from surgery, disease, or other major stress. However, fresh clean water, vegetables, seeds, fruits, nuts, bark, flowers, insects, invertebrates, nectar, pollen, roots, and berries usually constitute pet birds' diet. The Macaws require a diet with higher fat content, i.e., the addition of nuts while the Lories and

lorikeets mostly eat fruits, vegetables, pollen, and specific commercial or homemade nectars. Australian Grass Parakeets, cockatiels, and many cockatoo species spend most of their day foraging on the ground for seeds. Today, it is well known that the seeds let it be colored, mixed, or pressed into shapes, are not a complete and nourishing diet for the pet birds being missing in essential nutrients. Seeds are very low in calcium. The requirement of calcium for growing birds is close to 1% of the diet. Seeds contain only 0.02 to 0.05% calcium. Seeds are also deficient in protein, essential fatty acids, sodium, zinc, manganese, carotene, and vitamin D. A lack of vitamin D in seed is known to make the calcium deficiency worse. Seeds are higher in phosphorus than calcium. This imbalance of calcium to phosphorus causes severe problems in the birds if birds eat seeds solely. Sunflower seeds are preferred by parrots but there are 8 parts phosphorus to every part calcium. Many seeds are rich in fat which may lead to obesity. All seeds have low iodine, and thus prone to development of goiter. Therefore, if seeds are fed, a variety of other feedstuffs should also be furnished, otherwise, poor feather quality and color, feather picking, sore feet, dry, flaky skin, liver disease, obesity, listlessness, lack of singing, talking, and playing, chewing up cage, biting people, and self-mutilation may develop in pet birds.

Proper and adequate bird nutrition combined with proper husbandry is the most important factor affecting pet birds' healthy life. The manufactured diets have the most potential for providing apparent nutritional needs for the pet birds. Pelleted foods are blends of grains, seeds, vegetables, fruits, and various types of proteins, as well as additional vitamins and minerals. With extrusion, the ingredients are forced through a valve under high pressure and heat, resulting in a product with uniform appearance, increased palatability from caramelized carbohydrates and incorporated air, increased digestibility, and increased shelf life due to altered enzymes. A number of well developed, high quality formulated diets are available today based on direct feeding trials with various companion bird species. Unlike a seed mixture, the bird cannot select particular components out of a formulated diet, so nutritional imbalances are much less likely to occur. A balanced diet is the best type of diet to feed any companion animal to meet the nutritional requirements of the bird. However, some birds may starve to death when converted too quickly to a commercial diet. Therefore, a certain part of the bird's diet may be of seed.

In our study, we analyzed chemical components, i.e., DM, CP, CF, EE, NFE, and TA contents of different seed samples used as ornamental bird food in the present study. Results showed that there was a wide range of variations in the DM contents of different seed samples. The highest moisture content was found in chia seed. Hook et al. reported that the moisture content of a food influences the texture which explains the causes of unique texture of the chia seed [33]. They also said that, the more ordered endosperm structure was evident due to the lower level of moisture content. The low moisture content (2–4%) of some seed samples was well accepted by pet food producers because of low risks for microbial contamination. The CP contents of the seed samples in this study were widely variable. The CP content of foxtail millet in present study was 11.0% that did not support the earlier study done by Ravindran where the average protein content of foxtail millet was found to be 15.9% [34]. The most popular and expensive food ingredient used in pet bird food is chia seed. In our study, the CP content of chia seed was found to be 13.1% which was far below the percentage reported by Marineli et al. [35]. However, these two studies were found to be closely aligned with the crude fiber content of chia seed (35.0%). House et al. reported that the CP and the EE of the whole hemp seed were 24.0 and 30.4% respectively which were found almost similar to our study [36]. It is assumed that some decrease in protein quality with increased ash will occur due to the changes in amino acid concentration. In addition, an increase in ash could further decrease protein quality if bioavailability of amino acid is reduced. However, the effects of ash content on amino acid digestibility are unknown [37, 38].

Dog and Cat Food

Diets of dogs and cats have shifted as a result of domestication and changes in human diets through

the development of agricultural practices. In the United States, 63% of pet owners consider their pets to be their family member [39]. Anthropomorphism of dogs and cats has resulted in pet owner preference for pet foods containing ingredients that they find in their own diet and processed in a way to maintain the nutritional integrity of the ingredients and ensure sound health [16]. Contemporary trends in human diets in developed regions of the world are including more fresh fruits and vegetables [40] and whole grains [41]. The dog and cat diets usually contain dehulled cereal grains, e.g., corn, wheat, oats, barley; cereal by-products, e.g., wheat middlings, wheat germ meal, corn gluten meal; soybean products, e.g., soybean meal soy grits; animal products, e.g., meat meal, meat and bone meal, meat by-products, poultry by-products, fish meal; milk products, e.g., dried skimmed milk, dried whey; fats and oils, e.g., animal fat, groundnut cake, mineral and vitamin supplements [42]. The nutritional adequacy of these products is ascertained by the National Research Council [43] and The American Association of Feed Control Officials [44] of the United States. The ever-increasing dependence on dogs for security and companion is believed to be responsible for the tremendous growth being experienced in the pet industry, with its corresponding increase in demand for pet food by pet owners and dog breeders.

A facilitative fat improves palatability and increases the acceptable texture of foods, is a dense source of dietary calories and energy, and promotes the absorption of fat-soluble vitamins. Dogs and cats are able to consume both types of fats in their diets without undue risk of coronary artery diseases, heart attacks, or strokes to which humans are much more vulnerable. In contrast to humans, dogs and cats typically are resistant to the development of hypercholesterolemia and atherosclerosis. For dogs and cats, these fats enhance palatability, improve the texture of foods, provide energy, and aid in the digestion of fat-soluble vitamins. Functional fats provide for healthy skin and coat, promote health of the gastrointestinal tract and renal system, ensure adequate reproductive performance, control inflammation, and play an important role in neurologic development. However, only small amounts of functional fats are required in the diet. Despite many advantages, the fat substitute binds the fat-soluble vitamins in such a way that neither component is digested or absorbed. Many dog owners prefer feeding dry foods due to the convenience in feeding and storage [45]. In a study it was recommended that the nutritional value for a dry dogfood should be no less than 26.0% CP, no less than 15.0% EE, not more than 5.0% CF, carbohydrate content 37.0%, mineral content 7.0% and no more than 10.0% moisture [46]. In our study, it was observed that the CP% was 31.0% which is slightly higher than the recommended value. The CF was 2.6% which is below the standard of 5.0%. The EE was 10.5% which was below the recommended value. The ash was 6.8% which was close to the recommended value. It was observed that the labeled value provided by manufacturer and the analyzed value were little different.

In a Nigerian study, it was found that the label value of commercial dog and cat food available in Nigeria and the analyzed value in case of DM and CP were almost same but EE and CF were different [42]. In our study, in the laboratory test, it was found that the DM was almost same as the labeled value. In case of CP, the analyzed value was little higher than the labeled value. Protein is very important for a diet for the growth of body. Therefore, the dog owners must watch especially the CP content to cover the daily needs of essential amino acids [47]. From the laboratory test, we observed that the EE was lower than the labeled value. This deficit of EE in dry dog food was alarming. In a different study, it was reported that the diets for companion animals played an important role in contributing to the palatability and texture of food [48].

Fiber is added to canine and feline diets to increase gastrointestinal fill while lowering caloric intake. One disadvantage of high-fiber diets is that stool volume is increased. This can be an advantage in treating coprophagia because dogs are less likely to eat large soft feces. Fiber can also be used to treat pica in cats. In our study, the CF% was found below the labeled value. Although the dietary fiber cannot be broken down by enzymes of intestinal tract of the dogs and cats to

monosaccharide units for absorption in the small intestine, however, a part of fiber can be digested by the microbes found in the large intestine of the dogs and cats. Through the bacterial fermentation, they produce short-chain fatty acids and other end products. The short-chain fatty acids are an important energy source which act on the lining epithelial cells of gastrointestinal tract and these fiber sources help to maintain the health of the gastrointestinal tract [49].

In a published study, it was reported that the role of CF was important in modulating the bowel movement, influencing immune function, gut microbial profile, diluting caloric density, contributing to weight loss and, indirectly ameliorating the incidence of obesity and diabetes mellitus in the pet population [50]. It was further reported that high amount of fiber may hamper the digestibility and absorption of other nutrients. The minerals are the only inorganic elements which constitute only 4.0% of animals total body weight. The essential minerals must be present in the diet to sustain life and maintain normal health [46]. The optimum amounts of calcium and phosphorous are required for the dog but the optimum ratio of calcium to phosphorous in the ration have not been yet determined. Excellent results were obtained at those rations containing 1.2% calcium and 0.8% phosphorus. The calcium: phosphorus ratio in these rations was 1.5:1. Salt is also required by the dog in the same proportion as in the human diet [51].

Ornamental Fish Food

Nutrients essential to fish are the same as those required by most other animals. In addition, pigments are commonly added to the diet of ornamental 'aquarium' fishes to enhance their flesh and skin coloration, respectively. The general proportions of various nutrients included in a standard fish diet are 32–45% of proteins including 10 essential amino acids, 4–28% of fats that should contain 1–2% of omega 3 or 6 essential fatty acid series, 10–30% of carbohydrates, 1–2.5% of minerals and 1–2.5% of vitamins where the exact proportion depends on the type, size, and habitat of the fish [43]. In their natural environment, fishes have developed a wide variety of feeding specializations, i.e., behavioral, morphological, and physiological responses to acquire essential nutrients and utilize varied food sources [52]. Based on their primary diet, fish are classified as carnivorous (consuming largely animal material), herbivorous (consuming primarily plant and algae), or omnivorous (having a diet based on both plant and animal materials) [52]. However, regardless of their feeding classification, in captivity fish can be taught to readily accept various prepared foods which contain the necessary nutrients [53].

In our study, nutritional components of different fish foods, i.e., the DM, CP, CF, EE, and TA of different aquarium fish foods were analyzed. The DM level of fish food found in the study was higher than the reporting values supplied by the manufacturers. All the samples contained DM within a range of 93.5 to 95.4%. These imported foods are used throughout the world for their better nutrient contents. The DM content of fish foods affects the quality mainly during storage. High moist foods sometimes invite the bacterial growth [54]. Kabir et al. reported that none of the manufacturers provided any information about the ash content in the foods which was same here [54]. Analysis of ash percentage revealed that different brands of aquarium fish food contained ash within the standard range (6–7%) [55, 56].

Protein plays an important role for the growth of fish because growth mainly depends on the rate of utilization of protein [57]. Cost of a particular food is also determined by its protein content. Protein requirement of ornamental fish depends on size, water temperature, feeding rate, and availability of digestible energy in diets [55, 56]. Protein level found in the present study meets the requirement of ornamental fish (20–30%) according to the values reported by Boonyaratpalin [58]. Researches on freshwater fish indicated that 10–20% of EE is required in the diets for optimal growth [56, 59, 60]. The result was a bit higher than our study (4.4–6.0%) and the possible reasons behind this might be the variation in size, habitat, and type of the aquarium fishes. But the CF contents of the fish foods in this study were found within the standard level necessary for ornamental fish [55, 56].

CONCLUSION

Most of the available pet food brands either met or exceeded macro-nutrient requirements and appeared closely consistent with the manufacturer's labeled claim. However, substantiation of the nutritional adequacy of these pet foods simply based on the nutrient profiles may be misleading and less reliable adhered to the point of acceptability, palatability, digestibility, and metabolizability in direct feeding trials. Pets being non-ruminant and ultrasensitive to food allergy and food related gastrointestinal disorders, all pet foods should pass through trace element analysis and digestibility trial under prevailing environment.

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