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Macronutrients Comparison of Commercial Cat Foods in Malaysia

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Abstract | There are many cat food products sold in the current retail market. The cat food product industry is rapidly expanding due to the enlargement of middle-class citizens and the increase in spending on pets per capita. However, there is no validation of the actual nutritional value of these products. The present study aimed to determine the dietary nutrient profile of six commercial cat food available in Malaysia with comparison to the actual requirement of cats. The results showed that Grade A cat food product has a significantly higher protein, fat, moisture, and ash content in comparison to Grade B cat food. Meanwhile, Grade B has a significantly higher carbohydrate content as compared to Grade A cat food. The new cat food formulation innovated from this work via utilizing the local raw materials has the highest protein, fibre, and ash contents but is lower in fat, moisture and carbohydrate content in comparison to commercial cat food products. All of the cat food products in Malaysia that were analysed in this work met the Association of American Feed Control Officials (AAFCO) standard. However, not all cat food products are considered a perfect cat food formulation. This information provides insights into the nutrient profile of commercial cat food available in the Malaysian market.

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Introduction

Cats are strict carnivores that rely on a meat protein diet to fulfil their specific and distinctive

nutritional requirements. Years of domestication caused several adaptations in domesticated cats, especially in their gene and metabolism. In contrary to dogs that develop metabolic and digestive trait that

is omnivorous, cats are known and remain as obligate carnivore that develop strong food preferences to specific textures, food forms (canned vs. dry), and food flavours (Bosch *et al.*, 2015; McGrane *et al.*, 2023). Pet owners provide cats with commercially available food as an alternative to natural food, in which the presence of functional food play vital role in cat health and behavioural wellbeing (Delgado and Dantas, 2020). Commercial cat food is essential in providing health benefits and good growth. In addition, functional food provides improved health benefit well-being of cats (Di Cerbo *et al.*, 2017).

Thus, it is critical to ensure that the commercial food provide adequate nutrition for a healthy life of cat. Mounting studies in human and animal models suggested meat-based diets contain both saturated fat and animal protein (Korpela, 2018), which likely influence the gut microbiota and host health synergistically, and well known for their beneficial and adverse effects (Jensen *et al.*, 2016). If consume chronically, long term effect protein fermentation by gut microbiota will result in the production of diverse end products including ammonia, hydrogen sulphide (H₂S), short-chain fatty acids (SCFA), phenolic compounds and others, some of which are, while others have as yet unknown health effects and correlated to high mortality rate and reduced life-span (Fung *et al.*, 2010). Therefore, pet food industry is depended to manufacture safe and nutritious products. Generally, high protein and fibre contents are remarked as healthy diet (Korpela, 2018), which embarking the importance in the development of a healthy cat food product. However, processing condition and storage techniques can cause diminishing of nutritional value in commercial pet food (Oba *et al.*, 2022; Olatunde and Atungulu, 2018). In addition, verification of actual nutrient content provided by commercial cat food products is required to promote safety and transparency in pet food industry.

The main objective of this study is to determine the actual nutrient content of commercial cat food products based on their tier (Premium/Grade A and Standard/Grade B) and compare with recommended nutrient content according to literatures. Besides, the results were also compared with a new cat food formulation developed in this study which was innovated by utilising local raw materials. It is limited to the adult maintenance category cat food only. The tier of the products was classified based on the

average price in the market (Amir *et al.*, 2014). For this purpose, six commercial dry cat food products were analysed using proximate analysis to determine the protein, ash, mineral, and carbohydrate content. The nutritional composition of commercial and product development in this study was compared and revised with the Association of American Feed Control Officials (AAFCO) standard. The function of AAFCO dog and cat food nutrient profiles is to establish practical minimum and maximum nutrient composition for pet foods. The result from this study is set as benchmark to signify the differences of nutritional level between two tiers of commercial cat food. This will also help formulation of new cat food with better nutritional value for growth and health of the cat.

Materials And Methods

Commercial cat food selection

Six commercial cat food products were purchased from pet shops in Kuantan, Pahang, Malaysia and were classified based on their price per kg into two groups (Grade A and Grade B). Grade A group (price above RM 14 per kilogram) comprise of three commercial products namely A01, A02 and A03, while Grade B (price between RM 8.50 to RM 12.00 per kilogram) comprise of B01, B02 and B03 (Amir *et al.*, 2014). In the selection of sample product, the main ingredients of the commercial dry cat food were fish meal and chicken and shall be free from non-halal ingredients.

Development of new cat food formulation

Fish meal, rice powder, spinach powder, carrot powder, egg powder, salt, palm oil, and emulsifier were purchased from local supplier in Malaysia. The raw materials were mix with water, mould, and dried in an oven overnight, before it was further analysed for proximate analysis.

Proximate analysis

The chemical compositions of cat food were analysed for moisture, crude protein, crude fat, crude fibre, and ash analysis (AOAC, 1995). Oven drying method was referred to determine the moisture content (AOAC method 977.11), Kjeldahl's method for crude protein determination (AOAC method 955.05), Soxhlet method for crude fat determination (AOAC method 960.39, gravimetric method for determining crude fibre (AOAC 991.43), and dry ash method using

furnace to analyse ash content (AOAC method 923.03). Analytical grade chemicals were used in the analysis.

Meanwhile for carbohydrate composition, it was calculated by difference as shown in Equation 1 (Ho *et al.*, 2016; Nielsen, 2010). The result was expressed as gram per hundred grams of dry matter (g/100 g).

$$\text{Carbohydrate} = 100 \text{ g} - (\text{Moisture} + \text{Crude Protein} + \text{Crude Fat} + \text{Ash}) \text{ g} \dots (1)$$

Statistical analysis

Data was analysed using the analysis of variance (ANOVA) followed by Duncan multiple range test for mean comparison analysis. Statistical Analysis System (SAS) Ver 9.1 were used.

Results and Discussion

Proximate analysis

Figure 1 shows the proximate analysis result of two categories of cat food grades. Grade A commercial cat food showed protein content ranging between 41.37-36.2% while Grade B ranged between 31.95-34.2%. Crude fat content in Grade A ranged between 10.04-17.75% while Grade B ranged between 6.91-8.61%. Crude fibre content in Grade A ranged between 0.68-0.93% while Grade B ranged between 0.73-0.94%. Moisture content in Grade A ranged between 6.83%-7.88% while Grade B ranged between 6.26%-6.61%. Ash content in Grade A ranged between 6.14%-17.1% while Grade B ranged between 7.35%-10%. Lastly, carbohydrate content in Grade A ranged between 26.11%-33.09% while Grade B ranged between 42.27%-47.14%.

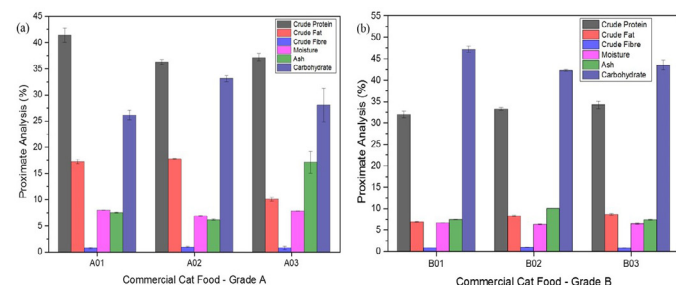


Figure 1: Proximate analysis of grade A (a) and grade B (b) commercial cat food.

Statistical analysis

Figure 2 shows the mean difference of Grade A nutritional composition. Group A showed significant differences ($P < 0.05$) in all parameters except crude fibre and carbohydrate content. Crude protein

percentage in A01 is significantly higher than in A02 and A03. Crude fat percentage is significantly lower in A02 than in A01 and A03. Moisture content percentage is significantly higher in A01 and A02 compared to A03, while ash content percentage is significantly higher in A03 compared to A01 and A02.

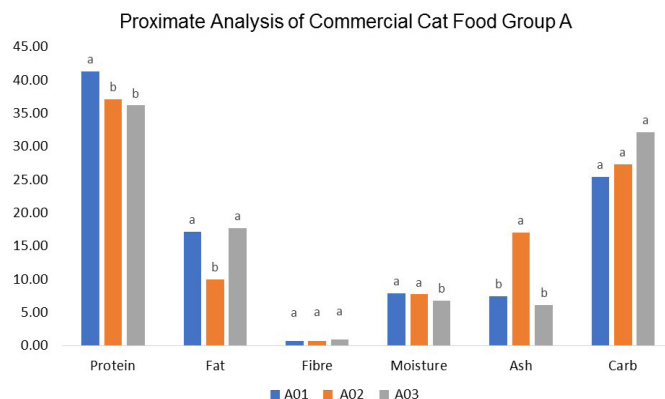


Figure 2: Mean differences of cat food from group A.

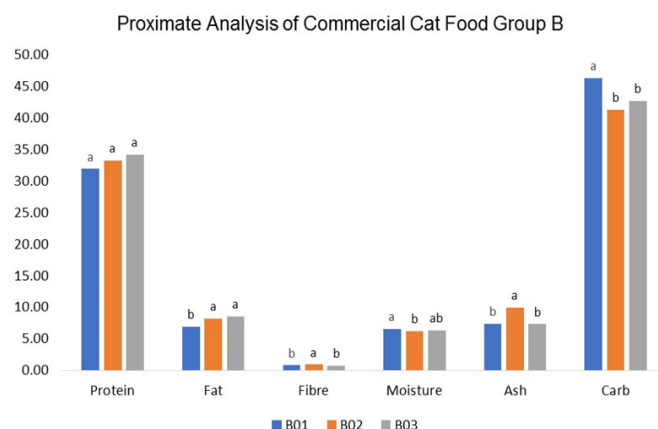


Figure 3: Mean differences of cat food from group B.

Figure 3 represents the mean difference of Grade B nutritional composition. Group B showed significant differences ($P < 0.05$) in all parameters except crude protein and moisture content percentage, where they are not significant in all cat food samples. Crude fat percentage in B01 is significantly lower compared to B02 and B03. Crude fibre percentage in B01 and B03 are significantly higher than B02. Ash content percentage in B02 is significantly higher than B01 and B03. Lastly, carbohydrate percentage in B01 is significantly higher than B02 and B03.

Figure 4 shows the nutritional content comparison between Grade A, B and new formulation of cat food developed in this work. Meanwhile, difference within and between group of commercial cat food Grade A, B and newly formulated cat food is presented in Table

1.

Table 1: Differences within and between group of commercial cat food and newly formulated food.

	Crude protein	Crude fat	Crude fibre	Moisture content	Ash content	Carbo-hydrate
Group A						
A01	41.35 ^a	17.20 ^a	0.68 ^a	7.88 ^a	7.46 ^b	26.12 ^a
A02	37.10 ^b	10.04 ^b	0.73 ^a	7.74 ^a	17.10 ^a	28.02 ^a
A03	36.20 ^b	17.75 ^c	0.93 ^a	6.83 ^b	6.14 ^b	33.09 ^a
Group B						
B01	31.95 ^a	6.91 ^b	0.81 ^b	6.61 ^a	7.41 ^b	47.14 ^a
B02	33.25 ^a	8.23 ^a	0.94 ^a	6.26 ^b	10.00 ^a	42.27 ^b
B03	34.20 ^a	8.61 ^a	0.73 ^b	6.39 ^a	7.35 ^b	43.46 ^b
Between groups						
Grade A	38.22 ^b	15.00 ^a	0.78 ^b	7.48 ^a	10.23 ^b	28.30 ^b
Grade B	33.13 ^c	7.91 ^b	0.83 ^b	6.42 ^b	8.25 ^c	43.46 ^a
New formula	54.65 ^a	8.88 ^c	1.60 ^a	3.80 ^c	19.90 ^a	12.78 ^c

^{a,b,c} denote significant differences between nutritional content within row.

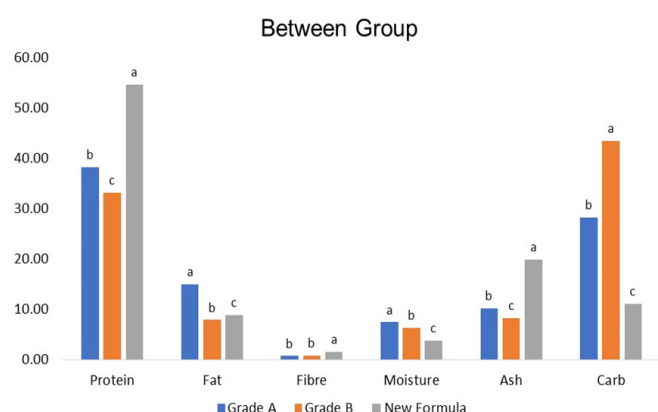


Figure 4: Between group comparison of Group A, B and new formulation in six parameters.

All of the nutritional compositions show that all groups are significantly different except crude fibre percentage. Crude protein and ash content percentage for new formulation is significantly higher followed by Grade A and Grade B. Crude fat percentage of Grade A is significantly higher followed by new formulation and Grade B. Crude fibre percentage for new formulation is significantly higher than Grade A and Grade B. Grade A has a significant higher in moisture content followed by Grade B and new formulation. Lastly for carbohydrate percentage, Grade B has the significantly higher composition percentage followed by Grade A and new formulation.

As the second-largest consumers of pet food, the cat food industry in Malaysia is forecasted to gain 4.21%

compound annual growth rate (CAGR) over the year from 2023 to 2028, resulting in a market volume of US\$318.30 million in 2028 and predominantly gain high demand in Asian countries (Mordor Intelligence, 2019; Statista Market Insights, 2023). In terms of cat food, the largest market segment in Malaysia is cats (adult), with a 52.95% value share in 2022, due to the high number of cat owners in the country, which is estimated to be around 658,000 in 2019 (Mordor Intelligence, 2019; Pet Fair, 2019). There are two main categories of cat food which are (1) growth and reproduction and (2) adult maintenance. Usually, growth and reproductive cat food is for specially formulated for kitten. It contains energy-rich animal-based ingredients and are packed with essential nutrients such as high protein and omega fatty acids to support a kitten's growth (Janelle *et al.*, 2023; Johnson *et al.*, 2020). In addition, cat food is divided into two sections which are wet food and dry food. Wet food is packed in canned food and it contains between 70 and 80% moisture, while dry cat food contains not more than 10%. This study is limited to the comparison and development of adult maintenance category of dry cat food only.

According to AAFCO standard, minimum dry matter percentage of crude protein is >26%, crude fat is >9%, mineral is >2.9%, and vitamin is >1% (AAFCO, 2014). Meanwhile, another literature reported that perfect cat food should comprise of important nutrients such as protein (50-60%), fat (30-50%), carbohydrate (5-10%), and micronutrients such as vitamin and minerals (<2%) (Amir *et al.*, 2014).

Each nutrient has its own benefits for the health and growth of cat. Crude protein is important to manufacture antibodies, enzymes, hormones, tissues, and as a pH balance in cat. It also provides energy and essential for growth and development especially for kitten. Both animal and plant sources of protein could be incorporated in cat food formulation. AAFCO set no regulatory standard for the source of protein either animal or plant based (Golder *et al.*, 2020). Manufacturer commonly used meat, fish meal, poultry, poultry by-product, bone meal, salmon meal, organs, shrimp meal, egg, dairy proteins, whole grains, rice, corn, soy, wheat, potato, spinach, carrot, rye, etc. as the crude protein source. Moreover, the incorporation of by products from other industries as the crude protein was considered as an alternative source to improve the environment sustainability

(Deng *et al.*, 2016). However, incorporation of the by-products will have some issue especially related to health and halal practice. Results in Figure 1 shows that all products in Grade A and Grade B fulfils the AFFCO standard, but not considered as a perfect cat food formulation. Meanwhile, the developed cat food from this research in Figure 4 can be considered as a perfect cat food formulation which has a crude protein percentage of 54.7%.

Crude fat functions as the source of energy and provides essential fatty acids (omega-3 and omega-6). The essential fatty acid can reduce LDL cholesterol level, lower blood pressure which improve heart health of cat and kitten. Crude fat could be found in animal, vegetable, and seed oil source for example animal fat, chicken/poultry fat, fish oil, tuna oil, vegetable oil, green leafy vegetables, dried beet pulp, yucca, etc. Fat could provide twice amount of energy as compared to protein and carbohydrate per gram. In fact, cats are categorized as an obligate carnivore which totally feed on protein and minimal amount of carbohydrate source (Amir and Mona, 2013). This may explain why cats required more protein and fat sources, instead of carbohydrates in their diet. The proximate analysis result of commercial cat foods shows that the grade of cat food products can be differentiated according to crude fat content. Grade A contains higher crude fat content (10-17 %) in comparison to Grade B cat food (6-8 %). Meanwhile, the New Formula cat food developed from this work can be considered as a Grade B cat food as it contains 8.8% crude fat.

In addition, study on feral cats showed that their daily energy intake from crude protein is about 52 %, from crude fat is 46 % and from N-free extract only 2 %. Meanwhile, minerals and trace elements are consumed in relatively high concentrations compared to the recommended allowances by standard (Plantinga *et al.*, 2011). In this study, all commercial cat food has crude protein and crude fat lower than 42% and 18%, respectively.

Crude fibre is classified as a substrate that is not digested in the small intestine but is instead partially or deliberately fermented in the large intestine (Butowski *et al.*, 2019). Although cat is obligate carnivores, it has been noted that it consumes the hair, bone and skin of their prey that may act as a source of fibre. Besides, cat also sometime consume grass. Extra fibre is also introduced to light foods to

reduce calories. Regular dry cat foods contain 1.5 to 4% crude fibre, while low calorie cat foods can contain up to 10% (Beynen, 2016). In fact, the minimum fibre content requirement was not prescribed by AAFCO (Butowski *et al.*, 2019). In cat food, crude fibre is supplied from pea fibre, barley, cellulose, wheat bran, sugarcane fibre, and others (Rochus *et al.*, 2014). Based on the result in Table 1, the crude fibre percentage in Grade A and Grade B is not significantly different. Meanwhile, the New Formula cat food has a significantly higher crude fibre content which may promotes a good digestion for cat.

Cats mostly consume less moisture from their food, despite that many are fed a dry-food diet containing just about 6 to 10% moisture (Nicholas, 2020). The statement is supported by the result of moisture content analysis in Table 1, which shows that commercial cat food products contain about 6.2 to 7.9 % of moisture. In fact, cats need to consume between 3.5 to 4.5 ounces of water per 5 pounds of body weight or about 50 mL of water per 1 kg of body weight per day (Fritz and Handl, 2018; Nicholas, 2020). When cats are served dry food only, they consume less water. Therefore, feeding mainly or only dry food is a risk factor for kidney and urinary tract disease, primary renal disease, and chronic hydration in cats (Buckley *et al.*, 2011; Fritz and Handl, 2018; Pachel and Neilson, 2010; Zanghi and Gardner, 2018). In order to increase fluid intake in cat, flowing water through cat fountain was recommended (Pachel and Neilson, 2010). In addition, by increasing the percentage of moisture content in dry cat food, the fluid intake can also be improved. However, the moisture content of the cat food product should be control. This is to prevent the product deterioration and contamination. Commonly, moisture content less than 15% is considered as safe to prevent microbial growth (Rezaei and Vander, 2010). Proximate analysis comparison results in Figure 4 show that Grade A cat food contains higher moisture content (6.8-7.9%) in comparison to Grade B cat food (6.2-6.6%). This result may differentiate the quality of the cat food products as higher moisture content in dry cat food is better for cat which results in higher fluid intake and increasing amount of urine produced.

Conclusions and Recommendations

The nutritional content of commercial cat food products in Malaysia, particularly the distinctions

between premium (Grade A) and standard (Grade B) tiers, was investigated to address the unique dietary requirements of cats as obligate carnivores. The research, based on proximate analysis of six products, revealed significant variations in protein, fat, fiber, moisture, ash, and carbohydrate content. Grade A cat foods exhibited higher protein and fat levels compared to Grade B, with a notable difference in moisture content. Most of the commercial cat food in Malaysia fulfil the AAFCO nutritional standards especially for crude protein and crude fat. But, only some of the cat food products met the perfect cat food nutrition standard that has been suggested by previous literature. A novel cat food formulation was introduced in this study, developed by utilising local raw materials, showcasing elevated crude protein and ash content. This study has shown that the developed cat food product is a perfect cat food formulation due to its significant crude protein content. These findings underscore the importance of tier classification in commercial cat foods based on price and emphasize the need for industry vigilance in maintaining the cat food nutritional quality. The study provides benchmark data that can guide the development of healthier cat food formulations, fostering transparency and safety within the pet food industry.

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Novelty Statement

This study proposes a new dry cat food formulation using locally produced raw ingredients, which has significantly higher crude protein and ash content than commercially available products. This research also provides the first benchmarking data for Malaysian cat food, highlighting important nutritional gaps and the importance of moisture content for optimal cat health.

Author's Contribution

Mohd Aiman Hamdan, Mufafikri Musa and Najmuddin Mohd Ramli: Planned the experiment, conduct the analysis, and wrote draft of manuscript.
Muhammad Fitri Yusof and Hajar Fauzan Ahmad:

Analysed the data, data validation, and prepare the data presentation.

Mohd Najib Razali: Assist in editing, review the manuscript, financial assistance, Project administration, and funding acquisition.

Conflict of interest

The authors have declared no conflict of interest.

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