

DETERMINATION OF NUTRITIONAL PROPERTIES OF LOCALLY MANUFACTURED DRY DOG FOOD

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ABSTRACT

The Sri Lankan dry dog food production does not satisfy the existing demand, where the imported brands dominate the local pet food market. Hence the formulation of locally sourced dry dog food with adequate nutritional properties has become a trending industry in Sri Lanka amid its national requirement. Therefore, this study was done to accomplish a nutritionally based comparison between imported dog food and locally manufactured food. Comparative growth performances were evaluated between the two groups of healthy, male, 6-8 weeks aged, mongrel puppies (n=5) fed with two food types. A sensory panel consisting of 30 untrained panellists evaluated the feed effect on hair coat conditions. Proximate composition, energy estimation, extrude characteristics, and palatability parameters of two food were analyzed through the independent sample t-test. The results of the proximate analysis revealed 18% (SD ± 0.30) protein, 6.4% (SD ± 0.09) fat, 9.70 (SD ± 0.08) moisture, 0.8% (SD ± 0.03) crude fiber, 9.3% (SD ± 0.07) ash, 55.8% (SD ± 0.55) carbohydrate, and 352.8 (SD ± 0.34) kcal/100g of energy in local food while imported food reported same parameters as 24.1% (SD ± 0.19), 10% (SD ± 0.19), 12.1% (SD ± 0.06), 2.8% (SD ± 0.05), 0.7% (SD ± 0.10), 44% (SD ± 0.56) and 362.4 (SD ± 0.27) kcal/100g, respectively. The two food types revealed a better impact and no significant difference (P>0.05) on hair coat condition. The imported food showed a significantly higher (P>0.05) growth performance of 0.595 kg per week (SD ± 0.03) in puppies than the locally manufactured food; 0.43 kg per week (SD ± 0.03), probably attributed to high protein content in the former. However, the nutrient content of the locally manufactured dry dog food is more compatible with adult dogs' maintenance requirements, as the literature cites.

Keywords: dry dog food, growth performance, nutritional properties, palatability

1. INTRODUCTION

Dog food is intended for the feeding of domestic dogs (*Canis lupus familiaris*), which became domesticated thousands of years ago. Domestic dogs can healthily digest a variety of foods regardless of their nutritional properties. This remarkable adaptability of the dog has led to the successful use of commercial diets that differ widely in their ingredient composition (Donfrancesco et al., 2018).

The global pet food market size was estimated at USD 83.02 billion in 2018 and is expected to grow at a compound annual growth rate of 5.4% between 2019 and 2025. Of the total production of pet food globally, dog foods account for the majority and even within that segment dry dog food category has managed to play a significant role. Commercial dog foods are of three basic types. Dry-type dog food contains low moisture content (10-12%) while semi-moist dog food comprises moderate moisture content (25-30%). Canned dog foods are high in moisture content and they contribute about 74-78% of the moisture out of

its total content (McEllhiney, 1994). Dry dog food shows an accelerating growth globally, unlike other alternative food for dogs owing to its convenience in storage and feeding pets without creating a mess (Lewis, 1992).

When it comes to Sri Lankan scenario the total pet food production of the country was 0.012 million metric tons in 2018 and it was barely noticeable when compared to the amount of pet food imported into Sri Lanka in the correspondent year. Unfortunately, as a nation, we have been importing these preliminary sundries largely even though the technical knowledge and infrastructure for commercial-scale production of pet foods are available in the country (Indexbox, 2022). However, even the information related to the analysis of the nutritional properties of locally prepared dry dog food under Sri Lankan conditions is very rare in the literature as well. Therefore, this research was carried out to fulfill the splashed gap in Sri Lankan dry dog food industry by being able to

introduce locally prepared chicken meat-based dry dog food with adequate nutritional properties.

2. MATERIALS AND METHODS

2.1. Sample collection

All ingredients which were required in the preparation of the dog feed (rice, maize, wheat flour, vegetables, chicken meat, animal fat, fresh milk, and vitamin and mineral additives) were purchased from commercial stores. Rice and maize were grounded into powdered form. The chicken meat was grounded, dried, and powdered. The vegetables were also dried and powdered. Animal fat was turned into liquid form using heat treatment.

2.2. Preparation of dry dog food

The dry dog food was formulated according to the procedure given in figure 1.

2.3. Proximate analysis

Proximate composition of the two feed, novel formulated dry dog food and the imported commercially available dry dog food were analyzed in terms of moisture content (AOAC, 1999), crude protein content (AOAC, 2000a), crude fat content (AOAC, 2000b), crude fiber content (Thiex, 2009), ash content (Nielsen, 2000). Total carbohydrate content was determined according to the following equation.

$$\text{Carbohydrate content (\% wet basis)} = 100 - (\% \text{ crude protein} + \% \text{ crude fat} + \% \text{ ash} + \% \text{ moisture content})$$

2.4. Energy Estimation of samples

Energy estimation of both formulated and imported feed samples were done according to the Codex Guidelines on Nutrition Labelling (FAO, 2003).

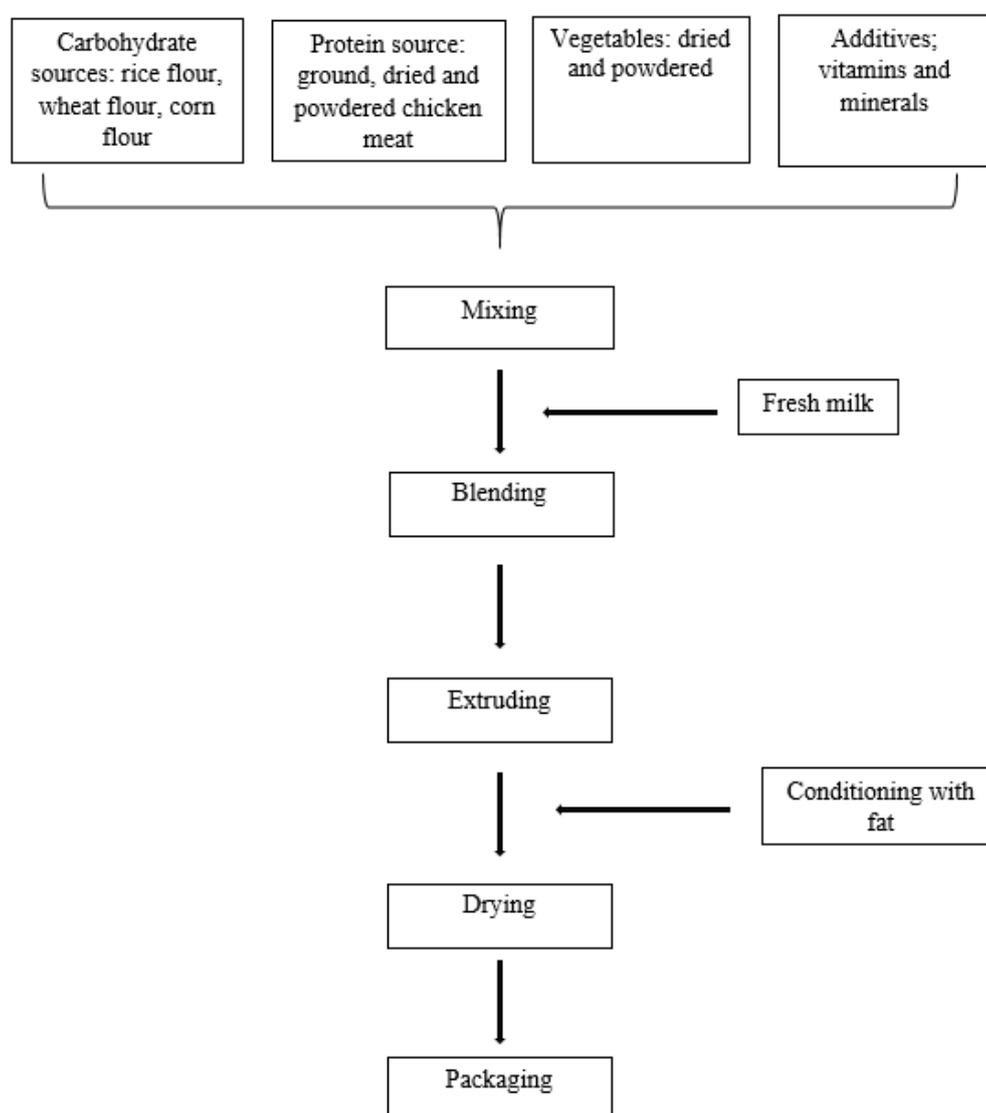


Figure 1. Manufacturing process of local dry dog food

The amount of energy of the samples were calculated by using the following conversion factors: carbohydrates, 4 kcal/g (17 kJ); protein, 4 kcal/g (17 kJ); fat, 9 kcal/g (37 kJ), alcohol, 7 kcal/g (29 kJ); and organic acid, 3 kcal/g (13 kJ).

2.5. Extrudate characteristics of samples

As extrude characteristics, bulk density (Varsha and Mohan, 2016), instrumental color by CR 400 Chromameter (Raipur, 2013), instrumental texture by TA-XT2 textural analyzer (Kozuchowicz, 2018), Water Solubility Index (WSI) and Water Absorption Index (WAI) (Raipur, 2013) of both formulated and the imported commercial dry dog food were analyzed.

2.6. Feeding trial

Five male mongrel puppies in the age range of 6 to 8 weeks that were apparently healthy were selected purposefully. Once acclimatized the puppies were fed with newly formulated feed for four weeks in ad-libitum. Then the puppies were flushed out for one week. The controlled experiment was conducted providing a locally well-established imported dry puppy feed in ad-libitum to the puppies for 4 weeks.

2.7. Data Collection

2.7.1. Determination of feed intake

During months of August, September and October of 2020, puppies were fed using formulated feed and imported feed. The puppies were fed as three times per day since they were fed as ad-libitum feeding. The daily feed intake was measured as collective weight of remaining feed in feeding bowl each three times that they were fed (Dilrukshi et al., 2012).

2.7.2. Determination of weight of puppies

Weight was determined using the weighing scale. Subjects were hanged using thread and measurements were recorded to the nearest 100 g at the end of each week for both formulated feed trial and the imported feed trial (Dilrukshi et al., 2012).

2.7.3. Determination of coat condition

Two sensory evaluations were conducted at the end of the formulated feed trial and the imported feed trial in order to determine the effect on hair coat condition. Five points Hedonic scale test was performed to evaluate the coat condition of puppies after two treatment groups (Dilrukshi et al., 2012).

2.8. Palatability assessment

The palatability assessment of imported and formulated feed samples was determined using the two-bowl free choice test. In this test, two food samples were presented to the animal at the same time, offering the animal a choice. The feed were available to each animal for a limited interval of time, 15-30 min for the determination of 'First approach' and 'First choice' (Koppel, 2014).

2.9. Statistical analysis

Statistical analysis was done using SPSS 16 software. Independent sample *t*-test was used to analyze the comparative difference between formulated and imported dry dog food for each measured nutritional aspect.

3. RESULTS

3.1. Growth performances

The growth performances of puppies fed with formulated and imported dog food for over the experimental period have been summarized in the Tables 1 and 2.

Results indicate, there is significant difference of growth rate of puppies that were fed using formulated feed and imported feed. The mean growth rate (kg/week) of puppies fed using imported feed was higher than the mean growth rate (kg/week) of puppies fed using formulated feed.

Table 1. Weekly mean growth performances of puppies during feeding trial

| Group | Week | Mean growth rate (kg/week) | SD |
|-----------------|------|----------------------------|-------|
| Formulated feed | 01 | 0.40 | 0.070 |
| | 02 | 0.40 | 0.000 |
| | 03 | 0.42 | 0.044 |
| | 04 | 0.50 | 0.070 |
| Imported feed | 01 | 0.50 | 0.070 |
| | 02 | 0.56 | 0.054 |
| | 03 | 0.64 | 0.054 |
| | 04 | 0.68 | 0.044 |

Table 2. Mean growth rate (kg/week) values of two groups of puppies

| Treatment | Growth rate (kg/week) | | |
|-----------------|-----------------------|--------|---------|
| | Mean | SD | P-value |
| Formulated feed | 0.4300 | 0.0325 | 0.000 |
| Imported feed | 0.5950 | 0.0325 | |

P-value is the value for independent sample *t*-test for the difference between growth rates of puppies were fed using formulated feed and imported feed.

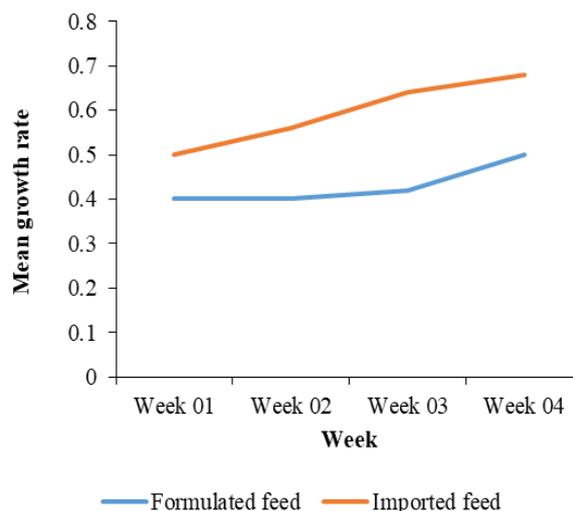


Figure 2. Weekly mean growth rates of two groups of puppies

3.2. Hair coat condition

The parameters of the coat condition determined through two sensory evaluations conducted after the feeding trials were summarized in the table 3.

Results of the sensory Results indicate, there is no significant difference between each of the sensory attributes of hair coat of puppies fed with either feed.

Table 3. Sensory attributes of hair coat condition of puppies fed with formulated feed and imported feed evaluated by 5-point hedonic scale

| Sensory attribute | Formulated feed (Mean \pm SD) | Imported feed (Mean \pm SD) | P-value |
|--------------------|---------------------------------|-------------------------------|---------|
| Glossiness | 2.23 \pm 0.430 | 2.10 \pm 0.403 | 0.220 |
| Softness | 2.10 \pm 0.481 | 2.03 \pm 0.414 | 0.567 |
| Optimum coat feels | 2.20 \pm 0.407 | 2.07 \pm 0.365 | 0.187 |

3.3. Proximate analysis

The proximate compositions of the formulated and imported dog feed have been summarized in the Table 4. Results shows significant different of proximate components between formulated feed and imported feed. The total ash content and carbohydrate contents of formulated feed is higher than imported feed while protein, fat, crude fiber, and moisture contents are higher in imported feed than the formulated feed.

Table 4. Proximate composition of formulated and imported feed

| Component (%) | Formulated feed (mean SD) | Imported feed (mean SD) | P-value |
|---------------|---------------------------|-------------------------|---------|
| Protein | 18.0 \pm 0.3 | 24.1 \pm 0.2 | 0.000 |
| Crude fat | 6.4 \pm 0.1 | 10.0 \pm 0.2 | 0.000 |
| Crude fiber | 0.8 \pm 0.0 | 2.8 \pm 0.1 | 0.000 |
| Moisture | 9.7 \pm 0.1 | 12.1 \pm 0.1 | 0.000 |
| Ash | 9.3 \pm 0.1 | 7.0 \pm 0.1 | 0.000 |
| Carbohydrate | 55.8 \pm 0.1 | 44.0 \pm 0.1 | 0.000 |

Table 5. Energy estimation results of formulated and imported feed

| Parameter | Formulated feed (mean \pm SD) | Imported feed (mean \pm SD) | P-value |
|--------------------|---------------------------------|-------------------------------|---------|
| Energy (kcal/100g) | 352.8 \pm 0.34 | 362.4 \pm 0.27 | 0.000 |

3.4. Energy estimation

Results of the energy estimation of the formulated and imported dry dog foods are depicted in the Table 5.

There is a significant difference between energy values of formulated feed and the imported feed. The energy of the imported feed is higher than the formulated feed.

3.5. Excrudate characteristics

Table 6 summarizes the extrudate characteristics of the formulated and imported dog foods. Whereas, figure 3 and 4 indicate texture profiles of formulated and imported dog foods, respectively.

Results shows the bulk density, lightness, and the hardness of the formulated feed sample is significantly higher than the imported feed sample, while the a* color value of imported feed is significantly higher than the formulated feed. There is no significant difference of Water Solubility Index, Water Absorption Index, crispness, and b* color values between formulated and imported feed.

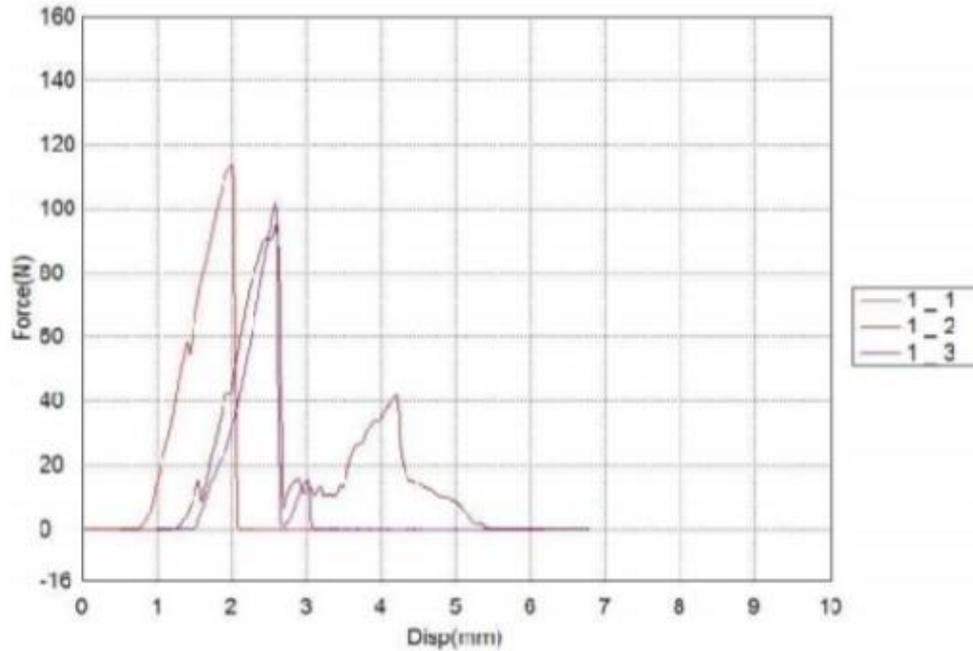


Figure 3. Texture profile of formulated dog food

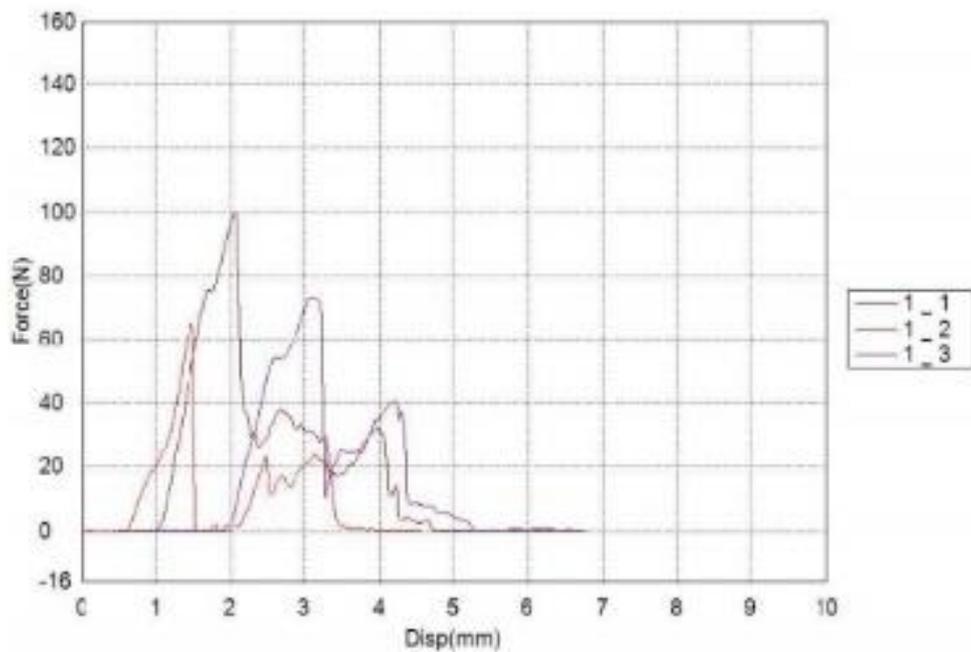


Figure 4. Texture profile of imported dog food

3.6. Palatability

In the study population of thirty adult dogs, 60% of the subjects had first choice for imported feed while the rest 40% had formulated feed as first choice. For first approach, the imported feed had 63.34% of subjects' preference while formulated feed had only 36.66%.

4. DISCUSSION

In a study conducted by Dilrukshi et al.2012, the results indicated no significant difference in growth performance of puppies fed with formulated food and imported food. In contrary, the results of the present study indicate, the growth rate of puppies that were fed using formulated food which is (0.430 kg/week) is

significantly lower than the growth rate of puppies fed with imported food which is (0.595 kg/week) (Table 2). These results may have befallen due to several reasons and they can be considered possible explanations for the results of this study.

One reason could be the employment of the same group of puppies for the imported feed trial and the formulated feed trial (controlled and experimental trials respectively) with a flush out time period due to the lack of puppies in the surrounding area during the study period. This approach may have yielded higher growth rate in puppies in the latter feed trial; imported feed trial. Since there is always a gap of one month of age between two feeding trials, the puppy's growth rate is always slightly higher in the second feeding trial; the imported feed trial than the first feeding trial; formulated feed trial.

However, the most obvious reason for observing better puppy growth in imported dog food feeding is the difference of the nutritional composition of the imported food and the formulated food. The most significant aspects of the nutrition of puppies are the energy, protein and the fat contents of the food fed to them. For the optimum growth, the NRC lists the minimum crude protein requirement for puppies to be met by feed formulas should be 18% on DMB.

The 2014 AAFCO dog food nutrient profile for growth and reproduction recommends the minimum crude protein and fat content of dry matter to be 22.5% and 8.5% for puppies while the caloric density for dog food products should be 400 kcal metabolizable energy (ME) per 100grams dry matter (DM).

the proximate analysis of the formulated food revealed only 352.80 kcal100g⁻¹ of energy, 18.0% of protein and 6.40% of fat on wet basis. The corresponding values on DMB of the formulated food for energy, protein and fat contents were 390.69 kcal100g⁻¹ [(352.8/90.3) × 100], 19.93% [(18/90.3) × 100] and 7.08% [(6.40/90.3) × 100] respectively. Hence, the nutritional composition of the locally formulated feed seems to be lesser than the recommendations established for puppy food.

The 2014 AAFCO dog food nutrient profile for growth and reproduction recommends the minimum protein and fat contents of 18% and 5.5% on DMB respectively for adult dogs while the caloric density to be 300 - 400 kcal metabolizable energy (ME) per 100grams dry matter (DM). Even though the nutrient profile of locally formulated food does not satisfy the nutritional requirements of the puppy stage, it complies with the nutrition demand of adult dogs which is lesser than the puppy stage. The availability of required nutrients in adequate quantities for puppy growth in imported food might have caused the higher growth rates of puppies fed with imported food compared to the formulated food.

When considering the carbohydrate content of both types of food since it is another energy source in the feed, The formulated food contains higher carbohydrate content (55.80%) than the imported food (44.0%) (Table 4). Although the carbohydrates accounts to the provision of energy in a food, protein and fat stand the major sources of energy for dogs owing to their evolution by grey wolves (Case *et al.*, 2011). Therefore, having high carbohydrate content in the locally formulated food than the imported food

Table 6. Extrudate characteristics of formulate and imported feed

| Property | Formulated feed (mean ± SD) | Imported feed (mean ± SD) | P-value |
|---------------------|--------------------------------|------------------------------|---------|
| Bulk density (g/L) | 515.8 ± 3.04 | 390.67 ± 3.3 | 0.000 |
| Instrumental colour | | | |
| L* | 44.03 ± 0.64 | 36.87 ± 1.32 | 0.001 |
| a* | 3.21 ± 0.30 | 7.00 ± 0.10 | 0.000 |
| b* | 20.57 ± 0.69 | 21.37 ± 0.23 | 0.130 |
| WSI (%) | 10.05 ± 0.52 | 11.10 ± 1.26 | 0.254 |
| WAI | 3.13 ± 0.28 | 2.76 ± 0.04 | 0.087 |
| Texture | | | |
| Hardness (N) | 103.56 ± 9.34 | 69.23 ± 5.53 | 0.020 |
| Crispiness (N) | 25.37 ± 15.16 | 25.12 ± 4.97 | 0.985 |

L*- Lightness from black to white color, a*- from green to red color, b*- from blue to yellow color.

The study results revealed imported feed contains 362.40 kcal100g⁻¹ of energy, 24.10% of protein and 10.0% fat on wet basis, while the same compositions were figured to be 412.28 kcal100g⁻¹ [(362.4/87.9) × 100], 27.41% [(24.10/87.9) × 100] and 11.37% [(10/87.9) × 100] respectively on DMB. The results of

does not contribute improving the growth rate of puppies.

As evidenced by Table 3, there is no significant difference between each of the sensory attributes of hair coat (glossiness, softness, optimum coat feel) of puppies fed with imported food and formulated food

(Table 3)., The formulated food has scored number 2 out from the 5-point hedonic scale in each of the above mentioned hair coat characteristics indicating better sensory conditions in hair coat of puppies fed with local feed. Therefore, the formulated food is more than capable of achieving desired hair coat conditions according to its composition. In a similar study by Dilrukshi et al.,(2012), the locally prepared food has showed better hair coat condition in puppies than the imported food.

The results of extrude characteristics of this study has shown that the bulk density of the formulated food (515.80 g l^{-1}) is significantly lower than the imported food (490.66 g l^{-1}) (Table 6). Typically, dry-expanded pet foods have bulk densities in the range of 280 to 400 grams per liter (Riaz, 2019) while the bulk density of a dry extruded product indicates how well the product is cooked or expanded. Therefore, the higher bulk density of formulated food may be beneficial in commercial scale pet food production by reducing the cost to store, but generally higher bulk density tends to decrease the palatability of extruded pet foods. The possible reasons for higher bulk density of the formulated feed could be the poor extrusion of starch, relatively low temperature in extrusion process and the lower moisture content of the extrudate.

The literature on colour estimation of extruded dry dog products is scarce limiting data for the comparison. However, the results of the present study showed that the lightness (L^*) of the formulated food (44.03) to be significantly higher than the imported food (36.86). a^* value of the formulated food is significantly higher in imported food (7.0) than the formulated food (2.31) which imparts more red colour to the food which is preferred by the dogs and their owners since it is the meaty colour (Baquero et al., 2018). But there is no significant difference in b^* value of the two food types. However, the lightness and lack of meaty colour of pet food may negatively affect the purchase of the product by the pet owner.

The results of the texture analysis of this study showed that the hardness of formulated food (103.55 N) is significantly higher than the imported food (69.23N) although the crispiness values have no significant difference. This higher hardness value of the formulated food negatively affect the feed intake of puppies and thereby have contributed largely to the lower growth rate of puppies fed with formulated food. The possible reasons for the increased hardness of formulated food could be the slightly lower amount of moisture content (Alvarenga et al., 2018). The results of WAI and WSI of this study showed that there is no significant difference of these two parameters in either of the tested foods.

For the palatability assessment, the results indicated that the palatability of the imported food is significantly higher than the formulated food. Since the quality of ingredients, and the way that they are cooked, processed, and stored, significantly affect the acceptability and palatability of pet foods, it can be concluded that, the one or more parameters mentioned

above may not have been up to the optimum level in the formulated food. Also, the poorly extruded starches cause food particles to have high bulk densities, which negatively affect the texture and chewiness of the product which ultimately lead to the poor level of palatability in the food (Baller et al., 2021). This trend is observable in the texture and bulk density results of the formulated food. On the other hand, meaty colour, scent and the fat content of the food being major driven forces for pets to accept or a reject a food, the poor meaty colour indicated through low value of a^* ; poor scent and relatively low fat content; might have contributed significantly to the lower palatability level in the formulated food (Hall et al. 2017).

5. CONCLUSION

Although the locally prepared dry dog food is capable of maintaining a moderate growth in puppies, the nutrient content of the food is not in adequate levels to achieve the optimal growth performance of puppies. Whereas the nutrient content of the locally prepared dry dog food is more compatible with adult dog's maintenance requirements.

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