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Evaluation of quality and acceptability of pet treat incorporating poultry shank powder#

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Abstract

The growing demand for high-quality and sustainable pet treats has driven the exploration of alternative protein sources, including poultry by-products. This study aimed to evaluate the nutritional, physicochemical and palatability attributes of pet treats formulated with poultry shank powder at two inclusion levels: 35 per cent (T_1) and 40 per cent (T_2). The base formulation comprised cereal flour, chicken, coconut oil, egg and additives, with poultry shank powder incorporated in addition to this standard composition. The ingredients were homogenised, moulded using specialised moulds, steam-cooked and dried under optimised conditions prior to packaging. Physicochemical analyses revealed that increasing the shank powder concentration significantly ($p<0.01$) elevated crude protein levels (T_1: 36.35 per cent, T_2: 37.49 per cent) compared to the control (C: 23.96 per cent). The ash content also increased (T_1: 10.82 per cent, T_2: 11.98 per cent), indicative of a higher mineral composition. Conversely, nitrogen-free extract (NFE) content was reduced and significantly ($p<0.01$) differed in T_1 (18.64 per cent) and T_2 (17.88 per cent) compared to C (34.64 per cent), reflecting a lower carbohydrate proportion. Moisture content declined with increasing shank powder levels, contributing to improved shelf stability. Water activity (a_w) values ranged from 0.86 to 0.88, indicating microbial stability. Palatability trials, conducted on ten dogs with repeated feeding sessions across four occasions, assessed eating behaviour, approach, and interest. The results indicated that T_2 was the most favourably accepted, likely due to its enhanced meat-derived flavour profile. These findings scores up the poultry shank powder as a protein-rich, sustainable ingredient suitable for pet treat formulations, offering both nutritional and sensory benefits.

Keywords: *Pet treat, shank powder, palatability*

The global pet food industry has experienced remarkable growth in recent years, propelled by increasing pet ownership, accelerating urbanisation and heightened awareness surrounding companion animal nutrition. In India alone, the pet population expanded from 22.1 million in 2018 to 38.1 million in 2023, with projections estimating a further rise to 58.7 million by 2028 (Statista, 2024). This burgeoning demographic has catalysed the rapid evolution of the pet food market, with pet treats emerging as the most dynamic and fastest-expanding segment. As pets are progressively viewed as cherished family members, there is a surging demand for treats that are not only palatable and affordable but also nutritionally sound and of superior quality.

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Within this context, the emphasis on sustainability in ingredient sourcing has become increasingly pertinent. One of the most promising avenues lies in the valorisation of poultry by-products generated during meat processing. Notably, between 32.5 per cent and 37.0 per cent of a chicken's total weight is typically discarded as waste, representing a significant opportunity for resource recovery (Mozhiarasi and Natarajan, 2022). The incorporation of such underutilised components into pet treat formulations offers a dual advantage-enhancing environmental sustainability while simultaneously improving economic efficiency within the poultry sector.

Intermediate moisture foods (IMFs), known for their ambient shelf stability and resistance to microbial spoilage, represent an innovative and cost-effective platform for delivering high-quality nutrition in pet treats. Against this backdrop, the present study was undertaken to investigate the incorporation of poultry shank powder into IMF-based pet treats, with particular emphasis on its effects on nutritional composition, physicochemical attributes, and palatability in dogs.

Materials and methods

Standardisation of formulation

The control formulation (C) was developed using a blend of cereal flours and functional additives, including egg, gelatin, guar gum and wheat gluten, to achieve the desired structural and textural attributes. In accordance with the experimental design, poultry shank powder was incorporated into the control pet treat formulation at two inclusion levels: 35per cent (T_1) and 40per cent (T_2), while maintaining the base composition of the cereal flour mix. The detailed formulation is presented in Table 1.

Table 1. Formulation for the preparation of pet treat

Sl. No.	Ingredients	Control C (%)	Pet Treat T_1 (Treatment 1) (%)	Pet Treat T_2 (Treatment 2) (%)
1	Cereal flour mix	80	80	80
2	Chicken	10	10	10
3	Coconut oil	5	5	5
4	Egg	4	4	4
5	Turmeric	1	1	1
		100 %	**100 %**	**100 %**
6	Shank powder	0	35	40
7	Gelatin	3	3	3
8	Glycerol	2	2	2
9	Guar gum	0.5	0.5	0.5
10	Methyl cellulose	0.5	0.5	0.5
11	Wheat gluten	0.5	0.5	0.5
12	Potassium sorbate	0.4	0.4	0.4

Preparation of pet treat

Ingredients were precisely weighed and homogenised using a planetary mixer (ITALYA Mixer, Model: VFM10A, India) for 15 minutes to ensure uniform distribution. The blended mixture was then shaped using custom-fabricated stainless-steel moulds. The moulded pet treats underwent steam cooking for 30 minutes, followed by sequential drying in a hot air oven under optimised conditions: 80°C for 40 minutes, 100°C for 30 minutes and 130°C for 40 minutes. These processing parameters were meticulously standardised to attain the desired moisture content and water activity. Upon completion of drying, the pet treats were cooled to ambient temperature and packaged in PE/Al/PA laminated stand-up pouches, which were hermetically sealed using a Sepack continuous sealer (Sevana, Cochin, India). The sealed samples were subsequently stored under ambient conditions for further analysis.

pH and Water activity (a_w)

The pH of the pet treats was measured post-drying using a combined electrode digital pH meter (Model No: 335, Systronics, India), in accordance with AOAC (2016) protocols.

For the determination of water activity, the pet treat samples were finely crushed and uniformly filled into the sample cup up to the designated mark. The prepared sample cup was then placed in the measurement chamber of a Labswift*water activity* meter (Novasina, Switzerland). The readings were recorded once a stable a_w value was displayed on the screen, as per the method described by Carbonell *et al.* (2005).

Proximate composition

The proximate composition of the pet treat was determined by the standard procedure of AOAC (2016).

Colour characteristics (L, a, b values)

Colour of the dried pet treat was determined objectively as per Navneet and Kshitij (2011) using a calibrated colour reader (Lovibond LC 100 Spectrocolourimeter) with diffuse illumination. The instrument was set to measure *L, a* and *b* values. It was calibrated using black and white calibration tiles before starting of the measurement and the colourimeter score was recorded with *L* of black equals zero and *L* of white equals 100, *a* of lower numbers equals more green (less red), higher numbers equal more red (less green) and *b* of lower numbers equals more blue (less yellow), higher numbers equals more yellow (less blue). The colour coordinates *L* (lightness), *a* (redness) and *b* (yellowness) of the samples were measured thrice and mean values were taken.

Palatability and acceptability test

The palatability assessment was conducted on a cohort of ten homogeneous dogs of similar size and breed. The feeding trials were replicated four times to ensure reliability. The pet treats were offered to the dogs 3–5 hours post-normal feeding and their behavioural responses were systematically observed. Special emphasis was given to parameters such as approach towards the treat, interest in consumption and eating behaviour. These observations were recorded using a modified scorecard, adapted from Pame *et al.* (2017). Additionally, dog owners' perceptions regarding the treat's colour, odour and overall appearance were documented using the same scorecard. The collected data were systematically tabulated and expressed as percentages.

Results and discussion

pH and Water activity (a_w)

The effect of adding shank powder at 35 per cent and 40 per cent levels on the pH of the pet treat is demonstrated in Table 4. The pH of T_2 (6.48 ± 0.11) was higher and significantly ($p<0.01$) different than that of C and T_1. Shendage (2019) reported that the pH of reconstituted chicken feet soup powder was 6.25, which aligns with the present findings. The water activity (a_w) ranged from 0.86 ± 0.00 to 0.88 ± 0.01, with T_2 exhibiting a lower and significantly ($p<0.05$) different a_w than C. Pame *et al.* (2017) observed that the a_w of the pet kibbles incorporated with meat-cum-bone meal (MCBM) ranged from 0.64 ± 0.01 to 0.66 ± 0.00, indicating that the addition of functional ingredient has significantly ($p<0.01$) reduced the a_w levels. This variation in a_w could be attributed to differences in ingredient composition and moisture retention properties.

Table 2. Effect of different levels of poultry shank powder on the physico-chemical characteristics and proximate composition of the pet treat (Mean ± SE) (n=6)

Parameters	C	T_1	T_2	F- Value
pH	6.07^{a} ± 0.15	6.40^{b} ± 0.12	6.48^{c} ± 0.11	311.712**
Water activity (a_w)	0.88^{b} ± 0.01	0.87^{ab} ± 0.01	0.86^{a} ± 0.00	3.418*
Moisture (%)	19.71^{c} ± 0.34	15.92^{b} ± 0.37	14.68^{a} ± 0.32	57.324**
Dry matter (%)	80.29^{a} ± 0.34	84.07^{b} ± 0.37	85.32^{c} ± 0.32	57.324**
Crude protein (%)	23.96^{a} ± 0.40	36.35^{b} ± 0.45	37.49^{b} ± 0.70	199.451**
Fat (%)	16.16 ± 0.24	17.14 ± 0.69	16.96 ± 0.17	1.482
Crude fiber (%)	1.61^{b} ± 0.04	1.12^{a} ± 0.05	1.01^{a} ± 0.03	62.443 **
Total ash (%)	3.92^{a} ± 0.10	10.82^{b} ± 0.13	11.98^{c} ±0.16	1073.162**
NFE (%)	34.64^{b} ± 0.32	18.64^{a} ± 1.17	17.88^{a} ± 0.85	121.84**
Energy (Kcal/100g)	379.84 ± 2.69	374.27 ± 2.59	374.10 ± 1.38	2.122

*Mean bearing different superscripts in a row differ significantly (P≤0.05- Significant *; P≤0.01-Highly Significant **)*

C- Control (Pet treat without poultry shank powder), T_1- Treatment – 1 (Pet treat with 35% shank powder),

T_2 - Treatment -2 (Pet treat with 40% shank powder)

Table 3. Effect on colour (L, a, b) on addition of different levels of poultry shank powder on the pet treat (Mean ± SE) (n=6)

Parameters	C	T_1	T_2	F- value
L (lightness)	38.47^{b}± 1.06	34.06^{a}± 0.80	32.29^{a}± 0.53	14.944**
a (redness)	14.88^{b}± 0.67	9.96^{a}± 0.65	9.48^{a}± 1.12	26.585**
b (yellowness)	15.79^{b}± 1.36	11.2^{a}± 1.01	10.22^{a}± 0.86	7.365*

*Mean bearing different superscripts in a row differ significantly (P≤0.05- Significant *; P≤0.01-Highly Significant **)*

C- Control (Pet treat without poultry shank powder), T_1- Treatment – 1 (Pet treat + 35% poultry shank powder),

T_2 - Treatment -2 (Pet treat + 40% poultry shank powder)

Proximate composition

The effect of poultry shank powder incorporation on the proximate composition of pet treats is summarised in Table 2. The moisture content ranged from 14.68±0.32 per cent to 19.71±0.34 per cent, aligning with the National Research Council (NRC, 2006) recommended range of 15-30 per cent for intermediate moisture foods. T_2 exhibited a higher and significantly ($p<0.01$) different dry matter content than the control. The crude protein (CP) levels were also higher and significantly ($p< 0.01$) different in T_1 (36.35±0.45 per cent) and T_2 (37.49±0.70 per cent) compared to C (23.96±0.40 per cent), which can be attributed to the protein-rich shank powder.

Fat content varied between 16.16±0.24 per cent and 17.14±0.69 per cent, with no significant differences among the formulations. Crude fibre was higher and significantly ($p< 0.01$) different in C, likely due to the greater proportion of tubers and fibre-rich cereals, while total ash content was higher and significantly ($p< 0.01$) different in T_2, reflecting the mineral-rich nature of shank powder. The nitrogen-free extract (*NFE*) was highest in C (34.64±0.32 per cent) and significantly lower ($p< 0.01$) in T_1 (18.64±1.17 per cent) and T_2 (17.88±0.85 per cent).

Energy content ranged from 374.07 ± 1.38 kcal/100 g to 379.84 ± 2.69 kcal/100 g, with no significant differences among the formulations. Overall, the moisture, protein, fat and energy content of the samples remained within the NRC recommendations, suggesting the suitability of poultry shank and offal powder incorporation in pet treat formulations.

Colour characteristics (L, a, b values)

The visual appeal of pet food plays a significant role in pet owners' purchasing decisions, with colour being one of the most influential factors (Yam *et al.*, 2017). Meat-based products and those containing animal-derived proteins often undergo colour changes due to processing conditions, particularly the Maillard reaction. In this study, the impact of varying levels of shank powder on colour characteristics was assessed using lightness (*L*), redness (*a*) and yellowness (*b*) values and are presented in Table 3.

The *L* values for C, T_1, and T_2 ranged from 32.39 ± 0.53 to 38.47 ± 1.06, while *a* values varied between 9.48 ± 1.12 and 14.88 ± 0.67. Treatments T_1 and T_2 exhibited lower and significantly ($p\leq0.01$) different *L* and *a* values compared to C. Pame *et al.* (2018) also observed a significant ($p\leq0.05$) decrease in redness (*a*) values when MCBM was incorporated into the control formulation for the preparation of pet kibbles.

The *b* values ranged from 10.22 ± 0.86 to 15.79 ± 1.36, with a reduction and significant ($p\leq0.05$) difference in the treated samples. The decrease in lightness, redness and yellowness in the treated formulations may be attributed to the inclusion of shank powder, which altered the pigment composition. Kumar (2021) similarly reported that increasing the level of poultry by-product powder in pet

Table 4. Palatability score for pet treat incorporated with different levels of poultry shank powder

Pet treat samples	Attributes	High (%)	Medium (%)	Low (%)
Control C	1. Colour & Appearance	70.0	30.0	0.0
	2. Odour	95.0	5.0	0.0
	3. Approach	15.0	65.0	20.0
	4. Interest to eat	5.0	70.0	25.0
	5. Nature of eating (chewing)	65.0	15.0	20.0
	6. Preference	5.0	70.0	25.0
Treatment T_1	1. Colour & Appearance	25.0	35.0	40.0
	2. Odour	0.0	100.0	0.0
	3. Approach	35.0	65.0	0.0
	4. Interest to eat	40.0	60.0	0.0
	5. Nature of eating (chewing)	90.0	10.0	0.0
	6. Preference	40.0	60.0	0.0
Treatment T_2	1. Colour & Appearance	20.0	65.0	15.0
	2. Odour	0.0	100.0	0.0
	3. Approach	65.0	35.0	0.0
	4. Interest to eat	65.0	35.0	0.0
	5. Nature of eating (chewing)	85.0	15.0	0.0
	6. Preference	60.0	40.0	0.0

C- Control (Pet treat without poultry shank powder), T_1- Treatment – 1 (Pet treat with 35% poultry shank powder), T_2 - Treatment -2 (Pet treat with 40% poultry shank powder)

food formulations led to a significant reduction ($p<0.05$) in *L* and *b* values, further supporting these findings.

Palatability and acceptability test

The palatability of the pet treat formulations was evaluated based on observational scores and owner preferences (Table 4), as palatability is a critical determinant of a pet food's success (Tobie *et al.*, 2015). The results indicated that C received higher owner preference scores than T_1 and T_2, potentially due to the shank powder masking the turmeric colour in the base formulation. However, T_2 achieved the highest scores for approach, interest and overall preference, suggesting that the protein-rich shank powder enhanced the meat flavour, thereby improving palatability.

These findings are consistent with previous studies (Mahender *et al.*, 2013; Pame *et al.*, 2017), which reported enhanced palatability and acceptability in pet foods incorporating poultry by-products. This underscores the potential of such ingredients to improve both the nutritional and sensory attributes of pet treats with appropriate formulation adjustments.

Conclusion

The inclusion of poultry shank powder at 40 per cent level significantly improved the nutritional qualities and palatability of the pet treat.

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Conflict of interest

The authors declared they have no conflict of interest.

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