

Chemical Characterization of Noodle Waste and Its Utilization as a Partial Maize Replacement in Canine Diets: Effects on Feeding Behaviour and Dermal Health

Nilakshi Prakash Patil,* Kalola Rajankumar and Anurag Kataria

Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India

Abstract

The present study evaluated the chemical composition of noodle waste (NW) and its suitability as a partial substitute for maize in canine diets, followed by evaluation of feeding behaviour and dermal health in Labrador dogs for 60 days. Noodle waste and experimental diets were analysed for proximate composition and gross energy prior to diet formulation. Noodle waste contained 11.3% crude protein, 16.3% ether extract, 1.48% crude fibre, 2.50% total ash, 97.5% organic matter, 64.5% nitrogen-free extract and a gross energy value of 4800 kcal/kg on dry matter (DM) basis. The control and experimental diets were formulated to be nutritionally comparable, exhibiting similar crude protein (21.3 vs. 21.1%), ether extract (6.90 vs. 6.75%), crude fibre (4.40 vs. 4.25%) and gross energy (3922 vs. 3897 kcal/kg) on DM basis. Ten adult dogs were randomly allocated into either the control diet (0% noodle waste) or 25% substitution of maize with noodle waste. The assessment of feeding behavior was done through video recording, while the assessment of hair coat and skin was done using a scoring system.

Dietary inclusion of noodle waste had no significant effect ($P > 0.05$) on consumption time (1.49 vs. 1.51 min/g), distraction frequency (0.40 vs. 0.60), post-consumption interest score (2.85 vs. 2.90), or anticipatory behaviors compared with the control diet. Likewise, skin and hair coat scores remained comparable between treatments ($P > 0.05$), with most dogs exhibiting normal to slightly greasy skin and medium to highly reflective, soft hair coats throughout the study. The chemical analysis confirmed that the experimental diets were comparable in nutrient composition. Feeding a diet in which 25% of the maize component was replaced with noodle waste had no adverse effects on feed acceptance, feeding behavior, hair coat or skin condition in adult Labrador dogs.

Keywords: Chemical characterization, dogs, feeding behaviour, maize, noodle waste

***Correspondence:** Nilakshi Prakash Patil

Introduction

There is a rising trend towards sustainable diets for canine and feline pets. The worldwide market value for vegan pet foods is expected to double its market size to reach US\$57 billion by 2034 [1]. Typical ingredients in vegan dog food are cereal grains, legumes, vegetable protein sources, vegetables, fruits, seeds and vegetable oils. Maize, a conventional cereal grain is one of the main ingredients for feeding livestock producing meat and milk as well as for the human diet [2]. Yet, rising demands for cereal grains as well as the necessity to diminish the food waste has prompted the need for finding alternative feeds [3, 4]. Specifically, former foodstuff products (FFPs) provide a sustainable source of energy for animal feeding. The utilization of alternative feed resources requires prior chemical characterization to determine their nutritional suitability and energy value. Proximate analysis provides essential information on the chemical composition of feed ingredients, enabling formulation of nutritionally balanced diets while ensuring consistency in nutrient supply.

Noodle waste (NW) is an example of FFPs, which is carbohydrate-based material that has a high level of metabolizable energy and no anti-nutritional properties [5]. Previous studies have shown that NW possesses a chemical composition comparable to conventional cereal grains and can successfully replace maize as an energy source in pig and poultry diets without adversely affecting feed intake or growth performance [6-9]. However, information on its chemical characteristics and utilization in canine diets remains limited. Feeding behavior, together with hair coat and skin condition is an essential factor in assessing the acceptability of food, nutritional status and general well-being.

These parameters can be useful in studying novel ingredients in dog diets [10-12]. As far as we know, no scientific study has investigated the chemical composition of noodle waste in relation to its incorporation into canine diets and the subsequent effects on feeding behaviour, hair coat and skin condition. Therefore, the present research was undertaken to characterize the chemical composition of noodle waste and investigate the effects of partial replacement of maize with NW on the feeding behavior and dermal health status of adult dogs.

Materials and methods

Ethical approval

The study protocol was approved by the Committee for Control and Supervision of Experiments on Animals (CCSEA), New Delhi, India-110008 (vide letter no: V-11011(13)/7/2024-CPCSEA-DADF).

Experimental Dogs and Treatments

The noodle waste (consisted of discarded dried noodles) was purchased from the local market and analysed for its proximate composition. The experimental diet was formulated by replacing 25% of the maize component with noodle waste while maintaining a nutrient composition comparable to that of the control diet, ensuring that both diets were isocaloric and isonitrogenous. The control diet consisted primarily of maize, soybean meal, black gram, skim milk powder, rice bran, flaxseed, vegetable oil, and a mineral-vitamin premix, along with essential feed additives. The experimental diet was formulated by replacing 25% of the maize component with noodle waste (12.75% of the total diet on a dry matter basis). To maintain comparable nutrient composition, the inclusion levels of maize, soybean meal, black gram, and vegetable oil were adjusted, whereas the levels of skim milk powder, rice bran, flaxseed, mineral sources, vitamin-mineral premix, enzymes, emulsifier, antioxidant (BHT), acidifier, yeast, and mycotoxin binder remained unchanged. The diets were formulated to meet the maintenance nutrient requirements of adult dogs as per NRC [13]. Ten healthy adult Labrador dogs (aged 14-16 months; 24.5 ± 0.69 kg) were selected based on the availability of experimental animals and randomly allocated to two dietary treatment groups ($n = 5$ per group; 3 males and 2 females in each treatment). The dogs had comparable initial body weights and were randomly allocated to treatments to minimize individual variation. Throughout the experimental period, the dogs were fed maintenance diets and housed individually in well-ventilated kennels under identical management practices, thereby preventing direct interaction during feeding and minimizing behavioral influences from neighboring animals. After 7 days acclimatization period, the dogs were fed their respective experimental feeds for 60 days. Fresh drinking water was provided ad libitum throughout the study.

Chemical analysis of noodle waste and experimental diets

The proximate composition of noodle waste (NW) and experimental diets was determined according to the standard methods of AOAC International [14]. Dry matter (DM; Method 934.01), total ash (Method 942.05), ether extract (Method 920.39), crude fibre (Method 962.09) and nitrogen by the Kjeldahl method (Method 984.13) were analysed. Organic matter (OM) was calculated by subtracting the ash content from the dry matter content. Nitrogen-free extract (NFE) was estimated by difference using the equation: $NFE (\%) = 100 - [\text{crude protein} (\%) + \text{ether extract} (\%) + \text{crude fibre} (\%) + \text{total ash} (\%) + \text{moisture} (\%)]$. Gross energy (GE) of the samples was determined using a bomb calorimeter (Toshniwal Bros., Delhi, India).

Feeding behavior

Each of the dogs received an equal quantity of food in the morning and in the evening and a video was recorded for four days during the process of feeding the dogs so that the feeding behavior of the dogs could be examined [15]. The recordings took place 10 seconds prior to feeding the dogs and stopped 10 seconds after the dogs finished their meals. It was also observed that the length of the feeding process, starting from the first kibble to the last kibble eaten was also recorded. In addition to this, the rate of consumption was also measured in minutes per gram. Hesitation time of the dog before feeding (in seconds), before taking the first bite was also recorded. Distraction behavior referred to how often the dogs attended to other stimuli during the time when they were eating. Four different types of behavior that were present (1) or absent (0) prior to feeding were considered in measuring the anticipation of the dogs before they ate (10 seconds prior to the provision of food). Examples of these behavior include jumping toward the front of the cage,

forcing faces through the bars, licking air or the lips and tail wagging. A rating of 1 to 3 was used to measure interest after consumption with 1 being low interest, 2 being moderate interest and 3 high interests.

Hair coat and skin

Skin and hair coat condition of the dogs was evaluated by four examiners consisting of two nutritionists and two doctors in each group for two consecutive days. None of the assessors was aware about the food that particular dog received. The dogs were subjectively examined according to the following criteria: 1. dull, coarse, dry; 2. weakly reflective, non-soft; 3. medium reflective, medium soft; 4. highly reflective, very soft; 5. greasy. For skin type: 1. dry; 2. slightly dry; 3. normal; 4. slightly greasy; 5. greasy. Examination was done at a stainless-steel table under examination lights used in operation rooms [12].

Statistical analysis

The dog was considered the experimental unit in the study. Data collected during the experiment were subjected to statistical evaluation using SPSS (version 20.0). The experimental unit for all behavioral and physical evaluation parameters was the individual dog. Behavioral observations recorded over four consecutive days (Table 2), were evaluated using a two-way repeated measures analysis of variance through the General Linear Model framework. The model integrated diet treatment (Control vs. Noodle-Waste Feed), observation day (Days 1–4), and their two-way interaction (Treatment $\times$ Day) as fixed factors. Parameters exhibiting zero variance or uniform responses across all experimental units (hesitation, tail wagging, and air/lip licking) were omitted from statistical modelling and are presented descriptively.

Hair coat characteristics and skin health proportion data (Table 3) were evaluated using an independent samples Student's t-test. Data are presented as treatment means accompanied by the pooled standard error of the mean (SEM). Statistical significance was defined at $P \leq 0.05$.

Results and Discussions

Chemical characterization of noodle waste and experimental diets

The chemical composition of noodle waste (NW) and the experimental diets (on dry matter basis) is presented in Table 1. The noodle waste contained 11.3% crude protein, 16.3% ether extract, 1.48% crude fibre, 2.50% total ash, 97.5% organic matter, 64.5% nitrogen-free extract and a gross energy content of 4800 kcal/kg on dry matter (DM) basis. These results indicate that NW is an energy-rich feed ingredient with low fibre content, making it suitable for partial replacement of cereal grains in canine diets. The results are in line with the findings of Aderolu *et al.* [16], who reported similar values for crude protein, ether extract and crude fibre in noodle waste.

The chemical composition of the control and experimental diets was also comparable, confirming that replacement of 25% of the maize component with NW maintained the intended nutrient composition. The crude protein (21.3 vs. 21.1%), ether extract (6.90 vs. 6.75%), crude fibre (4.40 vs. 4.25%), total ash (6.77 vs. 6.45%) and gross energy (3922 vs. 3897 kcal/kg) differed only marginally between the diets. The analytical results indicate that the experimental diet remained nutritionally comparable to the control diet, thereby allowing subsequent biological responses to be attributed primarily to ingredient substitution rather than differences in dietary nutrient composition.

Table 1. Chemical composition (%) and gross energy of noodle waste and experimental diets

Parameter	Noodle waste	Control diet	25% NW diet
Crude protein	11.3	21.3	21.1
Ether extract	16.3	6.90	6.75
Crude fibre	1.48	4.40	4.25
Total ash	2.50	6.77	6.45
Organic matter	97.5	93.2	93.6
Nitrogen free extract	64.5	56.1	56.0
Gross energy (kcal/kg)	4800	3922	3897

Feeding behavior

Dietary inclusion of noodle waste did not alter any of the measured feeding behaviour traits ($P > 0.05$) as reflected from Table 2. Mean consumption time was comparable between the control and noodle waste groups (1.51 vs. 1.49 min/g), while distraction frequency (0.60 vs. 0.40 events), post-feeding interest score (2.90 vs. 2.85), and anticipatory behaviors remained similar across treatments. No hesitation before feed intake was observed in either group, indicating excellent acceptance of both diets. These findings demonstrate that replacing 25% of maize with noodle waste-maintained diet palatability and did not influence feeding motivation or eating behaviour in Labrador dogs. As explained by Wurtman & Wurtman [17], the high carbohydrate level of the diet could have led to satiety through stimulation of insulin release and serotonin production in the brain. No differences in the speed of food intake and distractibility were found for various types of diet according to Strickling *et al.* [18]; nevertheless, hesitation, the degree of anticipation and interest in food after consumption were maximum on the first day when dogs started a new diet while the dogs' neophobic reactions had lessened with time. The comparable feeding responses observed in the present study indicate that partial substitution of maize with chemically characterized noodle waste did not compromise diet acceptability.

Table 2. Effect of inclusion of noodle waste-based feed on feeding behavior

Variable	Control	Experimental	SEM	<i>P value</i>		
				Treatment	Day	Day × Treatment
Consumption (min/g of food)	1.51	1.49	0.007	0.845	0.485	0.681
Distraction	0.60	0.40	0.218	0.535	0.927	0.526
Hesitation	0.00	0.00	-	-	-	-
Anticipation Pre-consumption						
Tail wagging	1.00	1.00	-	-	-	-
Licking air/lips	1.00	1.00	-	-	-	-
Pushing face through bars	0.45	0.55	0.166	0.681	0.518	0.744
Jumping at front of kennel	0.60	0.60	0.218	1.00	0.347	0.347
Interest Post consumption	2.90	2.85	0.127	0.789	0.260	0.488

Table 3. Effect of inclusion of noodle waste-based feed on hair and skin coat conditions (%)

Parameters	Control	Experimental	SEM	<i>P-value</i>
Hair Coat				
Dull, coarse, dry	0.00	0.00	0.00	-
Weakly reflective and non-soft	13.4	16.7	4.615	0.740
Medium reflective and medium	62.3	53.3	6.667	0.645
Soft	24.3	26.7	6.211	0.806
Highly reflective and very soft	0.00	3.30	1.667	1.000
Greasy				
Skin				
Dry	0.00	0.00	0.00	-
Slightly dry	6.67	10.0	2.778	0.580
Normal	40.0	40.0	4.444	1.00
Slightly greasy	50.0	46.7	5.800	0.790
Greasy	3.33	3.30	2.222	1.00

Hair coat and skin coat

The effect of partial replacement of noodle waste on hair and skin coat conditions of dogs is given in Table 3. The results indicated that the hair coat and skin scores were not affected by dietary treatment ($P > 0.05$). Most of the dogs in both the groups exhibited medium to highly reflective, soft hair coats, whereas approximately half of the observations were classified as slightly greasy skin and 40% as normal skin. The comparable dermal health observed between treatments is consistent with the similar chemical composition of the experimental diets. Yotis [19] found that dietary supplements using yeast could preserve but not improve the quality of the coats, while Geary *et al.* [20] and Kumar [21]

found that better quality of the coats resulted from the use of human-grade diet and chia seed supplements respectively, due to higher levels of good fats. Kirby [22] emphasized the importance of zinc and linoleic acid in maintaining healthy skin and hair. Since both diets in the present study were formulated to be chemically comparable and to meet nutrient requirements, replacement of maize with noodle waste did not compromise external indicators of dermal health.

Conclusion

Noodle waste is an energy-rich former foodstuff product (16.3% ether extract, 4800 kcal/kg GE) that can effectively substitute 25% of maize in adult canine diets without compromising feeding behavior, hair coat and skin condition. These findings demonstrate the practical feasibility of upcycling noodle waste into sustainable pet food formulations, offering an eco-friendly alternative to traditional cereal grains.

References

- [1] Knight, A. (2026). Sustainable Pet Diets: A Leading Effective Altruism Issue. *Animals*, 16(3), 460.
- [2] Tanprasertsuk, J., Tate, D. E., & Shmalberg, J. (2022). Roles of plant-based ingredients and phytonutrients in canine nutrition and health. *Journal of Animal Physiology and Animal Nutrition*, 106(3), 586-613.
- [3] Tiwari, M. R., & Dhakal, H. R. (2021). Bakery waste is an alternative of maize to reduce the cost of pork production. *Nepalese Journal of Agricultural Sciences*, 7(5), 1-9.
- [4] van Zanten, H. H., Mollenhorst, H., Oonincx, D. G., Bikker, P., Meerburg, B. G., & De Boer, I. J. (2015). From environmental nuisance to environmental opportunity: housefly larvae convert waste to livestock feed. *Journal of Cleaner Production*, 102, 362-369.
- [5] Eniolorunda, O. O., Taiwo, B. B. A., Oyewumi, O. O., & Adeyemi, O. A. (2008). Performance of laying hens fed graded levels of Indomie waste as replacement for maize in a humid tropical environment. *Research Journal of Animal Sciences* 2 (5), 135-138.
- [6] Fu, B. X. (2008). Asian noodles: History, classification, raw materials, and processing. *Food Research International*, 41(9), 888-902.
- [7] Munoz, A., & Mariela, L. (1990). Study on the effect of different replacement levels of corn for waste noodles during the raising and fattening period of pigs in an industrial swine herd of the 8th region.
- [8] Yakubu, S. T., Olugbemi, T. S., Onimisi, P., & Lasisi, O. T. (2017). Effects of indomie noodle waste (INW) on serum lipid profile of broiler birds fed during the wet season. *Nigerian Journal of Animal Production*, 44, 96-100.
- [9] Animashahun, R. A., Omoikhoje, S. O., Alabi, O. O., Shoyombo, A. J., & Olawoye, S.O. (2018). Influence of graded levels of instant noodle waste in the diets on the performance, carcass traits and haematology of broiler chickens. *Agrosearch*, 18(1), 40-52.
- [10] Watson, P. E., Thomas, D. G., Bermingham, E. N., Schreurs, N. M., & Parker, M. E. (2023). Drivers of palatability for cats and dogs- what it means for pet food development. *Animals*, 13(7), 1134.
- [11] Watson, T. D. (1998). Diet and skin disease in dogs and cats. *The Journal of nutrition*, 128(12), 2783-2789.
- [12] Rees, C. A., Bauer, J. E., Burkholder, W. J., Kennis, R. A., Dunbar, B. L., & Bigley, C. E. (2001). Effects of dietary flax seed and sunflower seed supplementation on normal canine serum polyunsaturated fatty acids and skin and hair coat condition scores. *Veterinary Dermatology*, 12(2), 111-117.
- [13] National Research Council. (2006) Nutrient requirements of dogs and cats. National Academies Press, Washington, DC.
- [14] AOAC International. (2007). Official Methods of Analysis. 18th Edn., Association of Official Analytical Chemists, Gaithersburg.
- [15] Callon, M. C., Cargo-Froom, C., DeVries, T. J., & Shoveller, A. K. (2017). Canine food preference assessment of animal and vegetable ingredient-based diets using single-pan tests and behavioral observation. *Frontiers in Veterinary Science*, 4, 154.
- [16] Aderolu, A.Z., Aarode, O.O. & Adigun, A. (2011) Replacement of maize with graded levels of noodle waste in commercial diet of African catfish. *Nigerian Journal of Fish* 8(2):265-71
- [17] Wurtman, R. J., & Wurtman, J. J. (1995). Brain serotonin, carbohydrate-craving, obesity and depression. *Obesity Research*, 3(4), 477S-480.
- [18] Strickling, J. A., Harmon, D. L., Dawson, K. A., & Gross, K. L. (2000). Evaluation of oligosaccharide addition to dog diets: influences on nutrient digestion and microbial populations. *Animal Feed Science and Technology*, 86(3-4), 205-219.

- [19] Yotis, S. M. (2022). Effects of a *Saccharomyces cerevisiae* fermentation product-supplemented diet on immune response, oxidative stress markers, and skin and coat health of dogs (Doctoral dissertation, University of Illinois at Urbana Champaign). <https://hdl.handle.net/2142/115746>.
- [20] Geary, E. L., Oba, P. M., Applegate, C. C., Clark, L. V., Fields, C. J., & Swanson, K. S. (2022). Effects of a mildly cooked human-grade dog diet on gene expression, skin and coat health measures, and faecal microbiota of healthy adult dogs. *Journal of Animal Science*, 100(10), 265.
- [21] Kumar, S. (2023). Evaluation of nutritional potential of chia seeds in the diet of pug puppies (Doctoral dissertation, Guru Angad Dev Veterinary and Animal Sciences, Ludhiana).
- [22] Kirby, N. A. (2005). Effect of dietary polyunsaturated fatty acids and related nutrients on sebum lipids, and skin and hair coat condition in canines (Doctoral dissertation, Texas A & M University). <http://hdl.handle.net/1969.1/1385>.

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