Indian J. Anim. Nutr. 2019. 36 (1): 77-82
doi: 10.5958/2231-6744.2019.00013.6

Indian Journal of Animal Nutrition

Development of Calcium Fortified Biscuits Incorporated with Chicken Slaughter House Byproducts and Evaluation of Their Palatability in Dogs

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ABSTRACT

This study was designed to optimize the level of poultry by-products *viz.,* liver and gizzard along with calcium fortification for the development of dog biscuits. Poultry liver and gizzard were minced, air dried at 60°C for 15 -16 h and ground. Three different levels of poultry liver and gizzard *viz.*, 10, 20 and 30% were incorporated separately in standardized dog biscuits formulation after replacing refined wheat flour. The developed product was analyzed for physico-chemical properties (pH and cooking yield), proximate composition (moisture, protein, fat and ash), mineral content (Ca and P), instrumental color and texture profile analysis. Dicalcium phosphate was incorporated at 2% level in the 30% liver powder incorporated dog biscuits with acceptable physico-chemical and sensory qualities. Among the selected levels, incorporation of liver powder at 30% level was found to be better for the preparation of dog biscuits.

Key words: Dog biscuits, Gizzard, Liver, Sensory evaluation, Texture profile

INTRODUCTION

Large number of poultry birds are slaughtered annually in India leading to production of 2.72 million tonnes of meat (BAHS, 2016-17). It leaves huge loads of slaughter house by-products *viz.*, offals, feathers, blood *etc.* In general, the total by-products range from 5 to 6% of the live weight of chicken. Efficient utilization of these by-products has direct impact on the economy and environmental pollution of the country. Meat by-products are produced by slaughter houses, meat processors, wholesalers and rendering plants. These can be used as feeds for the poultry, fish and pets like dogs and cats. In India, pet food production is mostly cereal based. Slaughterhouse wastes or animal by-products such as liver, lung, kidney, brain, spleen and tripe have high nutritive value and these can be efficiently utilized for the production of pet foods as the animal proteins are the integral part of their diet. Liver is richer source of protein, vitamins and minerals than fresh meat. It is excellent source of readily digestible haeme iron, vitamins particularly riboflavin, niacin, vitamin B_{12} and vitamin A, D, E and K. Gizzard is one of the principal edible byproducts of poultry processing which is being marketed as variety meats along with dressed chicken. Gizzard contains approximately 20% protein and could be of potential use in preparation of dog biscuits. Further, utilization of this byproduct would increase the profitability of broiler industry.

Pets play a significant role as companion animals. There are about 4.0 million pets in the Indian households with the population increasing by 26% every year. Pet food market has huge potential in India with the growth rate of 10-15% per annum. Dogs, cats and other pet food contribute 80, 15 and 5%, respectively to pet food market. Meat and meat products are deficient in calcium. Calcium requirement in pets during peak growth and lactation ranges from 1.0-1.8% of total diet on dry matter basis. Calcium deficiency is very common nutritional disorder among pets. It results primarily from animals fed diets high in meat and organ meats which are high in phosphorous and low in calcium that could lead to metabolic diseases. Therefore, the present study was designed to develop dog biscuits based on the slaughter house byproducts and fortified with calcium.

MATERIALS AND METHODS

Poultry byproducts *i.e.* liver and gizzard required for the experiments were collected from the

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Table 1. Ingredient composition (%) of dog biscuits in control diet

Ingredient	Percentage
Refined wheat flour (maida)	55
Vegetable oil	20
Whole egg liquid	16
Spice mix	3
Sugar	3
Table salt	2
Baking powder	1

Instructional Poultry Processing Plant of Department of Livestock Products Technology, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India. After slaughtering poultry birds, poultry liver and gizzard were collected, cleaned and packed in LDPE bags and stored in freezer. The refined soybean oil (Fortune, Adani Wilmar Ltd.),refined wheat flour (maida), common salt (Tata Chemicals Ltd., Mumbai, India), spice mix, chicken eggs, sugar, baking powder (Weikfield) and packaging material (LDPE and LDPE/ polyester/polyethylene laminated plastic bags) were procured from local market of Ludhiana, Punjab, India. Analytical grade chemicals, media and high purity standards required for analyzing the products were procured from different firms (SRL, Fisher Scientific, LobaChemie, Himedia). Formulation and processing protocols of the dog biscuit was standardized on the basis of available literature and various preliminary trials conducted in laboratory. The standardized formulation has been given in Table 1. Poultry liver and gizzard were minced in the meat mincer (Mado Eskimo Mew-714, Mado, Germany). Minced poultry liver and gizzard were air dried at 60°C for 15-16 h in industrial tray dryer and ground.

For the preparation of dog biscuits, first of all, sugar powder was added in paddle mixer followed by vegetable oil and whole egg liquid. All other ingredients left were mixed. Ingredients were used according to formulation and mixed in paddle mixture and dough was prepared by mixing the ingredients. Mixing of dough was done uniformally. Biscuits were made by filling dough in stainless steel mold of different shapes and cooking was done in hot air oven at temperature of 180°C for 10 min. Both liver and gizzard incorporated biscuits were prepared separately. The liver and gizzard powder was incorporated at 10, 20 and 30% levels after replacing the refined wheat flour in the formulation (Table 2).

The pH of finely grounded dog biscuits (10 g of sample was homogenized with 50 mL of distilled water for 1 min. using pestle and mortar) was determined (Trout *et al.,* 1992) with digital pH meter (FE-20-1-KIT, Mettler-Toledo India Pvt. Ltd., Mumbai). The weight of each product was recorded before and after cooking. The cooking yield was calculated and expressed as percentage by a formula:

$$\text{Cooking yield}\,(\%) = \frac{\text{Weight of baked product}}{\text{Weight of raw product}} \times 100$$

The acceptability of dog biscuits was tested (Griffin *et al.,* 2003). In this test, 12 dogs (BW= 4±2 kg) were selected and 100 g of dog biscuits were served to the dogs for 5 days after their regular meals. Food intake was recorded. The same procedure was repeated for other treatment dog biscuits. Under this test, 500 g dog biscuits from each treatment were served to all the dogs.

Hardness and fracturability of dog biscuits was

Table 2. Levels of liver powder and gizzard powder in different groups

Ingredient	Group						
	Control	T_1	T_2	T_3	T_4	T_5	T_6
Refined wheat flour	55	45	35	25	45	35	25
Liver powder	-	10	20	30	0	0	0
Gizzard powder	-	0	0	0	10	20	30

Where, $T_{1=}$ 10% liver powder; T_2=20% liver powder; T_3=30% liver powder; T_4=10% gizzard powder; T_5=20% gizzard powder; T_6=30% gizzard powder

analysed using texture analyzer (TMS-PRO, Food Technology Corporation, USA). Texture parameters hardness (N) and shear force value (kg/cm^2) were determined (Bourne, 1978) and interpreted as follows. Hardness (N) = maximum force required to compress the sample, shear force value (kg/cm^2) = the force required to cut the given product.

The moisture, protein, fat and ash contents of the product were estimated (AOAC, 1995). Color profile was measured using Lovibond Tintometer (Lovibond House, United Kingdom) set at 2^o of cool white light (d_{65}) and known as '*l*', *a*, and *b* values. '*l*' value denotes (brightness 100) or lightness (0), *a* (+ redness/ - greenness), *b* (+ yellowness/-blueness) values were recorded on/in a hundreds of dog biscuit kept in a plate. The experienced panel of seven members evaluated the samples for the sensory attributes *viz.*, color and general appearance, meat odour intensity and overall acceptability using 5-point descriptive scale where 5 represented excellent and 1 as extremely poor. The data were analyzed statistically using SPSS-16.0" (SPSS Inc., Chicago, II USA) software package as per standard methods (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

The scores for all the sensory attributes showed increasing (P<0.05) trend with increasing level of chicken liver powder in the formulation whereas the scores for the gizzard powder incorporated dog biscuits showed decrease (P<0.05) with the increasing incorporation level of gizzard powder which might be associated with increase in the dark colour of developed dog biscuits. Appearance scores for group T_3 were higher (P<0.05) than other treatment products which might be due to increase in redness value as shown in instrumental colour analysis. Similarly, there was increasing (P<0.05) trend in colour scores with the increase in level of chicken liver powder but there was decreasing trend noticed on incorporation of gizzard powder. Colour score for group T_3 was higher (P<0.05) than that found in groupsT_1 and T_4 but the colour values for both these treatment products were higher (P<0.05) than in groups T_1, T_5 and T_6. There was increasing (P<0.05) trend in meat flavour intensity scores with the increase in incorporation level of chicken liver powder and gizzard powder. Flavour scores for group T_3 were higher (P<0.05) than other products which might be due higher level of chicken liver powder which was more liked by the sensory panelists. Meat flavour intensity scores for gizzard powder incorporated meat biscuits and that in group T_2 were comparable to each other whereas group T_1 showed the lowest score among the groups.

The sensory scores for all the parameters in the dog biscuits containing 30% chicken liver powder (T_3) were highest among all the treatment products and highly acceptable. The overall acceptability score was higher (P<0.05) for dog biscuits containing 30% chicken liver powder (T_3) compared to the other treatment products which is reflective of scores of other sensory parameters (Table 4). The intake of dog biscuits in groups

Table 3. Effect of different levels of incorporation of liver powder and gizzard powder on the sensory parameters of dog biscuits

Sensory parameter	Liver and gizzard powder level					
	T_1 (10% liver)	T_2 (20% liver)	T_3 (30% liver)	T_4 (10% gizzard)	T_5 (20% gizzard)	T_6 (30% gizzard)
General appearance	2.95^{c}±0.14	3.90^{b}±0.12	4.33^{a}±0.12	3.57^{b}±0.12	3.08^{c}±0.11	2.83^{c}±0.10
Colour	2.82^{c}±0.13	3.66^{b}±0.14	4.19^{a}±0.14	3.43^{b}±0.14	2.99^{c}±0.12	2.73^{c}±0.12
Meat flavour intensity	2.68^{d}±0.12	3.57^{b}±0.16	4.39^{a}±0.13	2.91^{cd}±0.19	3.18^{bc}±0.17	3.21^{bc}±0.17
Overall acceptability	2.84^{c}±0.11	3.71^{b}±0.14	4.48^{a}±0.12	3.10^{c}±0.17	3.13^{c}±0.15	3.21^{c}±0.15

^{a,b,c,d}Means with different superscripts in a row differ significantly (P<0.05); N=21; T_1= 10% liver powder, T_2= 20% liver powder; T_3= 30% liver powder; T_4= 10% gizzard powder, T_5= 20% gizzard powder; T_6= 30% gizzard powder

T_2 and T_3 was the highest. A total of six kg of each treatment biscuit was served to all the dogs. The consumption of biscuits in groups T_2 and T_3 was higher than other groups. The consumption of biscuits in group T_3 was the highest which might be due to the more meat flavour intensity as shown in the sensory analysis of dog biscuits. Similarly Regenstein *et al.* (2003) and Karthikeyan *et al.* (2002) reported that incorporation of fish and animal waste in pet foods supplied high protein feed ingredients and palatability enhancing agents in animal foods. Mahender *et al.* (2013) also reported that incorporation of poultry slaughter waste in dog biscuits results in increased in palatability of dog biscuits by conducting an experiment on adult Labrador dogs.

The results for instrumental colour profile (redness (a^*), yellowness (b^*) and lightness (L) and texture profile (fracturability and shear force value) of all the liver and gizzard powder incorporated dog biscuits is presented in Table 5. Redness (a^* value) is an indicator of freshness of the meat and criteria for

Table 4. Effect of incorporation of liver and gizzard powder on acceptability of biscuits by dogs

Item	Dog No.	Liver and gizzard powder level					
		T_1 (10% liver)	T_2 (20% liver)	T_3 (30% liver)	T_4 (10% gizzard)	T_5 (20% gizzard)	T_6 (30% gizzard)
Amount served/dog (g)		500	500	500	500	500	500
Intake (g)/d/dog)	Dog 1	91.60^{b}	94.00^{ABa}	95.20^{ABCa}	90.80^{ABb}	90.40^{ABb}	88.40^{Ab}
		±2.29	±1.34	±0.80	±2.13	±2.11	±2.98
	Dog 2	$91.80\pm^{b}$	93.00^{BCb}	95.40^{ABCa}	90.80^{AB}	85.60^{BCc}	81.60^{ABd}
		±2.60	±0.70	±1.21	±2.48	±1.63	±1.96
	Dog 3	91.80^{b}	97.60^{Aa}	97.60^{Aa}	91.80^{ABb}	87.80^{ABbc}	83.80^{ABc}
		±2.60	±0.93	±0.93	±2.60	±2.52	±3.99
	Dog 4	91.60^{b}	97.20^{Aa}	97.20^{ABa}	90.00^{ABb}	90.00^{ABb}	82.80^{ABc}
		0±2.29	±1.07	±1.07	±1.60	±1.64	±4.35
	Dog 5	91.80^{b}	94.00^{ABa}	95.80^{ABCa}	91.80^{ABb}	87.80^{ABc}	83.80^{ABd}
		±2.60	±1.34	±1.53	±2.60	±2.52	±3.31
	Dog 6	91.80^{b}	94.60^{ABa}	94.60^{ABCa}	89.80^{AB}	89.80^{ABbc}	81.80^{ABc}
		±2.60	±0.51	±0.51	±1.59	±1.59	±2.78
	Dog 7	94.00^{a}	93.00^{BCa}	93.00^{Ca}	93.40^{Aa}	93.40^{a}	91.40^{Ab}
		±0.71	±0.71	±0.71	±1.08	±1.08	±2.56
	Dog 8	91.80^{b}	94.00^{ABa}	94.00^{BCa}	91.80^{ABb}	86.80^{ABCc}	85.40^{ABc}
		±2.60	±1.34	±1.34	±2.60	±3.35	±3.61
	Dog 9	91.60^{b}	90.00^{CDb}	95.20^{ABCa}	90.00^{ABb}	90.00^{ABb}	84.00^{ABc}
		±2.29	±2.30	±0.37	±1.64	±1.64	±4.76
	Dog 10	89.20^{b}	87.60^{Db}	93.20^{Ca}	85.80^{Bb}	80.80^{Cc}	75.40^{Bd}
		±1.24	±0.93	±1.28	±1.32	±1.93	±1.72
	Dog 11	90.80^{b}	93.00^{BCa}	94.00^{BCa}	90.80^{ABb}	89.80^{ABb}	87.80^{Ab}
		±1.71	±0.71	±0.71	±1.71	±1.36	±3.10
	Dog 12	91.60^{b}	94.00^{ABb}	97.20^{ABa}	91.60^{ABb}	90.00^{ABbc}	86.00^{ABc}
		±2.29	±1.34	±0.97	±2.29	±1.64	±4.32
Average intake (g/d/dog)		91.67^{b}	93.50^{a}	95.20^{a}	90.70^{b}	88.55^{bc}	84.35^{d}
		±1.39	±1.80	±1.27	±1.83	±1.19	±2.34

^{a,b,c,d}Means with different superscripts in a row differ significantly (P<0.05); ^{A,B,C,D}Means with different superscripts in a column differ significantly (P<0.05); N=12; T_1= 10% liver powder, T_2= 20% liver powder; T_3= 30% liver powder; T_4= 10% gizzard powder, T_5= 20% gizzard powder; T_6= 30% gizzard powder

Table 5. Effect of different levels of incorporation of liver and gizzard powder on colour and textural parameters of dog biscuits

Parameter	Liver and gizzard powder level					
	T_1 (10% liver)	T_2 (20% liver)	T_3 (30% liver)	T_4 (10% gizzard)	T_5 (20% gizzard)	T_6 (30% gizzard)
Redness (a^*)	10.73^{a}±0.09	10.69^{a}±0.06	9.04^{b}±0.13	6.77^{c}±0.05	6.68^{c}±0.15	7.03^{c}±0.20
Yellowness (b^*)	25.84^{a}±0.08	26.07^{a}±0.15	25.83^{b}±0.29	25.89^{a}±0.17	26.04^{a}±0.25	22.83^{b}±0.29
Lightness (L)	45.49^{b}±0.22	46.71^{ab}±0.23	45.62^{c}±0.73	47.54^{a}±0.27	47.65^{a}±0.22	47.47^{a}±0.67
Fracturability (N)	1.85^{c}±0.03	1.60^{d}±0.03	1.13^{f}±0.06	2.27^{a}±0.06	2.18^{b}±0.03	1.49^{e}±0.05
SFV (kg/cm^2)	3.71^{a}±0.08	3.36^{b}±0.06	2.87^{c}±0.05	3.56^{a}±0.07	3.30^{b}±0.07	2.89^{c}±0.08^{c}

^{a,b,c,d,e,f}Means with different superscripts in a row differ significantly (P<0.05); N=6; T_1= 10% liver powder, T_2= 20% liver powder; T_3= 30% liver powder; T_4= 10% gizzard powder, T_5= 20% gizzard powder; T_6= 30% gizzard powder

quality evaluation by the consumers. Redness (a^*) value showed the pattern in the order of $T_1>T_2>T_3>T_6>T_4>T_5$ and followed a decreasing trend in liver powder incorporated dog biscuits. Redness (a^*) value of dog biscuits incorporated with chicken gizzard powder was lower (P<0.05) than the liver incorporated dog biscuits. The yellowness (b^*) in groups T_3 and T_6 dog biscuits was also lower (P<0.05) than other groups. Lightness (L^* value) of chicken liver powder incorporated dog biscuits was higher (P<0.05) than the chicken gizzard powder incorporated dog biscuits. Meat oxidation caused a decrease in a^* value (Lavieri and Williams 2014; Kumar *et al.,* 2015). Realini *et al* (2015) also reported decrease in b^* values of beef patties containing Acerola fruit extract. Selgas *et al.* (2009) reported same trend for a^* and b^* values in hamburgers containing dried tomato powder.

The values for both fracturability and shear force showed declining trend with increase in the incorporation of liver and gizzard powder which might be due to the replacement of refined wheat flour with by-products powder having low starch content and lower gelatinization on cooking of the developed biscuits. Similarly, Malav *et al.* (2017) also reported higher (P<0.05) hardness and fracturability values in spent hen meat papad incorporated with black gram flour. The highest values for fracturability was observed for dog biscuits incorporated with 10% gizzard powder whereas the highest values for shear force was observed for the dog biscuits incorporated with 10% liver powder.

CONCLUSIONS

The poultry slaughter byproducts *viz.*, liver and gizzard could be effectively utilized for the development of biscuits for dogs. Dog biscuits with high nutritive value and sensory quality were developed by incorporation of chicken liver powder at 30% level.

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Received on 11-12-2018 and accepted on 13-02-2019