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Research Article

NUTRITIONAL ASSESSMENT OF DAL CHURI IN DOG FOOD

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ABSTRACT

This study was conducted to assess the effect of different processing techniques on nutritive value of dog food and to conclude the appropriate inclusion level of dal churi (DC) in dog food. The diets were subjected to different processing techniques *viz.* raw, boiling and extrusion after their standardization. The *in vitro* study included two incubation phases, gastric phase of 2 hours in the presence of pepsin, gastric lipase in HCl solution and intestinal phase of 4 hours in the presence of pancreatin and bile salts in buffer solution. Significant improvement in dry matter, crude protein and organic matter digestibility was observed with processing from raw to boiled and further with extrusion of feed. Irrespective of processing techniques, the digestibility of various nutrients reduced with supplementation of dal churi at both the levels; however, ether extract digestibility remained unaffected. It was concluded that extrusion has remarkable ($P<0.05$) effect on the nutrient digestibility and dal churi can be included in dog food up to 5%.

Keywords: Boiling, Digestibility, Dog food, Extrusion, *In vitro* analysis, Raw

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With increasing affinity towards pet led to increased demand of high-quality diets among pet owners, leading to rapid growth of pet food industry. Protein sources constitute the key component of canine diets as they contain essential amino acids as well as nonessential amino acids required for energy, muscle deposition and metabolic functions of the body. The quantity of protein which is required by a dog is age-dependent. Various commercial dry dog foods available use several protein rich ingredients of diverse qualities like meat and bone meals, poultry by-product meals, and soybean meal and are too expensive. Plant-based protein sources are less studied for their inclusion in dog food with respect to their digestibility of nutrients.

Pulses wastes and peas can also be cost-effective alternative protein sources in dog's diet, as they contain all the required levels of essential amino acids. Pulses generally have a 50-plus year history in the pet food industry, helping to provide many pets with a healthy and well-balanced diet when included in properly formulated food. Pulses can be 'powerhouse ingredients' for pet food, when formulated appropriately (Berry, 2019). However, relatively less data are available on the nutrient digestibility of plant-based protein sources by companion animals. Keeping in mind the above facts, this study was planned to *in vitro* evaluate the dal churi in dog diet.

MATERIALS AND METHODS

Dal churi used in this study was used as protein source as it contained almost 18% crude protein. Diets were formulated for puppy stage of dogs as per AAFCO (2014) specifications containing 22.5 % CP, 8.5 % EE, 1.2% calcium and 1% phosphorus and energy density of 3500 kcal ME/kg as per ICAR (2013). Chemical composition of different diets and samples of *in vitro* studies were analyzed for proximate principles, phosphorus (AOAC, 2005) and calcium (Talapatra *et al.*,1940).

Three diets were formulated using dal churi (DC) at 0, 5 and 10% level and applied to different processing techniques *viz.* raw, boiling and extrusion. Raw diets were formulated using dried ingredients which were kept overnight in hot air oven at 90 °C.For boiled diets, 100 g dried diets were weighed and boiled with 300 mL of water for 15 minutes, cooled and analysed. For formulating the extruded diets, all the ingredients were ground and mixed as per required level and analysed. Aflatoxin estimation of extruded feeds was done using Fluorometer.

In vitro method as validated by Biagi *et al.* (2016) was used with slight modifications such as nylon bags were used for collection of residue. Oven dried sample was finely ground (<1mm particle size) for *in vitro* digestion studies. Digested samples were collected in nylon bags, washed and oven dried at 65 °C for further analysis.

Gastric digestion simulation: 10 g sample of diet and 400 ml of a pepsin-HCl solution (HCl 0.075N; pepsin 2 g/L) containing gastric lipase (1 g/L) were incubated in labeled 1 L bottle in a bench top orbital shaking water bath at 39 °C for 2 h.

Small intestine digestion simulation: The pH of the above mix was adjusted to 7.5 using 1N NaOH solution. Bile salts (Cholic acid-Deoxycholic acid sodium salt mixture) at a final concentration of 25 g/L and 400 ml of a

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pancreatin solution were added to each bottle. Finally, the bottles were placed in a bench top orbital shaking water bath at 39 °C for 4 h. For collection of the undigested fraction, nylon bags were properly washed and oven dried at 65 °C. The dried weight of nylon bags were recorded and analysed. Nutrient digestibility was calculated with the following equation:

Nurtient digestibility = 100 - {[nutrient % in residue × (100 - diet digestibility)]/nutrient % in diet}

The data were subjected to statistical analysis using One-way ANOVA in Software Package for Social Sciences (SPSS, version 25.0). The treatment means were compared by Duncan's Multiple Ranged Test (Duncan, 1995) at 5 % level of significance.

RESULTS AND DISCUSSION

Chemical composition of raw diet: The analyzed value of control group and feed containing 5% and 10% dal churi subjected to different processing techniques were as per the requirement (Table 1). It was observed that on boiling, both ether extract and crude fiber decreased in diets. Ether extract may be reduced due to the diffusion of liquids into water; however, crude fiber content reduction after boiling may be due to softening of fiber fraction during boiling.

***In vitro* nutrient digestibility of control dog feed using different processing techniques:** *In vitro* nutrient digestibility of control feed (Table 2) using different processing techniques (raw, boiling and extrusion) discovered that dry matter digestibility (DMD) and organic matter digestibility (OMD) of boiled feed was significantly (P<0.05) higher than raw feed, however, it was significantly lower than that of extruded feed. No significant difference was observed in crude protein digestibility (CPD) among different processing techniques. Boiled feeds had significantly (P<0.05) lower ether extract digestibility than raw and extruded diets, while no significant difference was observed in ether extract digestibility (EED) of raw and extruded diets. These results indicated that extrusion of feed improved the *in vitro* digestibility of nutrients.

***In vitro* nutrient digestibility of different levels Dal churi based dog feeds using different processing techniques:** Nutrient digestibility of feed containing 5% DC is depicted in table 4. DMD of boiled feed containing 5% DC was significantly (P<0.05) higher (84.90%) than raw diet (64.83%) and lower (P<0.05) than extruded (89.15%) diet. CPD of extruded diets (91.57%) was best (P<0.05) but was comparable with boiled feed (90.69 %). EED was lowest (P<0.05) in case of boiled diets, but non-significant (P<0.05) difference was found in EED of raw and extruded diets. OMD of boiled (84.90%) and extruded feed (89.29%) had non-significant difference while it was lowest (P<0.05) in raw feeds.

In vitro digestibility of nutrients of DC based dog feed at 10% supplementation level subjected to different processing techniques (e.g. dried, boiled and extruded) is presented in table 3. Highest (P<0.05) DMD, CPD and OMD was observed in case of extruded diets and lowest (P<0.05) in case of raw diet. Boiled feed had DMD, CPD and OMD higher than raw and lower than extruded diet, Tran *et al.* (2008) reported that the extrusion process increases protein digestibility. There was non-significant (P<0.05) difference between EED of raw and extruded diet but declined (P<0.05) after boiling.

***In vitro* digestibility (%) of nutrients irrespective of processing techniques and level of dal churi used in the dog feed:** *In vitro* digestibility of nutrients irrespective of processing techniques (raw, boiled and extruded) and level of dal churi (0, 5 and 10 %) used in the dog feed is presented in table 4. DMD, CPD and OMD irrespective of the processing technique used, improved significantly (P<0.01) after extrusion of diet. DMD, CPD and OMD of boiled diet was higher (P<0.01) than raw diets but lower (P<0.01) than extruded diets. *In vitro* protein digestibility (IVPD) was reported to increase significantly after cooking (Park *et al.*, 2010 and Drulyte and Orlein, 2019). Extrusion increased *in vitro* protein digestibility as compared to other processing method e.g. dehulling or

Table 1

Analyzed chemical composition of formulated dog diets (DM basis)

	Raw Diets			Boiled Diets			Extruded Diets		
	Control	5% DC	10% DC	Control	5% DC	10% DC	Control	5% DC	10% DC
	Chemical composition (% DM basis)								
Crude Protein	23.18	23.19	22.75	22.75	23.63	23.63	23.18	22.97	22.75
Ether Extract	7.42	8.65	8.59	3.40	5.70	5.90	6.10	8.48	8.60
Crude Fiber	3.80	4.50	5.24	3.50	4.24	5.10	3.70	4.26	4.90
Total Ash	7.60	6.60	7.55	7.56	6.90	7.42	7.32	6.95	7.03
Organic Matter	92.40	93.40	92.45	92.44	93.10	92.58	92.68	93.05	92.97

Table 2

***In vitro* nutrient digestibility of control feed using different processing techniques**

Nutrient digestibility (%)	Control diet			P-value
	Raw	Boiled	Extruded	
Dry Matter	80.46[a]	84.01[b]	92.20[c]	0.001
Crude Protein	90.16	91.59	92.80	0.145
Ether Extract	94.18[b]	83.34[a]	94.92[b]	0.032
Organic Matter	84.38[a]	86.68[b]	91.27[c]	0.002

[a,b,c] Means bearing different superscripts in a row differ significantly (P<0.05)

Table 3

***In vitro* nutrient digestibility of Dal churi based dog feeds at different levels using different processing techniques**

Nutrient Digestibility (%)	5% Dal churi				10% Dal churi			
	Raw	Boiled	Extruded	P-value	Raw	Boiled	Extruded	P-value
Dry Matter	64.83[a]	84.90[b]	89.15[c]	0.001	68.64[a]	77.84[b]	88.83[c]	0.000
Crude Protein	87.21[a]	90.69[ab]	91.57[b]	0.069	87.08[a]	89.07[b]	92.65[c]	0.004
Ether Extract	91.96[b]	88.47[a]	93.95[b]	0.021	91.28[b]	85.42[a]	93.83[b]	0.011
Organic Matter	64.99[a]	84.90[b]	89.29[b]	0.001	64.01[a]	77.84[b]	89.28[c]	0.000

[a,b,c] Means bearing different superscripts in a row differ significantly (P<0.05)

Table 5

Effect of processing technique used and level of dal churi in the feed on *in vitro* digestibility (%) of nutrients

Nutrients	Processing technique[1] (P)			Level of dal churi[2], % (L)			PSE	P-value		
	Raw	Boiled	Extruded	0	5	10.0		P	L	P×L
DM	71.31[a]	82.25[b]	90.06[c]	85.56[B]	79.63[A]	78.44[A]	0.39	<0.001	<0.001	<0.001
CP	88.15[a]	90.45[b]	92.28[c]	91.45[B]	89.83[A]	89.60[A]	0.37	<0.001	0.013	0.127
EE	92.47[b]	85.75[a]	94.23[b]	90.81	91.46	90.18	0.68	<0.001	0.443	0.085
OM	71.12[a]	83.14[b]	89.95[c]	87.44[C]	79.73[B]	77.05[A]	0.40	<0.001	<0.001	<0.001

1: Irrespective of level of dal churi in the diet; 2: Irrespective of processing technique; Means with different superscripts[a,b,c] for different processing techniques and superscripts[A,B,C] for different levels of dal churi with in a row differ significantly; PSE:Pooled standard error

soaking (Alonso *et al.*, 2000). Lankhorst *et al.* (2007) reported that extrusion of canine diets at temperatures of 110, 130 and 150 °C caused no reduction in digestibilities of CP and AA, however it increased the digestibility of starch.

Ether extract digestibility (EED) remained unaffected after extrusion. These findings are in covenant to the findings of Biagi *et al.* (2016) who reported the ether extract digestibility of extruded dog food ranges between 93 and 99%. However, EE digestibility of boiled feed (79.96%) was significantly (P<0.01) lower than both, raw and extruded feed. Hur *et al.* (2014) reported that in *in vitro* human digestion model, total lipid digestibility was lower in the boiled samples as compared to microwave and oven cooked samples.

The effect of dal churi level on nutrient digestibility, irrespective of processing methods showed non-significant (P<0.01) difference in DMD and CPD of diets with 5 and 10% DC inclusion level. DMD and CPD at 0% DC supplementation level (P<0.01) was significantly higher than both 5 and 10% DC supplementation group. Burkhalter *et al.* (2001) reported that including soybean hulls as fiber source, decreases (P<0.05) the digestibility of the nutrients which could be the reason of decreased digestibility. Supplementation of dal churi in the dog food showed non-significant (P<0.01) difference to ether extract digestibility. OMD for 0% DC inclusion level (P<0.01) was highest (87.44 %). OMD decreased (P<0.01) linearly with increase in dal churi level in the dog diet. Fahey *et al.* (1992) also observed that the DM, OM and total dietary fiber digestibility coefficients decreased as the hulls were added to the food.

Aflatoxin content of dal churi was 30 ppb. Lowest aflatoxin content (5.7 ppb) was found in control diet. Aflatoxin content of feed with 5% dal churi was 18 ppb

which was within the permissible limits as per Food and Drug Administration.

CONCLUSIONS

It was concluded that extrusion improves the digestibility of nutrients in dog diet and *in vitro* studies shows that Dal churi can be incorporated into the dog's diet up to 5% level.

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