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M Siva
Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu, India

KA Doraisamy
Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu, India

MR Purushothaman
Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu, India

S Senthilkumar
Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu, India

Correspondence
M Siva
Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, Tamil Nadu Veterinary and Animal Sciences University, Tamil Nadu, India

Proximate composition, urease activity, water holding capacity and viscosity of raw and toasted guar meal

M Siva, KA Doraisamy, MR Purushothaman and S Senthilkumar

Abstract
Guar, *Cyamopsis tetragonoloba* or cluster bean is a drought resistant annual legume predominantly grown in India and Pakistan (APEDA, 2011). It offers inexpensive high protein meal, produced as a by-product of guar gum manufacture (Nagpal *et al.*, 1971). In this chapter the nutrients and feeding value of guar meal are reviewed. The crude protein (CP) content of guar meal as reported by various authors varied from 38.78 to 52.70 *vs* 44.0 per cent in soybean meal (NRC, 1994). The crude fibre (CF) content of guar meal varied from 4.9 to 12.55 *vs* 7.0 per cent in SBM. The highest CF of 12.55 per cent was reported by Nagpal *et al.* (1971) and with lowest crude protein. The high CF in guar meal is due to incomplete de-hulling (Das and Arora, 1978). The ether extract (EE) content of guar meal varied from 5.2 to 7.6 *vs* 0.8 per cent in soybean meal (SBM) (Nagra *et al.*, 1994; Afz and Cereopa, 2013).
Guar meal had low calcium (0.13 per cent) and comparable total phosphorus (0.70 per cent) when compared to SBM which contained 0.29 and 0.65 per cent of calcium and total phosphorus respectively. Lower level of lysine (1.6 - 2.7 *vs* 2.69 per cent) and high level of methionine (0.36 - 0.8 *vs* 0.62 per cent) and threonine (1.04 - 1.9 *vs* 1.72) in guar meal were recorded when compared to SBM (Conner, 2002; Hassan, 2013).

Keywords: guar meal, water holding capacity, viscosity

Introduction
Guar or cluster bean (*Cyamopsis tetragonoloba*), originated from Africa but it has been grown throughout southern Asia. India and Pakistan have distinct advantage of agro-climatic conditions for the cultivation of guar. Guar is a drought tolerant annual legume predominantly grown in India. India is the largest producer of guar and contributes 80% of total guar production in the world. Guar is a multi-purpose crop and used for extracting gum from seeds, the vegetative part is used as animal fodder or green manure. The guar seed is made up (%) of hull 13 -18, germ 41 – 46 and endosperm 34 – 43. The germ and endosperm components are used in livestock feeding (APEDA, 2011) [5]. However, some of the anti-nutritional factors such as galactomannan, trypsin inhibitors etc. present in guar meal is limiting its usage at high levels in broiler diets. The meal is therefore mainly used in ruminant feed.

Materials and Methods
The nutrient content and feeding value of raw and toasted guar meal were evaluated based on the performance and assay of biological materials. The chemical analyses and biological experiment were carried out in the Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal.

Chemical Analyses
Proximate Analysis
The raw, toasted guar meal (TGM) and other ingredients used for the preparation of the experimental diets were analyzed for moisture, crude protein, crude fibre, ether extract and ash, calcium and phosphorus as per AOAC (1995) [1]. Aflatoxin free ingredients were used for the preparation of experimental diets.

Viscosity of Digesta
The relative viscosity of the digesta was calculated by the method of Choct and Annison (1992) using Ostwald U-tube viscometer.

Immediately after slaughter, the ileal contents were squeezed out, collected in 15 ml of triple glass distilled water and centrifuged at 5000 rpm for 15 min. The volume of the supernatant (V_1) was recorded and the water content of the original digesta (V_o) was calculated $V_o = V_1$-15
A final volume (V) with a constant ratio of V_o to V was obtained by the addition of water. The time (T_x) for an aliquot digesta supernatant and time (T_w) for distilled water to flow through the viscometer was recorded. The relative viscosity of the sample was obtained from the following relationship

$$\text{Relative viscosity (cP)} = T_x / T_w$$

Urease activity
The urease activity of the raw and TGM was analysed as per AOAC (1995) [1]. Samples of raw or TGM (0.2g) were taken in two test tubes. Phosphate buffer solution (PBS) of pH 7.0 was prepared. Urea was added at 0.75 g to 25 ml of phosphate buffer solution and the pH was again adjusted to 7.0. To the test tube, 10 ml of PBS was taken as blank and urea added PBS was taken as test solution and kept in water bath for 30 minutes, pH of blank and test solution was checked in 5 minutes interval.

$$\text{pH difference} = \text{Sample pH} - \text{Blank pH}$$

Urease activity = (pH difference X 30) / sample weight
Water holding capacity
The water holding capacity (WHC) of raw and TGM was analyzed as per Selle *et al*. (2011) method. Samples of raw or TGM were ground through 1 mm sieve and weighed into centrifuge tubes with 50 ml deionised water. After stirring, the samples were left to hydrate for 15 minutes and then centrifuged at 3000 rpm for 10 minutes. The water was decanted and the tubes reweighed to calculate WHC by the following equation:

$$WHC = ((A - B) - C)/C$$

Whereas,
A – Weight of the tube containing guar meal after centrifuge and decanting
B - Weight of empty test tube
C - Weight of the sample

Results and Discussion
The results of various chemical analyses conducted to study the nutrient content and feeding value of raw and toasted guar meal were presented and discussed in this chapter.
The proximate composition, calcium and phosphorus contents of raw and toasted guar meal samples used by poultry and livestock farmers in Namakkal area were presented in Table 2 and compared with the soybean meal values presented in Table 1.
The details of the type of processing (toasted / roasted) of guar meal samples available in the market could not be ascertained. The mean crude protein, crude fibre, ether extract, total ash, calcium and phosphorus content of the market samples of guar meal were 48.61, 6.88, 6.31, 6.33, 0.50 and 0.74 per cent. Individual nutrients in the samples varied widely *viz*. the range for crude protein were 43.74 - 53.56, crude fibre: 3.59 - 9.95, ether extract: 5.1 - 6.88, total ash: 4.77 - 8.91, calcium: 0.35 - 1.05 and phosphorus: 0.6 - 1.04. The raw and toasted guar meal samples used in the biological experiments had proximate principles, calcium and phosphorus values within the ranges of the market samples.
The samples of guar meal available in the market and the samples (raw and toasted guar meal) used in the biological experiment in comparison to SBM (conventionally used vegetable protein source in broiler diet) were found to be higher in protein (48.61 *vs* 44), ether extract (6.31 *vs* 0.8), and calcium (0.50 *vs* 0.29) whereas the levels of crude fibre (6.88 *vs* 7.0) and phosphorus (0.74 *vs* 0.65) were similar.

Table 1: Nutrient content of guar meal as reported in literature

	Soybean meal (SBM) NRC 1994	**Guar meal**										
		Nagpal *et al.* (1971)	**Nagra *et al.* (1994)**	**Conner *et al.* (2002)**	**Dinani *et al.* (2010)**	**Tyagi *et al.* (2011)**	**Gharaei *et al.* (2012)**	**FAO (2012)**	**Hassan (2013)**	**Afz and Cereopa (2013)**	**Mahesh and Thakur (2015)**	**Muthukumar and Nidhina (2015)**
Dry matter (%)	89.00	90.25	-	-	95.34	91.50	-	95	-	94.20	-	-
Crude protein (%)	44.0	38.78	41.4	43.70	41.48	50.27	48.34	42	39.75	42.9	-	52.7
Crude fibre (%)	7.0	12.55	11.7	-	6.65	6.24	-	12.3	-	7.2	-	4.9
Ether extract (%)	0.8	7.11	7.6	-	6.65	5.32	-	5.3	-	5.2	-	5.4
Total ash (%)	-	5.47	8.0	-	7.55	7.08	-	5.8	-	8.8	-	5.1
Calcium (%)	0.29	0.47	-	0.16	0.28	0.13	-	0.70	0.16	0.59	-	-
Phosphorus (%)	0.65	0.57	-	0.16	0.42	0.30	-	0.64	0.16	0.70	-	-
Lysine (%)	2.69	2.7	1.88	1.7	-	-	2.34	1.72	1.64	1.81	1.82	-
Methionine (%)	0.62	0.40	0.86	0.36	-	-	0.57	0.46	0.45	0.50	0.86	-
Threonine (%)	1.72	-	-	1.51	-	-	-	1.26	1.04	1.13	1.94	-

Table 2: Proximate composition and calcium and phosphorus (in %), water holding capacity and urease activity of raw/toasted guar meal (on as such basis)

Composition	Guar meal*	Minimum value	Maximum value	Raw guar meal**	Toasted guar meal**
Dry matter	91.68 ± 0.27	90.62	92.97	92.03	90.1
Crude protein	48.61 ± 1.21	43.74	53.56	46.98	49.59
Crude fibre	6.88 ± 0.85	3.59	9.95	5.9	6.5
Ether extract	6.31 ± 0.22	5.1	6.88	6.4	6.7
Total ash	6.33 ± 0.60	4.77	8.91	6.9	7.4
Calcium	0.50 ± 0.09	0.35	1.05	0.54	0.55
Total phosphorus	0.74 ± 0.07	0.6	1.04	0.63	0.67
Water holding capacity (g H_2O/g sample)	2.61 ± 0.07	2.33	2.97	2.92	2.63
Urease activity (g/min)	0.002 ± 0.003	0.001	0.004	0.002	0.003

*Each value is the mean of seven samples obtained from the market which may be raw or toasted sample obtained from the market
**Test samples

Table 3: Viscosity (cP) of ileal digesta in birds fed raw/toasted guar meal

Treatment	Viscosity (cP)
T1- control	1.09^{a} ± 0.01
T2- 2% toasted guar meal	1.21^{b} ± 0.01
T3- 4% toasted guar meal	1.23^{b} ± 0.01
T4- 6% toasted guar meal	1.31^{cd} ± 0.01
T5- 2% toasted guar meal + β-mannanase enzyme	1.12^{a} ± 0.01
T6- 4% toasted guar meal + β-mannanase enzyme	1.21^{b} ± 0.02
T7- 6% toasted guar meal + β-mannanase enzyme	1.27^{c} ± 0.01
T8- 2% raw guar meal	1.30^{cd} ± 0.01
T9- 4% raw guar meal	1.32^{d} ± 0.02
T10- 6% raw guar meal	1.34^{d} ± 0.01

Each value is the mean of twelve samples
Mean with at least one common superscript in a column do not differ significantly (P > 0.05)

Conclusion

Guar meal contained (%) crude protein - 48.61, crude fibre - 6.88, ether extract - 6.31, calcium - 0.50, phosphorus - 0.74. The present study concluded that the toasted guar meal had better performance in production and better economical returns. Raw guar meal increased the intestinal viscosity and reduced the body weight gain of broilers. Toasted guar meal at minimum levels can be included in broiler chicken diets for better production performance and positive economical returns.

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