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Slaughter and serological characteristics of broiler chicken fed with raw and toasted guar meal

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Abstract
A feeding trial was conducted to study the slaughter characteristics of inclusion of toasted guar meal with or without β - mannanase enzyme and also raw guar meal as an alternative protein source in broiler chicken ration. For the trial, 480 day - old Cobb 400 broiler chicks (either sex) were divided into ten groups (with six replicates and each containing eight birds) and were fed isonitrogenous and isocaloric diets containing 2, 4 and 6 per cent toasted guar meal with or without β - mannanase enzyme and raw guar meal. The total serum cholesterol was numerically increased (192.55 - 203.19 *vs* 196.16 mg/dl) and the triglycerides level decreased as the level of guar meal increased. Toasted guar meal with β-mannanase enzyme at 6 per cent level had lowered (88.92 *vs* 93.60 mg/dl) triglycerides. Raw guar meal at all the three levels reduced (88.71 - 90.36 *vs* 95.92 mg/dl) the serum HDL cholesterol. Toasted guar meal without β-mannanase enzyme supplementation or raw guar meal at 6 per cent inclusion level increased the LDL cholesterol when compared to the control. It can be concluded that broiler birds fed with different levels of toasted guar meal with or without β-mannanase enzyme or raw guar meal had comparable dressing percentage, giblet, gizzard, liver, spleen, abdominal fat and intestinal length, cholesterol content of breast and thigh muscle, serum protein fractions *viz* total protein, albumin, globulin and albumin globulin ratio at 42 days of age.

Keywords: broiler - toasted guar meal – β - mannanase – slaughter characteristics

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 (APEDA, 2011) [2]. Guar is a multi-purpose crop and used for extracting gum from seeds, the vegetative part is used as animal fodder or green manure. In recent years, the cost of major conventional protein source for broilers namely soyabean meal has increased by 60 per cent which resulted in increased cost of broiler meat production. Hence alternative cheap protein sources needs to be explored for broilers.
The unit (g) price of soya bean and guar meal protein is 9.3 (42/kg for 450 g of protein) and 6.15 (29.5/kg for 480 g of protein) paise, respectively. Even a 1 per cent replacement of soya bean protein with guar meal protein will result in savings of `315 / tonne of broiler feed. 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. Therefore, an experiment was conducted to study the slaughter characteristics of toasted guar meal with or without β - mannanase enzyme and also raw guar meal as an alternative protein source in broiler chicken ration.

Materials and Methods
Biological experiments
The experimental broiler pre starter, starter and finisher diets were formulated by inclusion of raw or toasted guar meal at varying levels (0, 2, 4 and 6%). The three levels of toasted guar meal diets were supplemented with β-mannanase enzyme containing 800000 U/g of mannanase. The diets were formulated to have same levels of Apparent metabolisable energy (AME), protein, lysine and methionine within the type of diet. The various experimental groups were as follows.

T1 Standard broiler diet (Control)
T2 2% toasted guar meal

T3 4% toasted guar meal
T4 6% toasted guar meal
T5 2% toasted guar meal with β- mannanase enzyme
T6 4% toasted guar meal with β- mannanase enzyme
T7 6% toasted guar meal with β- mannanase enzyme
T8 2% raw guar meal
T9 4% raw guar meal
T10 6% raw guar meal

The ingredient and nutrient composition of broiler pre starter, starter and finisher diets are presented in Table 2. The pre-starter, starter and finisher diets were fed to birds from 1 to 14, 15 to 28 and 29 to 42 days of age, respectively.

The biological experiment was conducted with four hundred and eighty day old-broiler Cobb 400 straight run chicks. The chicks were wing banded and weighed individually, assigned randomly to ten experimental groups with six replicates and eight chicks per replicate. Completely randomized design was followed.

The birds were housed in deep litter pens and reared under uniform standard managemental practices. The chicks were fed with weighed quantity of experimental diets and had free access to water. The chicks were vaccinated against Ranikhet disease (RDVF1) on 7th and 21st day, and Infectious Bursal Disease on 14th day of age.

At the end of 42 days of age, twelve birds per treatment were randomly selected and slaughtered. The pre-slaughter body weight, dressed carcass weight, giblet, spleen, heart and abdominal fat weights and intestinal length were recorded. Percentages of above parameters were calculated on pre-slaughter live weight basis. From all the slaughtered birds' whole blood was collected with anticoagulant. Serum, breast and thigh muscle samples were collected and preserved at -180 C until analyses.

Serological analyses

The collected blood samples were allowed to clot and centrifuged for 10 minutes at 2000 rpm to separate the serum. Serum samples were analyzed for the following parameters using the biochemical kits from M/s. Span Diagnostics Ltd., Sachin, India.

a. Serum protein fractions

Serum total protein was estimated by Lowry *et al*. (1951) [12] method using kit (Code no -83LS100-60).Wherein the peptide bonds of serum protein reacted with cupric ions in alkaline pH to form blue coloured chelates. The intensity of colour was measured at 578 nm. Serum albumin action was quantified by binding the anionic dye bromocresol green at pH 3.68 to form a green colored complex whose absorbance was measured at 630 nm (Johnson *et al*., 1999) [9]. The assay was carried out using kit with Code no -84LS100-60. Serum globulin level was calculated as the difference between total protein and serum albumin.

b. Serum lipid profile

Serum cholesterol reacted with hot solution of ferric perchlorate, ethyl acetate and sulphuric acid (Code no of the kit -71MB100-64) which resulted in lavender coloured complex. The colour intensity was measured at 560 nm (Wybenga *et al*., 1970) [21]. Triglyceride was estimated as per method of Bucolo and David (1973) [3] using Code no -72LS100-60 kit. The principle of this method involves hydrolysis of triglyceride to glycerol and free fatty acids in the presence of lipase. Subsequently, glycerol was converted to hydrogen peroxide and dihydroxyacetone phosphate using Glycerol 3-Phosphate Oxidase. The H2O2was coupled with 4- Aminoantipyrine (4-AAP) and 4-chlorophenol to form a red coloured complex, whose absorbance was measured at 505 nm.

HDL cholesterol was estimated as per Seigler and Wu (1981) using Code no -71MB100-64 kit. About 200 µl of serum and 200 µl of precipitating reagent (polyethylene glycol) were added in a test tube, mixed well, incubated at 370 C for 10 minutes followed by centrifugation at 2000 rpm for 15 minutes. The supernatant represented the HDL fraction. This supernant fraction was estimated for HDL cholesterol as detailed in total cholesterol estimation. Serum LDL-cholesterol was calculated by Friedewald equation (Friedewald *et al*., 1972) [7].

LDL cholesterol (mg/dl) =Total cholesterol-(Triglyceride/5)-HDL cholesterol.

Muscle lipid profile

Estimation of muscle cholesterol

The breast / thigh muscle samples were chopped and minced with mortar and pestle. The total lipid was extracted from muscle tissue samples as per the method of Folch *et al*. (1957) [6] using chloroform and methanol (2:1) solutions. The chloroform layer containing cholesterol was separated using separating funnel. The extracted muscle cholesterol was estimated for cholesterol by one-step method of Wybenga *et al*. (1970) [21]. Cholesterol reacts with cholesterol reagent (solution of ferric perchlorate, ethyl acetate and sulphuric acid) which resulted in lavender coloured complex, the absorbance was measured at 560 nm.

The data collected on various parameters were statistically analysed as per the method of Snedecor and Cochran (1989) [18] and the means of different experimental groups were tested for statistical significance by Duncan's multiple range test (Duncan, 1955) [5].

Results and Discussion

Slaughter parameters and muscle lipid profile

The slaughter parameters and the breast and thigh muscle cholesterol content of birds fed toasted guar meal with or without β-mannanase enzyme or raw guar meal fed broilers are presented in Table 3&4. Inclusion of toasted guar meal with or without β-mannanase enzyme or raw guar meal up to 6 per cent did not influence the dressing percentage (66.5 - 69.89 %), giblet (4.54 - 5.32 g), gizzard (1.87 – 2.09 percentage of live body weight), liver (1.92 – 2.55 percentage of live body weight), spleen (2.16 – 2.83 g), abdominal fat (19.08 – 27.00 g) and intestinal length (175.25 – 201.66 cm) of broiler birds at 6 weeks of age.

Similarly, Tyagi *et al*. (2011) [19] also recorded that feeding of roasted guar meal had no significant influence on eviscerated weight, abdominal fat in relationship to live weight, liver, gizzard, spleen and bursa. The difference in the processing (toasting or roasting) of guar meal might have influenced the viscosity and the intestinal length of the birds.

The percentage of heart weight (0.65 – 0.86) in relation to live body weight was significantly lower in all the three levels of toasted guar meal without enzyme incorporated diets when compared to the control. However supplementation of enzyme in all the three toasted guar meal diets or incorporation of raw guar meal did not influence the heart weight. However Tyagi *et al*. (2011) [19] did not observe any influence on heart as percentage of live body weight when roasted guar meal was incorporated up to 10 per cent in broiler diet.

No definite reason could be assigned for the significant reduction (0.65 - 0.70 vs 0.72- 0.86) in heart as percentage of live body weight in toasted guar meal without β-mannanase enzyme supplemented fed birds only and not in toasted guar meal with β-mannanase enzyme and raw guar meal fed birds when compared to the control.

Muscle cholesterol

The breast and thigh muscle cholesterol content of birds fed toasted guar meal with or without β-mannanase enzyme and raw guar meal at different levels are presented in Table 4. The breast and thigh muscle cholesterol levels were comparable among the birds fed different experimental diets. The present study suggests that, the levels of toasted guar meal with or without β-mannanase enzyme and raw guar meal did not influence the absorption of lipid or the synthesis of cholesterol in the liver. The cholesterol content of breast (80.54-86.22 vs 85.67 mg/dl) and thigh muscle (104.78-114.27 vs 115.22 mg/dl) and the serum protein fractions viz total protein (3.24-3.47 vs 3.54 g/dl), albumin (1.88-2.01 vs 1.89 g/dl), globulin (1.25-1.61 vs 1.40 g/dl) and albumin globulin ratio (1.20-1.63 vs 1.36) were comparable in birds fed toasted guar meal with or without β-mannanase enzyme and raw guar meal up to 6 per cent level.

Serum parameters

The results of the serum protein fractions and Serum lipid profile namely total cholesterol, triglycerides, HDL and LDL cholesterol values are presented in Table 7. The serum protein fractions in terms of total protein, albumin, globulin and albumin globulin ratio was not significantly influenced by the levels of toasted guar meal with or without β-mannanase enzyme or raw guar meal. The results indicate the levels of toasted guar meal with or without β-mannanase enzyme and raw guar meal did not influence the availability of protein from the experimental diets.

The serum total cholesterol (192.55 - 203.19 vs 196.16 mg/dl) in all the experimental groups was comparable. Numerically the level of total cholesterol was found to increase linearly as the level of guar meal increased. Addition of β-mannanase enzyme found to reduce numerically the total cholesterol over the corresponding levels of guar meal without enzyme supplementation. Moriceau *et al*. (2000) [14] and Yamamoto *et al*. (2000) [22] observed decreased plasma cholesterol level in guar meal supplemented diets and these authors attributed the decrease to high viscosity of guar gum but in the present study, though the viscosity increased the total cholesterol was also correspondingly increased.

In contrast to the influence of guar meal on total cholesterol, the triglycerides levels were found to decrease linearly (P>0.05) as the level of guar meal increased. When compared to the control, 6 per cent guar meal with enzyme had significantly lower (88.92 vs 93.60 mg/dl) triglycerides. Inclusion of raw guar meal at all the three levels reduced significantly (88.71 - 90.36 vs 95.92 mg/dl) the HDL cholesterol, however, the inclusion of toasted guar meal with or without β-mannanase enzyme had no effect. In contradiction to the present study, Mohammad *et al*. (2011) reported increase in HDL cholesterol in guar meal fed birds due to the destruction of intestinal micro-flora which effects the amino acid intestinal-hepatogenic cycle. Gheisari *et al*. (2012) reported HDL cholesterol was not influenced by guar meal with β-mannanase and β-galactanase enzyme feeding.

Toasted guar meal without β-mannanase enzyme supplementation or raw guar meal at 6 per cent inclusion level significantly increased the level of LDL cholesterol when compared to control. The same level of toasted guar meal with β-mannanase enzyme supplementation had numerically higher LDL cholesterol content than control. At 2 and 4 per cent inclusion of raw/toasted guar meal with or without β-mannanase enzyme had comparable LDL cholesterol to the control. In contrary with the present study, Mohammad *et al*. (2011) reported no significant effect and Gheisari *et al*. (2012), reported reduced LDL cholesterol when guar meal was used at 15 and 18 percent with β-mannanase and galactanase enzyme respectively.

Conclusion

It can be concluded that the total serum cholesterol was numerically increased (192.55 - 203.19 vs 196.16 mg/dl) and the triglycerides level decreased as the level of guar meal increased. Toasted guar meal with β-mannanase enzyme at 6 per cent level had lowered (88.92 vs 93.60 mg/dl) triglycerides. Raw guar meal at all the three levels reduced (88.71 - 90.36 vs 95.92 mg/dl) the serum HDL cholesterol. Toasted guar meal without β-mannanase enzyme supplementation or raw guar meal at 6 per cent inclusion level increased the LDL cholesterol when compared to the control.

Table 1: Proximate composition and calcium and phosphorus (in %) 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

*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 2: Ingredients (as such basis) and nutrients composition (per cent DM) of guar meal in broiler chicken diet

Ingredients (per cent)	Pre starter				Starter				Finisher			
	0%	2%	4%	6%	0%	2%	4%	6%	0%	2%	4%	6%
Maize	61.85	62.15	62.46	62.76	63.67	63.97	64.23	63.88	63.67	63.97	64.23	63.88
Soyabean meal	33.83	31.59	29.35	27.11	32.73	30.49	28.30	26.64	32.73	30.49	28.30	26.64
Rice bran Oil	1.13	1.09	1.05	1.01	0.81	0.77	0.74	0.80	0.81	0.77	0.74	0.80
Calcite	1.96	1.91	1.85	1.80	2.03	1.98	1.92	1.87	2.03	1.98	1.92	1.87
Di calcium phosphate	0.75	0.76	0.76	0.77	0.45	0.45	0.46	0.46	0.45	0.45	0.46	0.46

Methionine	0.18	0.18	0.18	0.19	0.14	0.14	0.15	0.15	0.14	0.14	0.15	0.15
Lysine	0.23	0.25	0.27	0.29	0.09	0.11	0.13	0.13	0.09	0.11	0.13	0.13
Raw/Toasted Guar Meal	0.00	2.00	4.00	6.00	0.00	2.00	4.00	6.00	0.00	2.00	4.00	6.00
Nutrients (per cent)												
Crude protein	22.23	22.20	22.14	22.35	21.04	21.33	21.48	21.40	20.05	20.23	20.36	20.67
Crude fiber	3.85	3.30	3.31	3.59	3.21	3.49	3.48	3.13	2.12	2.20	2.26	2.37
Calcium	1.12	0.87	0.90	1.02	1.02	1.00	1.05	1.03	0.73	0.77	0.82	0.94
Total Phosphorus	0.54	0.54	0.51	0.60	0.55	0.55	0.55	0.55	0.45	0.45	0.45	0.44
Lysine *	1.20	1.20	1.20	1.20	1.07	1.07	1.07	1.07	1.07	1.16	1.16	1.16
Methionine*	0.52	0.52	0.52	0.52	0.48	0.48	0.48	0.48	0.48	0.54	0.54	0.54
Metabolisable Energy (kcal/kg)*	3.00	3.00	3.00	3.00	3.05	3.05	3.05	3.05	3.05	3.2	3.2	3.2

1. Diets of T5, T6 and T7 are the same as T2, T3 and T4 respectively with β – mannanase enzyme at 0.5 kg/ ton of feed and T8, T9 and T10 containing 2, 4 and 6 per cent of Raw guar meal/ton of feed instead of toasted guar meal
2. Vitamin A – 16500 IU, Vitamin B_2 –10 mg, Vitamin D_3 – 3200 IU and Vitamin K – 2 mg
3. Supplied per kg of diet: Thiamin – 4 mg, Pyrodoxine – 8 mg, Cyanocobalamine – 40 mcg, Vitamin E – 40 mg, Niacin – 60 mg, Calcium D pantohanate –40 mg, Folic acid – 4 mg and Coccidiostat added at 0.5g/kg of feed supplied 125 mg of Di-nitro-ortho- toluamide
4. Supplied per kg of diet: Manganese –54 mg, Zinc – 52 mg, Iron – 20 mg, Iodine – 2 mg, Copper – 2 mg, Cobalt – 1 mg.

*Calculated value.

Table 3: Effect of feeding toasted and raw guar meal on slaughter parameters in broiler chicken

Treatment	Dressing percentage	Giblet weight (g)	Percent live body weight (g %)			Weight (g)		Intestine length (cm)
			Gizzard	Liver	Heart	Abdominal fat	Spleen	
T1- control	66.97 ± 1.01	5.31 ± 0.14	2.04 ± 0.07	2.40 ± 0.10	0.86^{c} ± 0.05	19.25 ± 1.71	2.50 ± 0.23	187.08 ± 3.6
T2- 2% toasted guar meal	69.89 ± 2.88	4.87 ± 0.10	1.94 ± 0.06	2.24 ± 0.12	0.68^{ab} ± 0.03	22.91 ± 2.88	2.25 ± 0.13	185.00 ± 2.8
T3- 4% toasted guar meal	67.55 ± 0.70	4.87 ± 0.08	1.90 ± 0.05	2.31 ± 0.08	0.65^{a} ± 0.03	19.58 ± 2.27	2.66 ± 0.14	192.91 ± 4.1
T4- 6% toasted guar meal	67.53 ± 1.27	4.96 ± 0.15	2.00 ± 0.09	2.25 ± 0.10	0.70^{ab} ± 0.04	21.91 ± 2.00	2.83 ± 0.27	175.25 ± 16.3
T5- 2% toasted guar meal + β-mannanase enzyme	67.05 ± 0.44	5.09 ± 0.18	1.97 ± 0.04	2.39 ± 0.12	0.72^{abc} ± 0.04	19.08 ± 1.44	2.50 ± 0.19	188.58 ± 3.2
T6- 4% toasted guar meal + β-mannanase enzyme	67.08 ± 0.82	5.05 ± 0.14	2.06 ± 0.09	2.24 ± 0.08	0.73^{abc} ± 0.03	24.66 ± 1.96	2.75 ± 0.21	201.00 ± 3.06
T7- 6% toasted guar meal + β-mannanase enzyme	66.59 ± 0.28	5.32 ± 0.20	2.09 ± 0.08	2.48 ± 0.12	0.75^{abc} ± 0.03	19.08 ± 1.49	2.33 ± 0.14	195.83 ± 3.26
T8- 2% raw guar meal	68.96 ± 1.13	5.26 ± 0.25	1.95 ± 0.10	2.55 ± 0.18	0.75^{abc} ± 0.05	27.00 ± 4.11	2.16 ± 0.16	201.66 ± 4.94
T9- 4% raw guar meal	67.57± 0.92	4.54 ± 0.13	1.89 ± 0.07	1.92 ± 0.07	0.72^{abc} ± 0.05	25.83 ± 3.50	2.16 ± 0.16	200.00 ± 5.00
T10- 6% raw guar meal	66.50± 0.64	5.17 ± 0.11	1.87 ± 0.11	2.46 ± 0.10	0.83^{bc} ± 0.06	21.33 ± 2.67	2.66 ± 0.21	193.33 ± 5.27

Each value is the mean of twelve samples

Mean with at least one common superscript in a column do not significant (P > 0.05)

Table 4: Effect of feeding raw/toasted guar meal on muscle lipid profile in broiler chicken

Treatment	Breast Muscle Cholesterol (mg/dl)	Thigh Muscle cholesterol (mg/dl)
T1- control	85.67 ± 0.56	115.22 ± 2.55
T2- 2% toasted guar meal	84.37 ± 2.11	114.27 ± 2.62
T3- 4% toasted guar meal	82.67 ± 0.80	113.33 ± 2.23
T4- 6% toasted guar meal	83.65 ± 1.42	110.23 ± 2.00
T5- 2% toasted guar meal + β-mannanase enzyme	81.06 ± 2.10	111.53 ± 1.92
T6- 4% toasted guar meal + β-mannanase enzyme	84.56 ± 0.89	109.80 ± 1.54
T7- 6% toasted guar meal + β-mannanase enzyme	80.54 ± 2.05	108.08 ± 1.80
T8- 2% raw guar meal	81.48 ± 1.27	104.78 ± 2.79
T9- 4% raw guar meal	86.22 ± 0.89	106.88 ± 1.33
T10- 6% raw guar meal	85.04 ± 1.80	112.41 ± 0.91

Each value is the mean of twelve samples

Table 5: Effect of feeding raw/toasted guar meal on serum protein and serum cholesterol fraction in broiler chicken

Treatment	Total protein (g/dl)	Total cholesterol (mg/dl)
T1- control	3.54 ± 0.08	196.16^{ab} ± 2.47
T2- 2% toasted guar meal	3.38 ± 0.06	200.25^{ab} ± 2.30
T3- 4% toasted guar meal	3.24 ± 0.08	202.22^{b} ± 2.59
T4- 6% toasted guar meal	3.30 ± 0.02	202.92^{b} ± 1.91
T5- 2% toasted guar meal + β-mannanase enzyme	3.47 ± 0.07	192.55^{a} ± 2.76
T6- 4% toasted guar meal + β-mannanase enzyme	3.39 ± 0.07	195.62^{ab} ± 2.57
T7- 6% toasted guar meal + β-mannanase enzyme	3.39 ± 0.05	199.75^{ab} ± 1.61
T8- 2% raw guar meal	3.37 ± 0.02	193.14^{a} ± 5.02
T9- 4% raw guar meal	3.28 ± 0.04	198.80^{ab} ± 2.29
T10- 6% raw guar meal	3.29 ± 0.03	203.19^{b} ± 1.39

Each value is the mean of twelve observations

Table 6: Effect of feeding raw/toasted guar meal on serum protein fraction in broiler chicken

Treatment	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G ratio
T1- control	3.54 ± 0.08	1.89 ± 0.02	1.40 ± 0.04	1.36 ± 0.05
T2- 2% toasted guar meal	3.38 ± 0.06	1.93 ± 0.02	1.45 ± 0.07	1.38 ± 0.08
T3- 4% toasted guar meal	3.24 ± 0.08	1.88 ± 0.04	1.36 ± 0.11	1.55 ± 0.19
T4- 6% toasted guar meal	3.30 ± 0.02	1.92± 0.03	1.38 ± 0.03	1.40 ± 0.05
T5- 2% toasted guar meal + β-mannanase enzyme	3.47 ± 0.07	1.87 ± 0.03	1.61 ± 0.08	1.20± 0.07
T6- 4% toasted guar meal + β-mannanase enzyme	3.39 ± 0.07	1.95 ± 0.04	1.44 ± 0.09	1.43 ± 0.12
T7- 6% toasted guar meal + β-mannanase enzyme	3.39 ± 0.05	1.91 ± 0.03	1.51 ± 0.07	1.31 ± 0.07
T8- 2% raw guar meal	3.37 ± 0.02	1.97 ± 0.05	1.38 ± 0.08	1.46 ± 0.12
T9- 4% raw guar meal	3.28 ± 0.04	1.99 ± 0.05	1.32 ± 0.07	1.54 ± 0.12
T10- 6% raw guar meal	3.29 ± 0.03	2.01 ± 0.05	1.25 ± 0.06	1.63 ± 0.13

Each value is the mean of twelve observations

Table 7: Effect of feeding raw/toasted guar meal on serum cholesterol in broiler chicken

Treatment	Total cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
T1- control	196.16^{ab} ± 2.47	93.60^{bc} ± 1.19	95.92^{c} ± 1.29	81.52^{ab} ± 2.62
T2- 2% toasted guar meal	200.25^{ab} ± 2.30	92.58^{abc} ± 0.37	91.92^{abc} ± 1.18	89.81^{abc} ± 1.84
T3- 4% toasted guar meal	202.22^{b} ± 2.59	91.91^{abc} ± 0.59	96.04^{c} ± 1.51	87.80^{abc} ± 3.44
T4- 6% toasted guar meal	202.92^{b} ± 1.91	89.90^{ab} ± 0.96	92.91^{abc} ± 0.95	92.03^{c} ± 1.89
T5- 2% toasted guar meal + β-mannanase enzyme	192.55^{a} ± 2.76	94.14^{c} ± 0.65	92.10^{abc} ± 1.16	81.63^{ab} ± 3.25
T6- 4% toasted guar meal + β-mannanase enzyme	195.62^{ab} ± 2.57	90.95^{abc} ± 1.34	96.94^{c} ± 1.59	80.49^{a} ± 3.23
T7- 6% toasted guar meal + β-mannanase enzyme	199.75^{ab} ± 1.61	88.92^{a} ± 1.00	94.00^{bc} ± 2.15	87.96^{abc} ± 2.41
T8- 2% raw guar meal	193.14^{a} ± 5.02	93.01^{bc} ± 1.52	88.71^{a} ± 1.40	85.83^{abc} ± 5.57
T9- 4% raw guar meal	198.80^{ab} ± 2.29	91.28^{abc} ± 1.58	89.57^{ab} ± 1.25	90.97^{bc} ± 3.17
T10- 6% raw guar meal	203.19^{b} ± 1.39	90.23^{ab} ± 2.25	90.36^{ab} ± 1.23	94.78^{c} ± 2.26

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)

References

1. Almirall M, Francesch AM, Perez-Vendrell M, Brufau J, Esteve-Garcia E. The difference in intestinal enzyme activities and ileal nutrient digestibilities more in broiler chicks than in cocks. Journal of Nutrition. 1995; 125:947-955.
2. APEDA. Agri Exchange Ready Reckoner Series Commodity, 2011, GUARGUM, http://agriexchange.apeda.gov.in. AccessedonJanuary18, 2013.
3. Bucolo G, David H. Quantitative determination of serum triglycerides by the use of enzymes. Clin. Chem. 1973; 19:476-482.
4. Conner SR. Characterization of guar meal for use in poultry rations. PhD dissertation, Texas A&M University, College Station, TX, 2002.
5. Duncan DB. Multiple range and F tests. Biometrics. 1955; 11:1-42.
6. Folch J, Lees GHS Stanley M. A simple method for the isolation and purification of total lipids from animal tissues. J Biol. Chem. 1957; 226:497-507.
7. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low density lipoprotein cholesterol in plasma, without the use of preparative centrifuge. Clin. Chem. 1972; 18:499-502.
8. Gheisari AA, Shavakhi ZM, Toghyani M, Bahadoran R, Toghyani M. Application of incremental program, an effective way to optimize dietary inclusion rate of guar meal in broiler chicks. Livest. Sci. 2011;140:117-123.
9. Johnson AM, Rohlfs EM, Silverman LM. Proteins, In Tietz Textbook of clinical chemistry, 3rd Edn., CA. Burtis and E. R., Eds. W. B. Saunders, Philadelphia, 1999, 477-540.
10. Kamran M, Pasha TN, Mahmud A, Ali Z. Effect of commercial enzyme (Natugrain) supplementation on the nutritive value and inclusion rate of guar meal in broiler rations. Int. J Poult. Sci. 2002; 1:167-173.
11. Lee JT, Bailey CA, Cartwright AL. ß-mannanase ameliorates viscosity-associated depression of growth in broiler chickens fed guar germ and hull fractions. Poultry Science. 2003; 82:1925-1931.
12. Lowry OH, Rosebrough NJ, Farr AL, Randall RJ. Protein measurement with the folin phenol reagent. J Biol. Chem, 1951, 193:265.
13. Mohammad M, Karimi Kazem. The effect of guar meal (germ fraction) and βmannanase enzyme on growth performance and plasma lipids in broiler chickens. Afr. J Biotechnol. 2012; 11:8767-8773.
14. Moriceau S, Besson C, Levrat MA, Moundras C, Remesy C, Morand C *et al*. Lipids, 2000, 35, 437.
15. Muthukumar SP, Nidhina N. Antinutritional factors and functionality of protein-rich fractions of industrial guar meal as affected by heat processing. Food chem. 2015; 173:920-6.
16. Nagpal ML, Agrawal OP, Bhatia IS. Chemical and biological examination of guar meal (*Cyamopsistetragonoloba L*). Indian J Anim. Sci. 1971; 41:283-293.
17. Seigler L, Wu WT. Separation of serum high-density lipoprotein for cholesterol determination: ultracentrifugation vs precipitation with sodium phosphotungstate and magnesium chloride. Clin. Chem. 1981; 27:838-841.
18. Snedecor GW, Cochran WG. Statistical Methods.8th Edn, Iowa state university press, Ames, USA. Iowa – 50010, 1989.
19. Tyagi PK, Mandal AB, Tyagi PK. Utilization of roasted guar (*Cyamopsistetragonoloba*) korma in the diet of broiler chickens. Indian Journal of Poultry Science, 2011; 46:326-329.
20. Vohra P, Kratzer FH. Growth inhibitory effect of certain polysaccharides for chickens. Poultry Science. 1964; 43:1164-1170.
21. Wybenga DR, Pileggi PH, Dirstine J, Giorgio JD. Direct manual determination of serum total cholesterol with a single stable reagent. Cli. Chem. 1970; 16:980-984.
22. Yamamoto Y, Sogawa I, Nishina A, Saeki S, Ichikawa N, Iibata S. Improved hypolipidemic effects of xanthin gum-galactomannan mixtures in rats. Biosci. Biotechnol. Biochem. 2000; 64:2165-2171.