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Effects of Guar Bean, Guar Meal and Guar Gum on Productive Performance of Broiler Chicks

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ABSTRACT
Using guar meal in poultry nutrition is limited because of its anti-nutritional content. This study was set up to evaluate whether or not anti-nutritional compounds other than residual Guar Gum (GG) contribute to Guar Meal (GM) relatively poor feeding value for poultry. One hundred eighty one-d-old broiler chicks were randomly distributed among 3 treatments with 4 replicates of 15 chicks each. Three dietary treatments were prepared in which the same dietary concentration of GG was supplemented to growing broilers as pure GG, GM or Guar Bean (GB). All diets were calculated to contain 1.35% GG. Chicks were assigned to one of the following treatments: (1) broiler diet reformulated with 3.85% GB, (2) broiler diet reformulated with 2.5% GM and (3) broiler diet with 1.35% GG. Feed consumption, body weight, b. wt. gain, feed conversion ratio and mortality rate were recorded at weekly intervals from 1-35 d. Total feed consumption recorded from 1-21 was significantly higher in chicks fed 3.85% GB versus those fed 1.35% GG. Total feed consumption from 22-35 and 1-35 day was significantly higher in chicks fed 3.85% GM than those fed 3.85% GB. The final b. wt. at 35 d for chicks fed 1.35% GG were significantly lower than both chicks fed 2.5% GM and 3.85% GB. Significantly higher weight gains in 35-days-old broilers fed both whole (ground) GB and GM versus GG suggest anti-nutritional factors other than GG are not major contributors limiting GM use in poultry feeds.

Key words: Guar gum, guar meal, growth, broiler, performance

INTRODUCTION
Using unconversional feed ingredients in poultry diets to supplement or replace some of the expensive common feed ingredients is a strategy used by poultry nutritionists all over the world to reduce production cost. Guar Meal (GM), a feed ingredient, might be used in poultry diets to alleviate this problem. Guar, *Cyamopsis tetragonoloba* L. (syn. *C. psoraloides*) is a drought-tolerant summer annual legume native to India and Pakistan (Rahman and Shafivr, 1967; Patel and McGinnis, 1985). A large quantity of Guar Bean (GB) is processed in the world for Guar Gum (GG) extraction and residue left over from processing is converted into GM. GB consists of three fractions, namely endosperm, germ and hull. While the endosperm rich source of galactomannan polysaccharide is well known as GG (Vohra and Kratzer, 1964a; Couch *et al*., 1967), represents about 65% of the whole GB, the GM, a mixture of the germ rich in protein and hull rich in crude fiber fractions by-product of the GG extraction from the whole GB represents about 35% of the whole GB (Rahman and Shafivr, 1967).

Chemically, GG is a highly viscous linear chain of D-mannose units connected by β-1-4 glycoside bonds. Every other D-mannose unit bonds a D-galactose unit by α-1-6 glycoside linkage. GG recognized as an anti nutritional factor non-starch polysaccharides (NSP) (Annison and Choct, 1991; Choct, 2002). GM contains about 18% residual GG (Anderson and Warnick, 1964; Nagpal *et al.*, 1971; Hansen *et al.*, 1992; Lee *et al.*, 2004) in addition to saponin (Thakur and Pradhan, 1975a, b) residual GG (β-mannan) (Vohra and Kratzer, 1964a, b; 1965; Katoch *et al.*, 1971; Ray *et al.*, 1982; Furuse and Mabayo, 1996) and polyphenols (Kaushal and Bhatia, 1982) causing liver, kidney and intestinal damage in mice (Diwan *et al.*, 2000). The anti-nutritive effects attributed to a trypsin inhibitor (Bakshi, 1966; Couch *et al.*, 1967) were contradicted by Conner (2002) who determined that GM contained lower levels of trypsin inhibitor than processed soybean meal.

It is not yet clear whether residual GG or another anti-nutritional compounds in GM such as saponin is the main anti-nutritional factor contribute associated with GM. No data is available in the scientific literature directly comparing the effects of GB, GM and GG in a single broiler growth trial. Therefore, this study was carried out to evaluate the effect of adding equivalent concentrations of GG to broiler chicks as pure GG, unprocessed GB, or processed GM. A dietary concentration of 1.35% GG and 3.85% GB results in GG concentrations equivalent to feeding 2.5% GM. The primary concept is that if anti-nutritional compounds other than GG are significant in guar products, than broiler performance should be poorer in birds fed guar products containing equivalent concentrations of GG because of the additional anti-nutritional factors potentially present.

MATERIALS AND METHODS

Commercial GG and GM powders were purchased from Rama Industries, Manufacturer and Exporter of GG Splits and Powder, The Government Recognized Export House, Gujarat, India. This study was conducted from January till May 2012 at the experimental station belonged to collage of agriculture and food science, King Faisal University, Saudi Arabia.

Experimental design: One hundred eighty one d-old unsexed Ross broiler chicks were purchased from a local commercial hatchery weighed and randomly distributed in battery cages among three treatment groups with four replicates of 15 chicks per replicate. Chicks were assigned to one of the following three treatment groups: (1) Broiler diet reformulated with 3.85% GB, (2) Broiler reformulated with 2.5% GM and (3) Broiler diet supplemented with 1.35% GG. The broiler starter diets used in this study were calculated to be iso caloric and iso nitrogenous (Table 1). Feed and water were provided *ad libitum* and lighting was continuous throughout the entire 35 days course of the study. Weekly body weight, feed consumption and mortality rate were recorded and body weight gain and feed conversion ratio were calculated from 1-35 days of age.

Statistical analysis: Data obtained were subjected to one-way ANOVA using the GLM procedure of a statistical software package (SPSS 18.0, SPSS Inc., Chicago, IL). Experimental units were based on cage averages. Treatment means were expressed as Mean±standard error of means (SEM) and separated (p = 0.05) using the Duncan's multiple range test (Duncan, 1955).

Table 1: Composition of isocaloric and isonitrogenous broiler starter diets[1] containing 3.85% guar bean (GB), 2.5% guar meal (GM), or 1.35% guar gum (GG), respectively from 1-35 day of age

	Dietary treatments		
Ingredients (%)	GB	GM	GG
Corn	53.84	59.30	58.23
Guar bean[2]	3.85	0.00	0.00
Guar gum	0.00	0.00	1.35
Guar meal[3]	0.00	2.50	0.00
Dehulled soybean meal	34.00	33.50	33.61
DL-Methionine	0.29	0.29	0.29
L-Lysine HCL	0.29	0.29	0.29
Corn oil	4.00	2.50	2.50
Limestone	1.43	1.43	1.43
Dicalcium PO_4	1.55	1.55	1.55
Salt	0.25	0.46	0.46
Trace minerals[4]	0.25	0.25	0.25
Vitamins[5]	0.25	0.25	0.25

[1] Average calculated analysis of isocaloric and isonitrogenous broiler starter diets was as follows: CP, 23.16%, ME, 3,110 kcal kg^{-1}; Ca, 0.99%; non-phytin P, 0.41%; methionine, 0.57%; lysine, 1.30%; threonine, 0.77%; tryptophan, 0.28%, [2]The guar bean nutrient matrix used was CP, 25.00%; ME, 1,998 kcal kg^{-1}; Ca, 0.12%; non-phytin P, 0.11%; methionine, 0.34%; lysine, 1.05%; arginine, 2.41%; and threonine, 0.75%, [3]The guar meal nutrient matrix used was CP, 39.75%; ME, 2,033 kcal/kg; Ca, 0.16%; non-phytin P, 0.16%; methionine, 0.45%; lysine, 1.64%; arginine, 4.90%; threonine, 1.04%; and tryptophan 0.43%, [4]Trace minerals premix added at this rate yields: 149.60 mg Mn, 16.50 mg Fe, 1.70 mg Cu, 125.40 mg Zn, 0.25 mg Se, 1.05 mg I per kg diet, [5]Vitamin premix added at this rate yields: 11,023 IU vitamin A, 46 IU vitamin E, 3,858 IU vitamin D_3, 1.47 mg minadione, 2.94 mg thiamine, 5.85 mg riboflavin, 20.21 mg pantothenic acid, 0.55 mg biotin, 1.75 mg folic acid, 478 mg choline, 16.50 µg vitamin B_{12}, 45.93 mg niacin and 7.17 mg pyridoxine per kg diet

RESULTS

Body weight: No significant differences in the initial b. wt. were observed among all the dietary treatment groups. After 1 wk chicks receiving the diet containing 1.35% GG weighed significantly more than chicks fed 2.5% GM, whereas chicks receiving 3.85% GB were not significantly different in body weight from those fed either 2.5% GM or 1.35% GG at 7 d of age. Body weight was not different among the treatments after 21 day of feeding. By 35 day of the study chicks receiving 1.35% GG weighed significantly less than chicks fed both 2.5% GM and 3.85% GB (Table 2).

Feed consumption: Total feed consumption recorded from 1-21 day was significantly higher in chicks fed the diet containing 3.85% GB versus those fed 1.35% GG. Birds receiving 2.5% GM consumed an intermediate quantity of feed. Total feed consumption from 22-35 d and 1-35 day of age was significantly higher in chicks fed 3.85% GB than those fed either 2.5% GM or 1.35% GG (Table 2).

Body weight gain: Body weight gain was not different among the treatments after 21 day of feeding. From 22-35 day weight gain was significantly lower in broilers receiving the 1.35% GG treatment compared with either the 3.8% GB or 2.5% GM treatments. Cumulative weight gain at 35 day of the study was also significantly less in broilers receiving 1.35% GG (Table 2).

Feed conversion ratio: There were no significant differences in the feed conversion ratio by 21 day of the study. From 22-35 day feed conversion ratio was significantly lower for birds fed the

Table 2: Performance of 1 to 35-d-old broiler chicks fed 3.85% guar bean (GB), 2.5% guar meal (GM), or 1.35% guar gum (GG)

	Treatments		
Age (day)	3.85% GB	2.5% GM	1.35% GG
Body Weight (g)			
0	48.2±0.89	47.6±0.64	48.0±1.02
7	156.3±3.03^{ab}	145.9±4.39^{b}	165.6±2.79^{a}
14	387.5±1.03	375.3±7.19	389.2±7.19
21	738.0±4.76	716.2±6.89	723.4± 14.16
28	1127.1±25.25	1113.8±12.96	1081.6±34.83
35	1547.6±44.49^{a}	1539.2±18.53^{a}	1399.3±49.32^{b}
Feed consumption (g)			
1-21	870.2±11.26^{a}	850.7±29.71^{ab}	788.7±5.55^{b}
22-35	1676.3±36.88^{a}	1348.7±50.41^{b}	1464.9±38.58^{b}
1-35	2546.5±29.04^{a}	2199.5±70.39^{b}	2253.6±43.98^{b}
Body weight gain (g)			
1-21	689.7±4.77	668.7±7.02	675.4±13.45
22-35	809.6±40.37 ^{a}	822.9±14.87 ^{a}	675.9±41.57^{b}
1-35	1499.4±44.02^{a}	1491.641±18.84^{a}	1351.3±49.39^{b}
Feed conversion ratio (g feed consumption : g body weight gain)			
1-21	1.26±0.01	1.27±0.04	1.69±0.03
22-35	2.08±0.10^{a}	1.64±0.09^{b}	2.19±0.18^{a}
1-35	1.70±0.04	1.48±0.06	1.67±0.09

Means±standard errors of mean within a row that do not share a common superscript are significantly different at $p \le 0.05$

2.5% GM treatment. Feed conversions were not different from each other for birds receiving 3.8% GB or 1.35% GG. There were no differences in cumulative feed to gain ratios by 35 day of the study (Table 2).

Mortality rate: No significant differences in mortality rate among all the dietary treatment groups during the entire course of the study were recorded (data un-shown).

DISCUSSION

This study was set up to explore if anti-nutritional compounds other than beta galactomannan gum contributed significantly to limiting the use of GM in broiler diets. The treatments were designed to contain equivalent concentrations of GG supplied as whole GB, GM or pure GG. A base concentration of 1.35% GG was chosen as it was estimated to be equivalent to feeding GM at 2.5% of the diet. Lee *et al.* (2003b, 2005) found that there were no negative impacts on the productive performance of broilers fed a diet supplemented with 2.5% GM. On the other hand, negative effects for adding GM into broiler chicken diets at levels more than 2.5% on growth, feed intake and digestive viscosity have been reported (Anderson and Warnick, 1964; Vohra and Kratzer, 1964a; Thakur and Pradhan, 1975a, b; Patel and McGinnis, 1985; Conner 2002; Lee *et al.*, 2003a). If anti-nutritional compounds in addition to GG contributed significantly to limit GM feeding then one would suspect they would have a negative, if not synergistically negative effect, on broiler performance when GG was held constant across all treatments.

Several anti-nutritional properties of guar have been reported that limit its use in poultry feeds. These include trypsin inhibitor (Bakshi, 1966; Couch *et al.*, 1967) saponins (Thakur and Pradhan, 1975a, b) polyphenols (Kaushal and Bhatia, 1982) and beta galactomannan gum (Vohra and

Kratzer, 1964a, b; 1965; Katoch *et al.*, 1971; Ray *et al.*, 1982; Furuse and Mabayo, 1996). Trypsin inhibitor has largely been discounted as the primary anti-nutritional compound limiting the use of GM (Bakshi, 1966; Couch *et al.*, 1967) but saponins and polyphenols remain a possibility. Saponins are commonly known to decrease palatability and inhibit feed intake.

The residual beta galactomannan gum present in GM is generally thought to be the main cause of the anti-nutritional compound in guar. Results obtained in the current study lend credence to this assertion. Vohra and Kratzer (1964a, 1965) demonstrated that adding 2% GG in broiler chick diets causes a 25-30% depression of growth. Also, it has reported that β-mannan rich GG significantly reduced growth and increased feed conversation ratio in broilers (Ray *et al.*, 1982; Daskiran *et al.*, 2004). Lee *et al.* (2003a) also supported the idea that residual GG in GM was at least partially responsible for the negative effects of the GM on body weight gain.

Results in this study did not show reduction in performance that could be attributed to anti-nutritional compounds other than GG. In fact, weight gain was significantly higher in birds receiving GG from both whole GB and processed GM and feed consumption was higher for birds receiving the GB diet. If GG is indeed the primary anti-nutritional factor limiting feeding guar products in poultry diets then supplementation with appropriate exogenous enzymes may be a viable option for safely using GM in poultry diets.

GG is regarded as a rich source of soluble non-starch polysaccharides (Pluske *et al.*, 1998) and can be fed intact or as partially hydrolyzed GG. Partially hydrolyzed GG has less detrimental effects on productive performance of the poultry compared with intact GG (Furuse and Mabayo, 1996). Negative effects, mainly increased digesta viscosity, can be totally or partially corrected by supplementation of beta-mannanase to feeds containing GM by degrading β-mannan, reducing intestinal viscosity and alleviating the deleterious effects associated with GM feeding (Lee *et al.*, 2003b; Daskiran *et al.*, 2004). Hydrolyzed mannan rich GG may also have efficacy as enzymes capable of hydrolyzing GG include endo-β-D- mannanase, cellulase, hemicellulase, pectinase, or (Vohra and Kratzer, 1964a, 1965; Ray *et al.*, 1982; Patel and McGinnis, 1985; Furuse and Mabayo, 1996; Daskiran *et al.*, 2004; Lee *et al.*, 2003b, 2005, 2009). Fermentation of the GM with *Aspergillus niger* or *Fusarium sp.* was also found to be useful (Nagra *et al.*, 1998).

Interpretation of the results of this study presumes calculations were correct with respect to achieving equivalent concentrations of GG among the three treatments. Improved performance (35 day body weights) seen in the GB and GM treatment could also be attributed to higher nutrient density as a result of underestimating the true nutrient content when the experimental diets were formulated.

CONCLUSION

This study supports the conclusion of previous researchers that GG is the primary anti-nutritional factor in GM. The study also suggests that whole ground GB may also be a viable option for reducing production cost provided it is available at an economical price.

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