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Effects of Guar meal, Guar gum and saponin rich Guar meal extract on productive performance of starter broiler chicks

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The study was set up to evaluate whether Saponin rich guar meal extract (GS) or residual Guar gum (GG) is the main anti-nutritional compound contributing to Guar meal (GM) relatively poor feeding value for poultry. Two hundred forty 1-days-old chicks were randomly distributed among 4 treatments with 4 replicates of 15 chicks each from 1 to 21 days. Chicks were fed one of four treatments: Control broiler diet, control diet containing 5.0% GM, control diet containing 0.90% GG, and control diet containing 0.250% GS. Feed intake was the highest in chicks fed 5.0% GM from 1 to 7 days, but was the lowest in chicks fed 0.90% GG from 8 to 14 days. Over the entire course of the study from 1 to 21 days, feed conversion ratio was very poor; the highest was for chicks fed 0.250% GS as compared to other groups. The final body weight at 21 days was lower in chicks fed 0.250% GS than chicks fed 0.90% GG and control. Total body weight gain from 1 to 21 days was lower in chicks fed 0.250% GS than chicks fed 0.90% GG and control. We conclude that that there are more negative effects associated with adding 0.250% GS than 0.90% GG suggesting saponins may play a prominent role in the growth inhibition effects on feeding GM to broiler chicks.

Key words: Starter broiler chicks, Guar meal, Guar gum, saponin, performance.

INTRODUCTION

Using feed ingredient alternatives to supplement or replace traditional feed ingredients in poultry diets is an economical interest used by poultry nutritionists worldwide. Guar, *Cyamopsis tetragonoloba* L. (syn. *C. psoraloides*) or cluster bean is a drought-tolerant summer annual legume native to India and Pakistan (Rahman and Shafivr, 1967; Patel and McGinnis, 1985).

Guar meal (GM) is a by-product of the isolation of guar gum (GG) from guar bean. GM consists of a mixture of germ and hull fractions (Rahman and Shafivr, 1967). GM contains about 33 to 47.5% crude protein on a dry matter basis (Ambegaokar et al., 1969; Nagpal et al., 1971; Lee et al., 2004), about 18% residual GG (Anderson and Warnick, 1964; Nagpal et al., 1971; Lee et al., 2004) and about 5.0% crude saponin by weight of the dry matter basis (Hassan et al., 2010).

GG is produced by further processing the endosperm fraction of the guar bean (Lee et al., 2004). Chemically, GG is a 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. Commercial GG is composed of approximately 8.0 to 14% moisture, 75 to 85% galactomannan, 5 to 6% crude protein, 2 to 3% crude fiber and 0.5 to 1.0% ash (Maier et al., 1993).

GM is rarely used as a feed ingredient because of several anti-nutritional factors such as saponin (Thakur and Pradhan, 1975a, b; Yejuman et al., 1998) and

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Table 1. Composition of isocaloric and isonitrogenous broiler starter diets[1] containing 5.0% guar meal (GM), 0.90% guar gum (GG), or 0.250% saponin rich guar meal extract (GS), respectively from 1 to 21 days of age.

Ingredients (%)	Dietary treatments			
	C	GM	GG	GS
Corn	60.38	58.5.00	58.88	59.78
Guar saponin extract	0.00	0.00	0.00	0.250
Guar gum	0.00	0.00	0.90	0.00
Guar meal[2]	0.00	5.0	0.00	0.00
Dehulled soybean meal	32.00	28.28	32.20	32.20
DL-Methionine	0.27	0.27	0.27	0.27
L-Lysine HCl	0.29	0.29	0.29	0.29
Corn oil	2.00	2.60	2.40	2.15
Limestone	1.63	1.63	1.63	1.63
Dicalcium phosphate	1.00	1.00	1.00	1.00
Mono-dicalcium PO_4	1.72	1.72	1.72	1.72
Salt	0.21	0.21	0.21	0.21
Trace minerals[3]	0.25	0.25	0.25	0.25
Vitamins[4]	0.25	0.25	0.25	0.25

[1]Average calculated analysis of of isocaloric and isonitrogenous broiler starter diets were as follows: CP, 22.06%; ME, 3,059 kcal/kg; Ca, 1.22%; non-phytin P, 0.66%; methionine, 0.57%; lysine, 1.30%; threonine, 0.77%; tryptophan, 0.28%. [2]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%. [3]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. [4]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.

residual GG (Vohra and Kratzer, 1964a, b, 1965; Katoch et al., 1971). However, Bakshi (1966) and Couch et al. (1967) recognized trypsin inhibitor as an important antinutritional factor in feed ingredients. These findings were contradicted by Conner (2002) and Lee et al. (2004) who noted that GM contained lower levels of trypsin inhibitor than processed soybean meal.

It is not yet clear whether residual GG or guar saponin contribute to a greater extent regarding the growth inhibitory effects of GM in broiler diets. No data is available in the scientific literature directly comparing the effects of GM, GG or saponin rich guar meal extract (GS) in a single broiler growth trial. Therefore, this study was conducted to investigate whether addition of either 0.90% GG or 0.250% GS when used at low concentrations roughly equivalent to feeding 5.0% GM in broiler diets would affect productive performance of broiler chicks.

MATERIALS AND METHODS

A commercial GG and GM powder**s** was purchased from Rama Industries, Manufacturer and Exporter of Guar Gum Split and Powder**,** Government Recognized Export House, Gujarat, India. GS was isolated according to the procedure described by Hassan et al. (2010) from GM powder.

Experimental design

Two hundred forty one-day-old unsexed Ross broiler chicks were purchased from a local commercial hatchery**,** weighed and randomly distributed in battery cages among four treatments with four replicates of 15 chicks per replicate. Chicks were assigned to one of the following four treatment groups: (1) the control broiler starter diet, (2) the control broiler starter diet reformulated with 5.0% GM, (3) the control broiler starter diet supplemented with 0.90% GG, and (4) the control broiler starter diet supplemented with a 0.250% GS. 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* with a 22:2 h light: dark schedule throughout the entire 21 days course of the study. Weekly feed intake, feed conversion ratio, mortality rate, body weight, and body weight gain were recorded from 1 to 21 day 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 mean**s** (SEM) and separated ($P \leq 0.05$) using the Duncan's multiple range test (Duncan, 1955).

RESULTS

During the first wk of the study (1 to 7 days of age), feed intake was significantly higher in chicks fed 5.0% GM than all the other treatments. Howeve**r**, feed intake was significantly lower in chicks fed 0.90% GG than all the other treatments from 8 to 14 days of age. Although feed

Table 2. Weekly **f**eed intake, feed conversion ratio, body weight and body weight gain for broiler chicks from 1 to 21 days of age.

Age (days)	Treatments			
	Control	5.0% GM	0.90% GG	0.250% GS
Feed Intake (g)				
1-7	116.99 ± 2.66 ^{b}	127.00 ± 0.66^{a}	115.67 ± 1.84^{b}	117.67 ± 0.84^{b}
8-14	345.33 ± 3.50^{b}	365.00 ± 5.34^{a}	323.00± 4.00^{c}	347.00 ± 8.19^{ab}
15-21	599.00 ± 10.67	559.00± 17.33	563.33± 6.84	559.00.00± 10.11
1-21	1061.32± 16.83	1051.00 ± 23.33	1002.00± 12.95	1023.67± 34.12
Feed conversion ratio (g feed intake/g body weight gain)				
1-7	1.19 ± 0.00^{c}	1.27 ± 0.00^{a}	1.23 ± 0.01^{b}	1.23 ± 0.00^{b}
8-14	1.24 ± 0.00^{c}	1.29 ± 0.00^{b}	1.18 ± 0.01^{d}	1.37 ± 0.01^{a}
15-21	1.53 ± 0.00^{b}	1.89 ± 0.07^{a}	1.64 ± 0.03^{b}	1.98 ± 0.07^{a}
1-21	1.38 ± 0.00^{c}	1.54 ± 0.02^{b}	1.41 ± 0.01^{c}	1.62± 0.03^{a}
Body weight (g)				
1	44.33 ± 0.19	44.67 ± 0.19	44.67 ± 0.19	44.63 ± 0.07
7	142.67 ± 2.34^{ab}	144.65 ± 0.84^{a}	139.00 ± 0.90^{b}	141.92± 1.17^{ab}
14	421.33 ± 5.50^{a}	428.33± 4.01^{a}	412.67±8.17^{ab}	395.67± 9.17^{b}
21	813.33± 13.17^{a}	726.33± 25.40^{bc}	755.54± 6.54^{ab}	697.67± 25.50^{c}
Body weight gain (g)				
1-7	98.34 ± 2.15^{ab}	99.98 ± 0.65 ^{a}	94.59 ± 0.71^{b}	97.31 ± 0.98^{ab}
8-14	278.66± 3.16^{a}	283.68 ± 3.17 ^{a}	273.67 ± 7.29^{a}	253.75± 8.00^{b}
15-21	392.00 ± 7.67^{a}	298.00 ± 21.40^{bc}	342.87 ± 4.12^{b}	284.00 ± 16.33^{c}
1-21	769.00 ± 12.98^{a}	681.66 ± 25.21^{bc}	710.87 ± 6.38^{ab}	634.34± 25.31^{c}

$^{a-d}$ Means ± standard errors of mean within a row that do not share a common superscript are significantly different (P ≤ 0.05).

intake was significantly higher in chicks fed 5.0% GM than control, there were no significant differences observed between chicks fed 0.250% GS and both chicks fed 5.0% GM and control diet during the same period (8 to 14 days) (Table 2).

Feed conversion ratio was poor and significantly higher for chicks fed 5.0% GM than all the other treatments from 1 to 7 days of age, but there were no significant differences in feed conversion ratio between chicks fed 0.250% GS and chicks fed 0.90% GG during the same period (1 to 7 days). From 8 to 14 days of age, feed conversion ratio was poor and significantly higher than all the other treatments for chicks fed with 0.250% GS. Feed conversion ratios for chicks fed 0.250% GS and 5.0% GM were significantly higher than chicks fed 0.90% GG and control diet from 15 to 21 days of age. Over the entire course of the study (1 to 21 days), feed conversion ratio was very poor and significantly higher than all the other treatments for chicks fed 0.250% GS (Table 2).

The initial body weight of broiler chicks distributed among the four dietary treatments was not significantly different at the start of the experiment. Body weight was significantly lower in chicks fed 0.90% GS/GG than chicks fed 5.0% GM at 7 days of age, but were not different from chicks fed 0.250% GS and control treatment. At 14 days of age, body weight was significantly lower in chicks fed 0.250% GS than both chicks fed 5.0% GM and control treatment, but were not different from chicks fed 0.90% GG. The final body weight at 21 days of age was significantly lower in chicks fed 0.250% GS than chicks fed 0.90% GG and control treatment, but were not different from chicks fed 5.0% GM treatment (Table 2).

Body weight gain was significantly lower in chicks fed 0.90% GG than chicks fed 5.0% GM from 1 to 7 days of age, but were not different from chicks fed 0.250% GS and control treatment. From 8 to 14 days of age, body weight gain was significantly lower in chicks fed 0.250% GS than all the other treatments, but were no significant differences among chicks fed 0.90% GG, 5.0% GM and control treatment. Body weight gains from 15 to 21 days of age were significantly different among all treatment groups ranging from 284 g of body weight gain for chicks fed 0.250% GS to 392 g of body weight gain for the control treatment. Body weight gain was significantly lower in chicks fed 0.250% GS than chicks fed 0.90% GG and control treatment, but were not different from chicks fed 5.0% GM treatment. Total body weight gain from 1 to 21 days of age was significantly lower in chicks fed 0.250% GS than chicks fed 0.90% GG and control treatment, but were not different from chicks fed 5.0% GM treatment (Table 2).

DISCUSSION

Results obtained were in disagreement with Miah et al.

(2004) who noted that adding 75 mg steroid saponin per kg feed for broiler chicks increased feed intake. On the other hand, Cheeke (1996), Ueda and Ohshima (1987), and Makkar and Becker (1996) noted that adding saponin to the broiler diet decreased feed intake. These differences may be attributed to the specific chemical structures and concentrations of the saponins fed. From 1 to 14 days of age, feed intake for chicks fed the 5.0% GM was significantly higher than those fed the control diet. Thakur and Pradhan (1975a, b) reported that GM use in poultry diets historically was limited by its adverse effects on feed intake.

Results obtained in this study were in agreement with several studies reported that adding GM in broiler and laying hen diets showed deleterious effects on feed conversion ratio (Saxena and Pradhan, 1974; Nagra et al., 1985; Patel and McGinnis, 1985; Nagra and Virk, 1986). Lee et al. (2003) found that GM contains GG whose impact on intestinal viscosity adversely affects feed conversion ratio.

While our results exhibited negative effect for adding GS in broiler chicks on feed conversion ratio, Yejuman et al. (1998) reported that at appropriate concentration saponins have potential as dietary additives to favor better feed conversion ratio. Our results were in disagreement with the findings of Johnston et al. (1982), Al-Bar et al. (1993), and Miah et al. (2004) who found that adding 75 mg steroid saponin per kg feed for broiler chicks improved feed conversion ratio.

In the current study, there was no significant effect for of all dietary treatments on mortality rate (unshown data). Hassan et al. (2008) found no significant effect of adding GM in broiler diet on mortality rate. On the other hand, Al-Bar et al. (1993) noted that adding saponin to broiler diets decreased mortality rate. Other reports mentioned that adding GM in broiler diets increased mortality rate (Sathe and Bose, 1962; Anderson and Warnick, 1964; Thakur and Pradhan, 1975b; Verma and McNab, 1982; Patel and McGinnis, 1985).

Our results obtained from the present study were in agreement with the observation of Anderson and Warnick (1964) and Conner (2002) who reported no significant negative impacts on the body weight of broiler chicks fed a diet supplemented with 5.0% GM. Previous studies reported that the negative effects of adding GM on body weight might be attributed to the presence of anti-nutrient compounds such as saponins (Thakur and Pradhan, 1975a, b). It was reported that GM contains about 5.0% crude Guar saponin (Hassan et al., 2010).

While Lee et al. (2005) reported GM could be safely fed to broilers at 2.5% of the diet without adversely affecting performance, the findings of Saxena and Pradhan (1974) that showed that GM has deleterious effects on body weight gain of broiler chicks. Saxena and Pradhan (1974), Cheeke (1996), Ueda and Ohshima (1987), and Thakur and Pradhan (1975a, b) reported that GM use in poultry diets historically was limited by its adverse effects on body weight gain. On the other hand, Daskiran et al. (2004) and Vohra and Kratzer (1964a, 1965) demonstrated that 1% GG in broiler diets causes a 25 to 30% depression of body weight gain. When diets contained 2% GG, the relative growth of broiler chicks was 61 to 67% of controls (Kratzer et al., 1967; Rogel and Vohra, 1982, 1983). Lee et al. (2005) also supported the idea that residual GG in GM was at least partially responsible for the negative effects GM on body weight gain.

The growth reduction of broiler chicks fed GG is likely due to increased viscosity of the digesta (Blackburn and Johnson, 1981). Previous studies reported that the negative effects of adding GM on body weight gain might be attributed to the presence of anti-nutrient compounds such as residual GG (Vohra and Kratzer, 1964a; 1965; Katoch et al., 1971; Annison and Choct, 1991). It was reported that GM contains about 18% residual GG on a dry matter basis (Anderson and Warnick, 1964; Nagpal et al., 1971; Lee et al., 2004).

The growth depressing properties of GG supplementation in poultry diets may be overcome by treating the feed with enzymes capable of hydrolyzing it, namely pectinase, and cellulase, a preparation from sprouted guar beans (Vohra and Kratzer, 1964a) or endo-β-D- mannanase (Vohra and Kratzer, 1964a; 1965; Ray et al., 1982; Verma and McNab, 1982; Patel and McGinnis, 1985; Lee et al., 2003; Daskiran et al., 2004). These exogenous enzymes are thought to reduce intestinal viscosity and alleviated the deleterious effects associated with excessive GG.

These results were in agreement with the previous studies which reported that the negative effects of adding GM on body weight gain might be attributed to the presence of anti-nutrient compounds such as saponins (Thakur and Pradhan, 1975a, b). The results obtained from the present study showed that adding 0.25% GS to broiler diets decreased body weight gain over the entire course of the study from 1 to 21 days (Table 2). The results were in agreement with the observations of Ueda et al. (1996), Cheeke (1996), Makkar and Becker (1996) that reported that adding saponins to broiler diets decreased body weight gain. On the other hand, several reports surprisingly found that adding saponins to poultry diets increased body weight gain (Johnston et al., 1982; Al-Bar et al., 1993; Yejuman et al., 1998). Also, Miah et al. (2004) noted that adding 75 mg steroid saponin per kg feed for broiler chicks increased body weight gain. However, Ishaaya et al. (1969) reported no adverse effect on body weight gain after feeding fenugreek seeds containing steroid saponins and soybean triterpenoid saponins (Petit et al., 1995) at concentrations as much as five times the concentration in a normal soybean-supplemented diet of chicks, rats and mice. Miah et al. (2004) reported that, recently some medicine companies are marketing saponins as feed additive in poultry production. Yejuman et al. (1998) reported that at appropriate concentrations saponins have potential as dietary additives to favor higher body weight gain.

In conclusions, it appears that guar saponin is the main compound in GM affecting body weight, body weight gain, and feed conversion ratio, although no significant differences in feed intake were observed compared with the control group. Productive performance of broiler chicks in the present study was less negatively inhibited by the 0.90% GG treatment suggesting that GM triterpenoid sapon**s** may be the most important anti-nutritional factor present in GM.

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