Short communication

Effect of water treatment of sorghum on the performance of broiler chicks

M. Sharif[#], M. Idrees, N.A. Tauqir, M.A. Shahzad, M.F. Khalid, M. Nisa, M. Sarwar & M.L. Khan

Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad, Pakistan

Abstract

The present study was conducted to observe the efficacy of water treatment on sorghum grain and to determine its optimum inclusion in broiler diets. Sorghum grain was treated with water and dried. Seven isoenergetic and isonitrogenous diets were prepared, using raw and treated sorghum, and designated diets A, B, C, D, E, F and G. Diet A, containing 0% sorghum, was kept as control. In diets B, C and D, raw sorghum was used at levels of 10%, 20% and 30%, respectively, while in diets E, F and G, treated sorghum was used at the same levels. Two hundred and ten day-old chicks were randomly divided into 21 experimental units of 10 chicks each. These experimental units were randomly allocated to seven treatments. It was observed that water treatment reduced the tannin contents of sorghum. Birds fed diets A, E and F showed the best weight gains, and diet G showed a better weight gain than diets B, C and D. The best feed efficiency was observed in chicks fed diets with treated sorghum compared with those fed raw sorghum. There was no significant effect of treated or raw sorghum on the weight of the internal organs. The study revealed that tannin contents in sorghum grain can be reduced with water treatment and that this treated sorghum can be used in broilers' diet up to the level of 20% to obtain efficient broiler production.

Keywords: Water treatment, tannin, birds, performance
[#] Corresponding author. E-mail: drsharifuaf@yahoo.com

The poultry industry has been developing rapidly over the last few decades and has become a major contributor to overcoming the shortage of animal protein in human nutrition. Broiler production is the quickest means of achieving high-quality animal protein in the shortest possible time. In raising poultry, feed expenditure accounts for about 70% - 75% of the total cost (Esonu *et al*., 2006; Sharif *et al.*, 2012). High feed cost is the major constraint for further progress of the poultry industry in developing countries such as Pakistan. Feed formulation requires the judicious use of feed ingredients to supply adequate amounts and proportions of nutrients required by poultry. Cereal grains such as maize, wheat and rice are the major energy sources and major components of poultry diets. Increased cost of cereal grains and competition between human beings and poultry over the consumption of cereal grains has compelled the nutritionists to explore new and non-conventional feedstuffs.

Sorghum grain is the fifth most important cereal after wheat, rice, maize and barley (Reddy, 1993). In Pakistan, the annual production of sorghum is 170 thousand tons (Anonymous, 2007/8). It is comparable with other cereal grains in chemical composition. Sorghum is not used extensively by the human population. Its usage in poultry feed is limited, because it contains a high level of tannin, which is an anti-nutritional feed component (Serna-Saldivar & Rooney, 1995). Sorghum contains up to 6% tannin (Doka *et al*., 2004; Dicko *et al*., 2005), which binds dietary protein (Butler *et al*., 1984), rendering it unavailable for absorption (Chibber *et al*., 1980). Owing to their astringent taste, tannins have negative effects on feed intake,

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palatability and digestibility of nutrients (Hassan *et al*., 2003; Makkar, 2003; Kim & Miller, 2005) with a consequent decrease in weight gain of birds.

If the tannin contents are removed, sorghum can replace other costly cereal grains in poultry diets. Various processes are used to remove the tannin content of sorghum, which include methanol, ammonia and hexane solvent treatments. Water can also be used, and can be an economical treatment since it is cheap and readily available in abundant quantities. However, information is limited on the evaluation of water treatment of sorghum in reducing tannin contents and production performance of broiler chicks. The following study was therefore planned to determine the effectiveness of water treatment of sorghum and optimum inclusion level of treated sorghum in the diets of broiler chicks.

The study was conducted at the R.M. Akram Animal Nutrition Research Centre, University of Agriculture, Faisalabad, Pakistan. Its main objective was to examine the efficacy of water treatment on sorghum and to determine its optimal level of inclusion in broiler diets. For water treatment of sorghum, a representative sample was taken to determine the moisture content of the sorghum and a calculated amount of water was added to the sorghum grains to bring the moisture level up to 30%. After the complete absorption of the water, the grains were placed in polyethylene bags and stored at 32 °C for three days (Teeter *et al.*, 1986). The treated sorghum grains were then dried at 55 °C and ground. The proximate composition and condensed tannin contents of raw and treated sorghum grains are shown in Table 1.

Table 1 Proximate composition and condensed tannin contents of raw and treated sorghum grains

Parameter (g/kg DM)	Raw sorghum	Treated sorghum
Crude protein	105	106
Ether extract	20	21
Ash	21	19
Condensed tannin	39	6

Two hundred and ten day-old broiler chicks were randomly divided into 21 experimental units with 10 chicks per unit. The chicks were housed and reared under standard environmental conditions. Seven isoenergetic and isonitrogenous diets were prepared and designated A, B, C, D, E, F and G. Diets A, B, C and D contained 0% (control), 10%, 20% and 30% raw sorghum grain, while diet E, F and G contained 10%, 20% and 30% treated sorghum. The ingredients and nutrient composition of broiler diets are shown in Table 2. These diets were randomly allocated to the 21 experimental units in such a way that each treatment was allocated to three experimental units. The chicks were fed *ad libitum*. The experiment was conducted for 42 days.

Feed consumption and weight gain were recorded daily and feed conversion ratio (FCR) was calculated. At the end of the sixth week of the feeding trial, two birds from each experimental unit were collected randomly and slaughtered to measure the dressing percentage and relative weight of the internal organs; the liver, spleen, pancreas and heart.

Analysis of raw and treated sorghums and the experimental diets for crude protein, crude fibre and ether extract was done according to AOAC (1990). Tannin contents were analysed using the butanol-HCl method described by Porter *et al*. (1986). The calcium content was analyzed via atomic absorption spectrophotometry and phosphorus photometrically via Spectronic 1001. The amino acid profile was determined according to the procedure described by Moore & Stein (1954).

The data were subjected to statistical analysis using the ANOVA technique. The treatment means were compared using the Tukey's test (Steel *et al*., 1997).

Water treatment of sorghum grain resulted in a significant reduction in tannin content, that is, from 39 g/kg DM to 6 g/kg DM (Table 1). Our findings are supported by Russell & Lolley (1989), who also observed a significant reduction in tannin contents if sorghum grain were treated with water and urea.

Birds that were fed the treated sorghum had higher weight gains than the birds fed raw sorghum. Maximum weight gains (1676.7 g and 1650.3 g) were observed in the birds fed diets E and F containing

treated sorghum at the levels of 10% and 20%, while the minimum weight gain (1444.6 g) was observed in birds fed diet D, containing 30% raw sorghum (Table 3). Our findings are consistent with those of Hassan *et al*. (2003), who reported a decreased weight gain in birds fed diets containing tannin-rich sorghum compared with those fed low tannin-sorghum diets. A high concentration of tannin in feed reduced the weight gain in birds (Widodo *et al*., 1996). This is because tannin has adverse effects on feed intake and its digestibility, which affect growth rate negatively (Makkar, 2003; Kim & Miller, 2005). Treatment of sorghum grain with water reduced its tannin content, which resulted in an improved weight gain.

Table 2 Percentage ingredients and nutrients composition of broiler diets

Ingredients	Diets[1]						
	Control	Raw sorghum			Treated sorghum		
	A	B	C	D	E	F	G
Sorghum	0	10	20	30	10	20	30
Maize (Yellow)	34	24	14	4	24	14	4
Rice broken	20	20	20	20	20	20	20
Rice polishing	6	6	6	6	6	6	6
Cotton seed meal	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Guar meal	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Canola meal	5.25	5.25	5.25	5.25	5.25	5.25	5.25
Corn gluten (60%)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Soybean meal	6.75	6.75	6.75	6.75	6.75	6.75	6.75
Fish meal	6	6	6	6	6	6	6
DCP	0.625	0.625	0.625	0.625	0.625	0.625	0.625
Limestone (ground)	1	1	1	1	1	1	1
Soybean oil	2.25	2.55	2.825	3.10	2.55	2.825	3.10
Molasses (cane)	2.375	2.075	1.8	1.525	2.075	1.8	1.525
Lysine	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vit/min premix	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Nutrient composition (g/kg DM)							
ME (MJ/kg)	12.64	12.65	12.65	12.65	12.65	12.65	12.65
Crude protein	200	201	201	201	201	201	201
Phosphorus	3.7	3.7	3.6	3.6	3.7	3.6	3.6
Calcium	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Lysine	11.0	10.7	10.6	10.6	10.7	10.6	10.6
Methionine	5.7	6.5	6.0	5.6	6.5	6.0	5.6

[1] Diet A contains 0% sorghum (control); diets B, C and D contain 10%, 20% and 30% raw sorghum while diets E, F and G contain 10%, 20% and 30% water treated sorghum.
DCP - dicalcium phosphate; ME - metabolizable energy (calculated according to NRC, 1989).

However, the results of the present study are not in concordance with Park *et al*. (1985), who observed a non-significant effect on weight gain in chicks fed raw sorghum. Mitaru *et al*. (1985) reported similar findings. This might be because of a low tannin sorghum variety in their experimental diets or different experimental conditions.

The average feed consumption of chicks fed diets A, B, C, D, E, F and G was 2987.7 g, 2937.3 g, 2855.7 g, 2764.3 g, 2993.3 g, 2977.0 g and 2956.7 g, respectively. The highest feed consumption was observed in chicks fed treated sorghum, whereas the lowest was recorded in chicks fed diet D, containing raw sorghum at the level of 30% (Table 3). Our findings are in concordance with those of Kim & Miller (2005), who observed reduced feed intake in animals fed tannin-rich diets. Similarly, Hassan *et al*. (2003) observed reduced feed intakes in birds fed tannin-rich sorghum compared with those fed low tannin sorghum. The reduced feed intake with tannin-rich diets might be because of its adverse effect on palatability or their poor digestibility, which resulted from increased excretion of inactivated enzymes of the gastrointestinal tract.

Table 3 Weight gain, feed consumed, feed conversion ratio (FCR), dressing percentage and weight of internal organs of broiler fed diets containing raw and treated sorghum

Parameter	Diets[1,2]							SE
	Control	Raw sorghum			Treated sorghum			
	A	B	C	D	E	F	G	
Weight gain (g)	1656^{ab}	1600^{c}	1523^{d}	1445^{e}	1677^{a}	1650^{ab}	1632^{b}	17.56
Feed consumed (g)	2988^{a}	2937^{b}	2856^{c}	2764^{d}	2993^{a}	2977^{a}	2966^{ab}	17.86
FCR (g feed/g gain)	1.80^{de}	1.83^{c}	1.87^{b}	1.91^{a}	1.78^{e}	1.80^{de}	1.82^{cd}	0.01
Dressing percentage	61.0^{ab}	59.0^{ab}	58.3^{ab}	57.1^{b}	62.5^{a}	61.8^{ab}	61.5^{ab}	0.57
Relative weight[3] of the digestive organs (g/100 g),								
Heart	4.00	4.04	3.00	3.93	3.98	4.03	4.04	0.10
Liver	41.3	42.2	42.8	41.3	41.0	41.6	41.1	0.21
Spleen	3.48	3.46	3.48	3.47	3.56	3.53	3.54	0.02
Pancreas	5.45	5.44	5.43	5.40	5.49	5.49	5.50	0.01

[1] Diet A contains 0% sorghum (control); diets B, C and D contain 10%, 20% and 30% raw sorghum respectively, while diets E, F and G contain 10%, 20% and 30% water treated sorghum, respectively.
[2] Means in a row with different superscripts differ significantly (P <0.05).
[3] Digestive organ weight relative to carcass weight (g/100 g), excluding digesta in gastrointestinal tract.

The FCR of birds fed diets A, B, C, D, E, F and G was 1.80, 1.83, 1.87, 1.91, 1.78, 1.80 and 1.82, respectively (Table 2). Better FCRs (1.78) were observed in chicks fed diets A, E and F, containing 0, 10 and 20% treated sorghum and the poorest (1.91) in chicks fed diet D, with 30% raw sorghum (Table 3). Tannin-rich sorghum resulted in a reduced weight gain and feed intake of broiler chicks, resulting in a poor FCR (Hassan *et al*., 2003). This is because tannin decreases energy, protein and specific amino acid utilization, which interferes with growth (Elkin *et al*., 1990), resulting in poor FCR.

Dressing percentage was the highest in broilers fed diet E, while it was the lowest in those fed diet D (Figure 4). However, the dressing percentage in the bird fed the other experimental diets was similar (P >0.05) (Table 3). Other researchers (Hulan & Proudfoot, 1982; Kank *et al*., 1995) reported non-significant differences in dressing percentage of chicks fed treated and raw sorghum. On the other hand, Mohamedian *et al*. (1986) and Widodo *et al*. (1996) observed higher dressing percentages in birds fed raw sorghum. The reason might be different environmental conditions.

There was a non-significant effect on relative weight of the heart, liver and spleen among birds fed the different experimental diets (Table 3). These results indicate that the raw and treated sorghum had no adverse effect on the weight of the internal organs. Our findings are in accordance with Nyachoti *et al*. (1996), who observed a non-significant effect on liver weight of sorghum containing tannin. Similar findings were reported by Ahmed *et al*. (1995). The pancreas also remained unaffected by dietary treatments. However, Ahmed *et al*. (1995) reported that feeding tannin-rich diets resulted in pancreatic hypertrophy in chicken.

Enlargement of pancreas is caused by the need for increased production of digestive enzymes, which is inhibited by tannins (Longstaff & McNab, 1991).

In conclusion, tannin in sorghum grains can be reduced with water treatment and this treated sorghum can be used successfully in broiler diet up to the level of 30%. However, for efficient broiler production, it should be used up to the level of 20% of the diet.

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