Effect of Tannin Extraction on the Feeding Value of Grain Sorghum in Broiler Starter Diets.

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SUMMARY

An experiment was conducted to determine the effect of tannin extraction from brown grain sorghum AR 3003 x TX 430 compared with low-tannin containing grains TX 399 x TX 430 and TAM 2566 DW3 on performance of broiler starter chicks. Extraction was made with alkaline hot water or by soaking grains in hot water (60 C) for lh. Tannin content was reduced by 75 and 25%, respectively. Six isonitrogenous and isoenergetic diets (with protein supplements made of peanut meal, meat and bone meal, and cottonseed meal) were formulated. In one diet, 0.15% DL-methionine was added above the recommended level to study its effectiveness in reducing the harmful effect of tannin.

No difference in feed consumption and feed conversion was found among chicks receiving the three varieties of grain sorghum. Methionine supplementation to the untreated brown grain AR3003 x TX430 diet increased feed consumption, improved weight gain, and reduced incidence of leg abnormalities when compared to the tannin-extracted diet ($P<0.05$). Both extraction methods had no effect on feed con-

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sumption or weight gain. However, feed conversion was improved ($P<0.05$) by the two extraction methods, and soaking of grains in water appeared to reduce the incidence of leg abnormality significantly.

INTRODUCTION

In many developing countries, sorghum grain is the major cereal crop available for feeding poultry. Some varieties of sorghum grain are known to contain the antinutritional factor tannin, which causes a depression in chick performance and deformation of leg. Chicks fed high-tannin (1 to 3%) diets ate less, grew more slowly, and had pooer feed conversion than chicks fed low-tannin or corn-based diets (Chang and Fuller, 1964; Connor et al., 1969; Armstrong et al., 1973; Mohamed and Ali, 1988). Tannin is concentrated in the pericarp or seed-coat of the sorghum grain, and a dietary level between 0.64 and 0.83% was required to reduce performance (Fuller et al., 1966). Different methods were developed to extract tannin, including physical dehulling (Chibber et al., 1978), chemical dehulling by alkaline treatment (Blessin et al., 1971, Chavan et al., 1979; Price et al., 1979), and soaking in water (Mohammed and Ali, 1988).

The present study was conducted to determine the effects of two tannin extraction methods on the feeding value of sorghum for broiler from 1 to 21 days of age. The first method was a modification of the alkaline-hot water process of Armstrong et al., (1974). The second was soaking the grains in hot water. The role of DL-methionine supplementation in alleviating the adverse effects of tannin on chick growth was investigated.

MATERIAL AND METHODS

Sorghum grains utilized in the present study were donated by the University Arkansas Agricultural Experiment Station. Variety I was TX399 x TX430 (yellow), variety II was TAM2566 DW3 (purple-testa), and variety III was AR3003 x TX430 (brown testa) Jhe¯proteifi precipitation values for these varieties were 0.00, 0.00, and 0.79, respectively (J.0. York, Department of Agronomy, University of Arkansas, Fayetteville, AR, 1990, personal communication). Protein precipitation values provide information on the nutritional value of feed containing tannin based on the ability of tannin to precipitate protein (Hagerman and Butler, 1978). Therefore, variety III was considered to be an intermediate-tannin sorghum grain and was subjected to extraction methods to reduce its tannin content.

The first tannin extraction method was modification of the alkali dehulling procedure described by Blessin et al. (1971) and Armstrong et al., (1974) Eighteen kg of grains were presoaked in water (60 C) for 5 min with continuous stirring. Grain: water ratio was 1:3. The grains were then drained and soaked in a 20% solution of sodium hydroxide at 70 C for 12 min. In the present study, a ratio of 1 L of sodium hydroxide solution for every 3.6 kg of grains was used in contrast to 1:0.85 ratio used by Armstrong et al. (1974). The grains were allowed to drain for about 2 min, transferred into a round 75 liter plastic container and hot tap water (60 C) was allowed to overflow for 3 mins with constant stirring. A 5% solution of glacial acetic acid was used to neutralize any remaining sodium hydroxide. Drying of the treated grains was done in a forced-air oven at 70 C for -4 h. The grains were

left to equilibrate to room moisture for 24 h.

On the second tannin extraction method, sorghum grains were soaked in water (60 C) for 1 h with constant stirring, using the same grain: water ratio. The grains were allowed to drain and transferred to the forced air oven for drying, followed by equilibration to room moisture in the same manner as described previously. Tannin content of the sorghum grains was determined by the vanillin-HCL method of Price et al, (1978) and is expressed as a percentage of catechin equivalent (% CE). The protein content of the sorghum grains was determined by the Kjeldahl procedure (Association of Official Analytical Chemists, 1980).

Six isonitrogenous and isoenergetic diets (20.67% C.P. and 12.34 MJ / kg M.E.) were formulated to study the effects of different tannin levels and methods of tannin extraction on the performance of broiler chicks from 1 to 21 days of age. Diet 1 contained one low-tannin sorghum variety, TX399 x TX430 (LT_1). Diet 2 was based on another low-tannin sorghum variety, TAM2566 D W_3 (LT_2). Diet 3 was based on an intermediate-tannin sorghum variety, AR-3003 x TX430 (MT). Diet 4 was basically Diet 3 in which D.L-methionine (0.15% of the diet) was added above the requirement to investigate whether or not methionine ameliorate the toxic effect of tannin (MT-Met). In diet 5 and 6, respectively, the medium-tannin variety, AR3003 x Tx430, was treated with 20% Na OH solution (MT-Na OH) or soaked in water (MT - H2O) to extract tannin described previously.

The composition of the diets is given in Table 1. Protein supplements were composed of peanut meal (49.08% protein), cottonseed meal (41% protein), and meat and bone meal (50.4% protein). Wheat

Table : **(1)** Composition of the experimental diets with three levels of tannin (%) 1

Ingredient	Diets					
	1	2	3	4	5	6
		LT_1	LT_2	MT_3	MT-Met	MT-NaOH	MT-H_2O
Sorghum grains	61.09	59.07	61.38	61.23	57.56	57.56
Peanut meal	20.00	16.00	18.40	18.40	16.60	16.06
Cottonseed meal	5.00	5.00	5.00	5.00	5.00	5.00
Wheat bran	2.00	7.12	3.23	3.23	7.00	7.00
Meat and bone meal	7.00	6.50	7.00	7.00	7.00	7.00
Hydrolyzed fat	3.17	4.5	3.19	3.19	5.00	5.00
Dicalcium phosphate		0.16				
Limestone	0.53	0.35	0.52	0.52	0.54	0.54
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin-trace mineral mix2	0.25	0.25	0.25	0.25	0.25	0.25
Lysine-HCI (98%)	0.36	0.41	0.41	0.41	0.42	0.42
DI-Methionine	0.30	0.34	0.32	0.47	0.33	0.33
Calculated analysis : for all diets :						
Crude protein,%	20.67					
Lysine,%	.11					

1 LT1 = Low tannin sorghum grain TX399 x TX430, = 0,37% CE; LT2 = low tannin sorghum grain TAM2566 DW3, = 0.4% CE, MT = Medium tannin sorghum grain AR3003 x TX430; = 1.35% CE; MT = Met = 0.15% methionine added to sorghum variety AR3003 x TX430; MT NaOH: = sorghum AR3003 x TX430 treated with 20% solution NaOH and MT-H20 = sorghum variety AR3003 x TX430 soaked in hot water.

2 supplied per kg of diet: vitamin A, 3000 IU; vitamin D, 2000 IU; vatamin E, 10 IU; vitamin K3, 0.5mg; thiamine, 1.8mg; riboflavin, 3.6mg; pantothenic acid, 10mg; niacin, 27mg; pyridoxine, 3mg; biotin, 0.15mg; choline, 1300mg; folacin, 0.55mg; vitamin B12, 0.009mg; ethoxyquin, 250mg, iron, 50mg; manganese, 50mg; zinc, 50mg; copper, 5mg; iodine, 1.5mg; cobalt, 0.5mg; selenium, 0.1mg;

bran (14% protein) was also used. These are the most common poultry feed ingredients found in many developing countries. The protein and energy contents of the contents of the diets were below the National Research Council (NRC, 1984) recommendations for broiler-chicks. To provide a better nutrient balance, Iysine-HCL and DL-methionine were added to supply a ratio of 1 : 2667 Iysine percent to ME (cal / g) and 1 : 3441 methionine plus cystine percent to ME (cal / g), which satisfied the NRC (1984) ratio of these essential amino acids to metabolizable energy in the diet.

One hundred and eighty day-old Hubbard broiler chicks were purchased from a commercial hatchery. Birds were housed in an electrically heated petersime battery brooder with raised wire floor under continuous light (Petersime Incubator Co., Gettysburg, OH). Feed and water were offered ad libitum. Each diet was fed to five replicates of six chicks. Records were kept for weekly feed consumption, body wieght change, and mortality. At the end of the 21-day study, a subjective leg score was used to assess abnormal leg conditions. Assesment was made according to the following criteria : 1- normal; 2- slightly abnormal; 3- severely abnormal; 4- unable to stand.

Data were analyzed by the General Linear Modle (G L M) which uses the principle of least squares to fit a linear model (S A S Institute, 1985). Means were statistically compared by using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

The levels of tannin content in sorghum varieties TX399 x TX430

and TAM2566 DW_3 were 0.37 and 0.4% catechin eqivalent (CE), respectively (Table 2). These were considerd to be low values, because the minimum level of tannin suggested by Fuller et al. (1966) to depress chick growth was between 0.64 and 0.84%. The tannin in variety AR3003 x TX430 was 1.35% CE, which was considered as an intermediate level. Extracting tannin by the alkaline-hot water process from sorghum variety AR3003 x TX430 reduced tannin content 75% compared with 25% reduction when the grains were treated with hot water alone (Table 2). Armstrong et al. (1974) reported a 90% reduction in tannin content with the alkaline-hot water method, using a ratio of 1 L of a 20% solution of sodium hydroxide for every 0.7 to 0.9 kg of grains, whereas in the preasent study, the ratio used was 1 L of sodium hydroxide solution for every 3.6 kg of grains. Mohamed and Ali (1988) reduced tannin content 40% by soaking sorghum grain in water for 24 h at ambient room temperatures of 35 C.

Table : (2) Determined crude protein and tannin content of sorghum grain varieties (mean + SE)

Measurement	Sorghum variety				
	TX399	TAM	AR3003 x TX430		
				Na OH	H2O
	TX430	25661DW3	Untreated	Treated	Treated
Crude protein,%	8.12+0.2	10.99+0.3	9.35+0.2	10.33+0.3	10.32+0.2
Tannin content,% CE	0.37±0.02	0.4±0.03	1.35+0.09	0.32+0.02	1.01+0.04

CE = Catechin equivalent.

No difference in feed consumption was noticed among broiler chicks receiving the low-tannin sorghum grains (TX399 x TX430 and TAM2566 DW3) or the intermediate-tannin variety(AR3003 x TX430) (Diet 1, 2, and 3, respectivelly) (Table 3). Neither the sodium hydroxide treatment nor the water soaking of the variety AR3003 x TX430 helped to increase feed consumption (P > 0.05) (Diets 5 amd 6). The chicks were able to tolerate a tannin level of 1.35% CE without depression in feed intake, probably because of the adequate supply of nutrients in the diets of the present study.

Table(3) : Effects of tannin extraction and DL-methionine Supplementation of sorghum grains on feed consumption, weight gain, feed conversion, and leg scoress of chicks.

Diet	Feed consumed	Weight gain	Feed: gain	leg score
	(g per chick)		(g/g)	
1. Low tannin (LT 1)	747bc	474bc	1.57a	1.20b
2. Low tannin (LT2)	792ab	510a	1.55ab	1.24b
3. Medium tannin (M1')	743bc	461c	1.61a	1.94a
4. Medium tannin + 0.15% Met	809	506a	1.59a	1.36b
5. Medium tannin - NaOH treated	759abc	510a	1.49bc	1.48ab
6. Medium tannin - H20 treated	723c	494ab	1.46c	1.36b
SEM	18.87	9.90	0.02	0.16

abc Within columns, treatment means with no common superscripts differ (P<0.05)

[1]Values are means for 21-day-old chicks .

[2]Leg score: 1 = normal; 2 = slightly abnormal; 3 = severely abnormal;
4 = unable to stand .

Methionine supplementation to the untreated medium-tannin variety AR3003 x TX430 (Diets 4) increased feed consumption ($P<0.05$) when compared with consumption of the unsupplemented AR3003 x TX430 diet (Diet 3) (Table 3). This finding was in agreement with previous studies (Conner et al., 1969; Armstrong et al., 1973).

Sorghum variety AR3003 x TX430 supplemented with methionine (Diet 4) or treated with sodium hydroxide solution (Diet 5) or hot water (Diet 6), supported better weight gain ($P < 0.05$) when compared with the same intact sorghum variety diet (Diet 3). Low-tannin sorghum grain TAM2566 DW_3 (Diet 2) supported higher body weight gain ($P < 0.05$) than did the other low-tannin sorghum grain TX399 x TX430 (Diet 1) and the medium-tannin sorghum grain AR3003 x TX430 diets (Diet 3) (Table 3).

There was no difference in feed conversion between the low-tannin sorghum varieties TX399 x TX430 and TAM2566 DW_3 (Diet 1 and 2) and the untreated medium-tannin variety AR3003 x TX430 diet (Diet 3) even with methionine addition (Diet 4). However, extraction of tannin by either alkaline-hot water or hot water soaking (Diet 5 and 6) improved ($P < 0.05$) feed conversion compared with that of Diet 3 (Table 5). Similar improvement was noted by Armstrong et al. (1974), who attributed the response to the lower fiber content which resulted from the loss of the grain pericarp during the extraction procedure. Blessin et al. (1971) estimated that about 30 to 60% reduction in fibre took place in their experiments, depending on the type and variety of grain used.

Chicks fed the unextracted medium-tannin grain (Diet 3) had the highest rate of incidence of leg abnormalities (Table 3). Extraction of

tannin by soaking in hot water (Diet 6) or methionine supplementation to the unextracted sorghum grains (Diet 4) reduced ($P < 0.05$) the incidence of leg abnormalities. Leg abnormalities noted in the present study consisted of a bowing of the legs accompained with a swelling of the hock joints. Similar observations were made by Armstrong et al. (1973), (1974) and Elkin et al. (1978). No mention of leg abnormalities was described in a recent study by Mohammed and Ali (1988) when broiler chicks were fed a high-tannin sorghum with 1.94% CE.

Methionine supplementation to the untreated brown grain AR3003 x TX430 (Diet 3) reduced the deter imental effects of tannin on growth. This has been suggested to be independent of the methyl group donation as the addition of choline alone has failed to minimize tannin adverse effects (Armstrong et al. 1973).

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