Effects of tannins as constituents of sorghum grain on broiler chicks growth, protein digestibility and some minerals availability.

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SUMMARY

Two experiments were conducted to study the effects, of tannins as a constituents of sorghum grain on broiler chicks growth, protein apparent digestibility and some minerals availability.

In experiment 1, sorghum tannins at 12 g CE of tannins / kg diet depressed growth rate, protein digestibility and ash availability when included in broilers diets at two (19 and 15 g protein / kg diet) protein levels. The same parameters also showed a decrease in response to a decrease in protein level.

In experiment 2, sorghum tannins reduced (P>0.01) growth rate, protein apparent digestibility and minerals (Ca , P, Mg , Co, Fe) availability when included in chicks diets at graded levels (0 , 4 , 8 and 12 g CE / kg diet).However, Zn availability was not affected by sorghum tannins addition.

This study indicated that, sorghum tannins depressed growth rate and decreased protein apparent digestibility and some minerals availability. when fed to broiler chicks at low protein level:

INTRODUCTION

Tannins is a naturally occurring water-soluble polyphenolic compounds with a molecular weight between 500-3000. It is cabable of forming effective cross- links with other molecules such as protein, carbohydrates, enzymes and minerals (Jansman, 1993). It forms complexes with proteins which may lead to coagulation and precipitation, thereby reducing their digestibility (Hagerman and

Klucher, 1986). They may also form effective cross linkges with enzymes (Griffiths, '1979) and diminish mineral bio-availability (Chang , *et .a1.* • 1993.)

Tannins is divided into two major types, condensed and hydrolysable tannins. Condensed tannins, which is a polymers of flavan - 3- ols is the type found in sorghum grain.Under natural conditions a high level of tannins imparts some positive agronomic characteristics which allow the plant to resist bird predation, microbial attack and the incidence of preharvest germination (Harris et *at* 1970.)

A consistent negative effects of sorghum tannins on nutrient digestibility were reported (Mohammed and Ahmed, 1987; Mustafa and El Zubair, 1993; Elkin, *et al.*, 1995; Nyachoti and Atkinson, 1995). Elkin, et *al.,* (1995) found a highly significant (P>0.01) overall inverse relationships between sorghum catechin equivalents (CE) and the digestibility of all amino acids of 20 sorghum cultivars. Tannins from other sources produce similar detrimental effects. Ahmed, *et al.* (1991) found that nitrogen digestibility decreased as the proportion of salseed *(Shorea robusla)* meal tannins in the diet of male chicks was - increased. Similarly Mahmood and Smithard (1993) reported that, digestibility of nitrogen both apparent and ideal was substantially lower with salseed meal diet than with the control diet.

The objective of this study therefore is to examine the effect of sorghum tannins fed at low protein level on protein, ash and mineral digestibility in broiler chickens.

MATERIALS AND. METHODS

Husbandry and experimental materials:

Two experiments were carried out to examine the effect of sorghum tannins on broilers growth, protein, ash and mineral retention. Tannins source was sorghum cultivar cross 35x18 provided by Gezira Research Station, Wad-Medani, Sudan. Tannins content of this sorghum cultivar was 16 g CE of tannins / kg of the sample determined by the modified vanillin-Hcl (MV-HCL) method of Price, *et al.,.* (1978). The two experiments employed a commercial unsexed broiler chicks (Lohmann) brought from a local source. Chicks were kept in cages inside a deep litter poultry house where feed and water were provided *ad-libitum.* Ingredients and diets were analysed according to A.O.A.C. (1980) procedures. In all diets,

groundnut meal, sesame meal and superconcentrates were used as major protein sources, sorghum, and oils as energy sources and oyster shell as calcium source . In both experiments sorghum with no detectable level of tannins was used as a control diet. All diets were formulated to meet the requirements of broiler chicks for essential nutrients as outlined by NRC (1994).

Nutrient digestibility:

In the two experiments chicks were randomly distributed into experimental cages (one chick / cage). The cages were made of welded mesh floors to facilitate the passage of the excreta. Experimental diets were assigned to the chicks in the experimental cages so that, each dietary treatment was fed to 6 chicks. Birds were adapted for one week after which feed intake and excreta were collected once per week for 4 consecutive weeks. Precautions were made to reduce feed and water losses by half filling the containers. Collected excreta were dried, weighed and kept in polythene sacks for analysis. Later excreta were analysed according to A.O.A.C. (1980) method . Based on the results of chemical analysis the apparent digestibility of the experimental diets were calculated by expressing the weight of digested food as percent of food weights consumed as follows:

$$\text{Apparent digestibility} : \frac{\text{WFC x \% NF} - \text{WEV x \% NF}}{\text{WEC x \% NF}} \times 100$$

Where WFC= Weight of feed consumed, NF= Nutrient in feces and WEV= Weight of excreta voided.

Experimental diets:

In experiment (1) four isocaloric diets having two sorghum tannins (0.0,12g CE / kg) levels and two protein (190,150 g / kg) levels were formulated (Table 1). Each diet was fed to 6 individual chicks.

In experiment (2) four isocaloric (3200 k cal / kg diet) and isonitrogenous (120g protein / kg diet) diets, with graded levels (0.0 , 4 , 8 and 12 g CE of tannins / kg of the diet were formulated (Table 2). Each diet was fed to 6 chicks in two replicates for 4 weeks. In this experiment samples of diets and feces were subjected to A.O.A.C. (1980) procedures to determine some minerals retention using atomic absorption.

Statistical analysis:

In Experiment 1 , data were subjected to analysis of **variance to** detect differences between treatments and means were compared by LSD test when F values were significant. On the other hand results of experiment 2 were analyzed by regression analysis (Gomez **and** Gomez, 1984) and differences among means were evaluated by T-test and values 0.05 were considered significant.

RESULTS

The effects of feeding two levels of sorghum tannins at two protein levels are shown in Table (3). Results indicated that, increasing tannins level in broiler diet adversely affected ($P<0.05$) BWG, protein and ash digestibility. Likewise decreasing the level of protein reduced ($P>0.01$) all of the measured parameters. Unlike as at high protein level, tannins inclusion significantly reduced protein and ash apparait digestibility at low protein level.

Results of BWG, protein and ash apparent digestibility of birds fed graded levels of sorghum tannins. are given in Table (4). Increasing tannins content of the diet had ¯a significant ($P>0.01$) negative linear decrease in protein and ash digestibility.

Results of minerals (Co, Zn, P, Mg, Ca and Fe) apparent digestibility are presented in Table (5). Tannins increment in broiler diet had a highly significant ($P<0.01$) negative linear decrease in all of` the tested minerals except Zn where no statistical difference was seen.

Table 1 . Ingredient Constituents of the Experimental Diets (Experiment 1).

Ingredient g / kg	Tannin level g CE / kg			
	190 g protein		150 g protein	
	0.0.	12	0.0.	12
Sorghum*	750	0.0	750	0.0
Sorghum	0.0	750	0.0	750
Groundnut meal	100	100 .	55	30
Sesame meal	80	70	40	20
Superconcentrates*	50	' 50	50 .	50
Oyster shell	9.5	10.0	11.7	13.5
Vegetable oils	0.0	7.5	9.8	20.6,
Lysine	5.0	5.2	6.5	6.5
Methionine	0.5	1.3	1.5	2.2
Wheat bran	0.0	1.0	70.5	102.2
Common salt	5.0	5.0	5.0	5.0

Sorghum * = Sorghum with negligible tannins.
**** Superconcentrate: A concentrated feed for broilers 5% inclusion rate, containing 35 % CP ,12 % Ca , 5.8 % P 5.3 % Lysine , 2.8 % Methionine , 1650 k cal /kg Metabolizable energy , plus vitamins and minerals.***

Tible 2. Ingredient Coitituents of the Experimental Diets (Experiment 2).

Ingredient	Tannin level g CE / kg			
g / kg	0.0	=4	8 --	12
Sorghum*	/50	500	250	**0.0**
Sorghum	0.0	250	500	**750.0**
Groundnut meal	30	, 30	30	**30**
Sesame meal	25	23	22 ,--	**20**
Superconcentrates*	50	50	50	**50**
Oyster shell	14.3	14.6	14.6	**14**
Vegetable oils	9.3	12.1	14.5	**16.5**
Lysine	4.3	4.2	4 1	**4.1**
Methionine	2.1	2.1	2.2	**2.4**
Wheat bran	110.0	109.0	107.6	**108.0**
Common salt	5.0	5.0	5.0	**5.0**

Sorghum * = Sorghum with negligible tannins.
**** Superconcentrate: A concentrated feed for broilers 5% inclusion rate, containing 45 % CP ,12 % Ca 6% P, 11% Lysine, 2.5% Methionine, 2000 k cal /kg Metabolizable energy , plus vitamins and minerals.***

Table 3 . Body weight gain' , protein and ash digestibility[2] of broilers fed sorghum tannins at two protein levels.

Level of protein gikg	Level of tannins g CE /kg	Body weight gain (g / bird)	Crude protein	Ash
190	0.0	713.8[a]	78.3[a]	39.9'
190	1.2	600.6[b]	75.5'	36.0'
150	0.0	600.1	73.6'	28.0[b]
150	1.2	366.6	57.1[b]	18.9'
SEM[3.]		34	2.29	1.65
Test for significance				
Level of protein		**	**	**
Level of tannins		*	*	
Interaction		NS		NS

1 = Values are means of 4 replicates of 5 chicks.
2 = Values are means of 2 replicates of 2 chicks.
3 = Standard error of means.
[a.b.c.] Values on the same column with different superscripts differ.
Significantly:
NS = Not significant at 5% level.
** = Significant at 5% level.*
*** = Significant at 1% level.*

Table 4 . Body weight gain'', protein and ash digestibili of broilers fed graded levels of sorghum tannins.

Level of tannins g CE /kg	Body weight gain (g / bird)	Crude protein	*Ash*
0.0	1688	70.2	28.8
4.0	1640	68.4	27.8
8.0	1500	63.8	24.0
12.0	899	56.6	19.2
S F;[3]	263	6.2	4.51
Linear effects (t value for			
Significance)	-62.8**	-11.38*	-12.89*

1 = Values are means of 4 replicates of 5 chicks.
2 = Values are means of 2 replicates of 2 chicks.
3 = Standard error of estimate.
** = Significant at 5% level.*
*** = 'Significant at 1% level.*

Table 5 . Mineral intake of broilers fed graded levels of sorghum tannins[1] .

Level of tannins CE/kg	Mineral digestibility					
	Co	Zn	P	Mg	Ca	Fe
0.0	59	60	60 \	72	62	59
4.0	58	60	56.5	69	58	57.5
8.0	55.5	63'	54.5	66	56	51.5
12.0	54.5	58	48.5	60	51	45
SE[2]	2.16	2.82	4.8	5.14	4.6	6.4
Linear effects (t value for significance)	-.4**	-.075Ns	-.91**	-.98**	-.88	-1.2*

1 = Values are means of 2 replicates of 2 chicks.
2 = Standard error of estimate.
*NS = Not significant at 5% level. ** = Significant at 1% level.*

DISCUSSION

In both of the present experiments feeding graded levels of tannins as a constituent of sorghum grains reduced BWG, protein, ash and mineral digestibility.

The negative impact on BWG observed in this study is consistent with earlier reports on diets containing high tannins from sorghum grains (Trevino, *et al.* 1992, Elkin, *et al.*, 1995) salseed meal (Ahmed *et al.*, 1991) and tannic acid (Vohra, *et al.*, 1966). With lower protein level and higher tannins concentration, BWG as well as protein and ash digestibility were reduced. This exemplifies the simultaneous effect of both low protein level and high tannins level. Scott, *et al.*, (1982) reported that, birds will fail to adapt when two stresses are simultaneously applied.

The decreased BWG due to decreased protein level observed in experiment (1) is in line with that obtained from diets with suboptimal protein level. There are evidences that poultry diets with lower dietary protein impair feed intake (NRC, 1994) and Douglas, *et al.* , (1993) reported decreased BWG with suboptimal protein level in turkey diets.

The decreased protein digestibility with increasing tannins level at low protein level is consistent with previous research work (Mohammed and Ahmed 1987, Elkin, *et al.*, 1995). It was known that, tannins reduce the nutritive value of diets mainly by reducing both dietary protein availability and digestive enzyme activity. Consequently, nitrogen retention is substantially decreased due to reduced protein digestibility (Nelson, *et al.* • 1975). Reduced nitrogen retention was manifested by high fecal nitrogen losses. This effect is likely to be severe since our diets contain protein at suboptimal (12 g/kg of diet) level. Featherston and Rogler (1975) showed that, the amount of fecal nitrogen excreted by rats increased with increasing dietary tannins level. This was reflected in a 30% reduction in apparent nitrogen retention and an increase of about 0.54% for fecal nitrogen.

The negative effects of increasing levels of sorghum tannins on BWG, protein and ash digestibility were also confirmed in experiment (2) when 12g protein / kg diet was fed.

Apparent Ca, Mg, Co, P and Fe digestibility of broilers fed graded levels of sorghum tannins were significantly less than in controls fed tannin-free diets. This is most likely since tannins are known to form insoluble complexes with divalent ions rendering them less available for absorption (Jansman, 1993).

With respect to the reduction found in Ca digestibility, dietary tannins have been found to influence Ca absorption. Chang, *et aL*, (1993) reported significant reduction in Ca absorption in rats fed diets containing medium to high tannins levels from 11-18 days of age.

Similarly, Mitjavilla, *et al.*, (1977) observed a 40% increase in fecal excretion of Ca when feeding 1% tannic acid in the diet for 25 days. Results of both studies suggested that Ca obsorption is very sensitive to tannins level even this is very low (0.0057%). The cause of reduced Ca obsorption is not /clear but may be due to reduced obsorption or increased endogenous excretion of Ca- rich substances (Mitjavilla, *et al.*, 1977).

The decreased Mg digestibility observed in this study is in line with the finding of Mitjavilla, *et* <u>*al.*</u>, (1977) who reported a significant increase in fecal magnesium excretion when tannins of 1.09/100g was incorporated in the diets of rat.

The adverse effects of sorghum tannins per se on P, Fe and Co digestibility noted in the present study has not been reported before in literature. However, addition of orthophosphoric acid and dicalciurn

phosphate to alleviate the negative effects of sorghum tannins was repofted by Ibrahim, *et al.*, (1988). In addition Roa and Prabhavathi (1982) suggest that, tannins are responsible for the low bioavailability of iron in legume seeds.

The non-significant effect of sorghum tannins on Zn digestibility indicates that tannins may bind preferentially to certain minerals than others. Freeland, *et al.* (1985) gave another possible explanation for the difference between apparent absorption of minerals that, tannins may alter the proportion between urinary and fecal excretions of such ions.

Results of this study indicate that sorghum tannins fed to broiler chicks at low levels of protein altered protein, ash and minerals apparent digestibility.

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تاثير محتوي العصفرين في الذرة على نمو الكتاكيت اللاحم ، معامل هضم البروتين ودرجة الاستفادة لبعض المعادن

الفاضل أحمد الزبير وسالم جبريل .

ملخص البحث

في هذه الدراسة تم اجراء تجربتين بغرض معرفة أثر المواد الدابغة (عصفرين) الموجودة بالذرة الرفيعة علي معدل النمو وقابلية هضم البروتين ودرجة الاستفادة من الرماد وبعض العناصر المحلية في الدجاج اللاحم

التجربة الأوئي اوضحت أن إضافة 12 جرام معادل كتاشين (CF) من المواد الدابغة لكل كيلوم من عليقة الدجاج اللاحم أحدث نقصان في معدل النمو وقابلية هضم البروشن مستفادة من الرماد علنما شملت هذه الكمية من المواد الدبغة في عليقتين ذلك مستويين (15 , 19 جرام بروتين / كيلوجرام عليقة) من البروتين . كذلك أنخفض معدل النمو وقابلية هضم البروتين ودرجة الاستفادة من الرماد أعلاه يتدني مستوي البروتين

نتائج التجربة الثانية و التي استخدمت فيها مواد دابغة بنسب مشرحة (0 ، 8،4 ، 12 جرام CE / كيلوجرام من العليقة أظهرت أن المواد الدابغة الموجودة بالذرة لها أثار سلبية على معدل نمو الطير وقابلية الهضم البروتين ودرجة الاستفادة من الرماد وبعض العناصر المعدنية (F , Co , Mg , P , Ca) عدا عنصر الزنك و الذي لم يشهد تغييرا في درجة الأستفادة به

خلاصة هذه التجربة أوضحت أن المواد الدامغة (عصفرين) المحتواه في الدرة الرفيعة الت لي نقصان في معدل النمو ونقصان في قابلية هضم البروتين ودرجة الاستفادة من الرماد وبعض العناصر المعدنية عندما ضعفت في غذاء الدجاج اللاحم أو مستوي من البروتين