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USE OF LOW TANNIN SORGHUM TO REPLACE YELLOW CORN PARTIALLY OR TOTALLY IN BROILER RATIONS

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ABSTRACT

An experiment was conducted to evaluate the best level of low tannin- sorghum grains to be included in broiler diets as a source of energy partially or completely replace yellow corn. Chemical composition and nutritional value of low tannin-sorghum grains were determined. Six hundred and thirty one day old Cobb broilers were used in this study. The chicks were randomly distributed among five dietary treatments (Control and four treatments). The experimental diets contained 4 levels of low-tannin sorghum grains during each stage of the three stages of growth (starter; grower and finisher). Each dietary treatment was offered to 3 replicates each replicate contained 42 chicks housed in broiler cages. The diets were formulated to be iso-caloric and iso-nitrogenous and covering the chick requirements as recommended by the management guide data of cobb chicks. The effects of different inclusion rates of low-tannin sorghum on growth performance and carcass characteristics were evaluated. The economic efficiency of replacing yellow corn by low-tannin sorghum was calculated. During the entire growth period (starter, grower and finisher), there were no significant differences in live body weight, weight gain, feed intake and feed conversion between chicks fed the control diet and those fed diets containing low-tannin sorghum up to 100%. There was also no significant difference in carcass yield at 35 days of age between birds fed the control diets and those fed diets containing different levels of sorghum. The economical efficiency study showed that replacing 50% and 25% of yellow corn with sorghum grains had the best economical efficiency and relative economical efficiency. Accordingly, this study demonstrated that low-tannin sorghum can safely be used in the broiler starter, grower and finisher rations as a substitute for yellow corn up to 100%, in spite of the exceptionally lower protein content of the sorghum, the present results confirm previous results in the livestock that low or non-tannin sorghum could partially or completely replace yellow corn in broilers rations. The fact that sorghum normally contains 10-11% CP compared to corn emphasizes the importance of using sorghum on the productive and economic efficiency of broilers especially in areas where the white skin color of broilers has consumer preference.

Keywords: Low tannin sorghum, broiler, performance, carcass

INTRODUCTION

Dietary energy ingredients represent the major items in feed cost in livestock and poultry operations. The poultry industry in Egypt has suffered heavy losses due to the continual increase in input prices. Apart from the increased prices of other inputs there is an estimated increase in corn and soy prices by 50% and 75% between 2008 and 2012 associated with world economic crisis; increased energy prices; increased demand for energy by

emerging markets as well as the advent of the ethanol revolution. Feed cost represent about 70 to 80% of the total running cost of poultry operations. Energy sources as corn represents about 65 to 70% of the feed formulation. Thus corn as an energy source represents about 50% of the total feed cost. Livestock and poultry feed cost is likely to continue on upwards swing (Conolly, 2012) driven by the increased medium class; urbanization; change in consumer behavior and consequently increased demand for animal protein sources. Therefore, exploring the possibility of using alternative energy feed ingredients in livestock and poultry feeds either to reduce cost of production or to broaden the opportunities to nutritionists to formulate the least or the best cost rations became an urgent necessity (Nyannor *et al.,* 2007). Sorghum is considered to be the fifth most important crop after wheat, rice, corn and barley (Bryden *et al.,* 2009). Sorghum is tolerant to drought and salinity thus it occupies areas unsuitable for growing corn in stress-prone semi-arid region (FAO 2009). Sorghum is the only cereal that contains tannins. Tannins reduced pre-harvest molding; enhance resistance to pathogens and pets; lower bird depredation and lower pre-harvest germination Taylor (2001).

Many research workers suggest that maximum level of dietary tannins is between 3 and 2.5% on dry matter basis. Giner-Chavez (1996) however reported that levels of tannins ranging from 0.5% to 2.0% in poultry diets can cause depression in growth and egg production while levels of 3% to 7% can cause death. Tannins are phenolics that form complexes with protein thus making it resistant to enzyme digestion (Giner-Chavez 1996). Due to plant breeding efforts the sorghum currently produced are tannin free in the U.S.; Europe (Vignau – Loustau and Huyghe 2008), Australia; India and Thailand (Awika and Rooney 2004; Subramanian *et al.,* 2000 and Walker 1999). Those new varieties are excellent sources of energy and protein for broilers; layers; turkeys and water fowl (Nyachoti *et al.,* 1996). In countries where birds' predation is a serious issue, the production of low tannin sorghum may not be of economic importance. The use of high tannin sorghum cultivates is likely to be more economical (Taylor, 2003; Kyarisiima *et al.,* 2004).

The nutrient profile of sorghum in terms of protein is very similar or slightly higher than corn (Kriegshauser, *et al.,* 2006). Amino acid digestibility compares favorably with corn, especially the newer sorghum varieties (Smith and Waldroup 1988) and (Lemme, *et al.,* 2004). The fat content of grain sorghum and thus the energy value for poultry is slightly lower than corn but these differences can easily balance other sources of energy as animal by products meals or oils (Beyer, 2010). Compared to corn, grain sorghum contains reduced quantities of yellow xanthophylls. In some cases where lighter color meat products are preferred by the consumer, sorghum may be the suitable grain to use. Where color is required for some poultry products, other sources of pigments such as marigold oil, yeast products, synthetic compounds and even corn dried distillers grains with solubles (DDGS) could be used as sources for the yellow pigmentations (Beyer, 2010).

The main objectives of this study are therefore to determine the effects on broiler performance; carcass characteristics and economic efficiency of partially or completely replacing yellow corn by low tannin sorghum.

MATERIALS AND METHODS

Experimental chicks

The present work was carried out in the poultry house in Nubaria (North West of the Nile), affiliated to the Regional Center for Food and Feed, Agric. Res. Center, Ministry of Agric., Egypt. Six hundred and thirty commercial (630) day-old Cobb broilers were purchased from (El-Wadee Poultry Company). The average initial live body weight of all birds was nearly similar (Av. 45 gm/chick). Chicks were distributed randomly among five dietary treatments (control and four tested groups). Birds were placed in brooders battery with 14 birds per compartment; nine compartments were assigned to each dietary treatment. The trial was conducted under controlled lighting period (24hrs.).

Experimental diets

Sorghum:

A low or non-tannin sorghum sample of U.S. origin was donated to the Regional Center for Food and Feed by Dakahlia Poultry Company.

Sorghum was analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), Crude Fibers (CF), minerals and amino acids using standard official methods (AOAC, 2005). A comparison between the determined chemical compositions of sorghum with that of corn based on the NRC 1994 are shown in Table 1.

The tested diets were formulated to contain 25, 50, 75, and 100% low tannin sorghum in place of corn. These diets were formulated to cover the chick requirements according to the management catalogue for Cobb chicks as shown in Tables 2, 3 and 4. The commercial sample used in this study is of U.S. sorghum and contains 0.08% to 0.19 % tannin or less. All diets were iso-coloric and iso-nitrogenous being 3000; 3100 and 3200 Kcal ME/kg and 23%; 22% and 20% CP for starter; grower and finisher rations, respectively.

Feed and water were provided *adlibitum* throughout the whole growth period.

Body weight, weight gain; feed intake, feed conversion and mortality rate were recorded at 14; 28 and 35 days of age for all treatments.

At 35 days of age; three chicks from each replicate were randomly selected, slaughtered for determination of carcass traits. The weights of breast meat, thigh, drum stick, liver and gizzard were recorded.

Economical efficiency

The economic efficiency and relative economical efficiency of the various experimental diets were calculated based to both the market price kg feed and the market price kg live body weight gain.

Statistical analysis

The data obtained were subjected to a one way analysis of variance using the linear model (GLM) of SAS (SAS institute, 1991). Treatment means

were subjected to Duncan's new multiple range test (P<0.05) (Duncan, 1955) to detect the significant differences between means.

Table (1): Nutrient compositions of corn (estimated) and low tannin sorghum (determined).

Item	Sorghum (Determined)	Corn (NRC, 1994)
Dry matter	87	88
CP%	7.5	8.5
Fat%	3.2	3.8
Fiber%	2.3	2.2
MEn (Kcal /Kg	3288	3350
TME (kcal/Kg)	3376	3470
Ca%	0.04	0.02
Total P%	0.30	0.08
Potassium%	0.35	0.30
Sodium%	0.04	0.04
Amino acids:		
Arg%	0.35	0.38
Gly%	0.31	0.33
Ser%	0.40	0.37
His%	0.22	0.23
Iso%	0.35	0.29
Leu%	1.14	1.00
Lys%	0.21	0.26
Meth%	0.16	0.18
Cys%	0.17	0.18
Phe%	0.47	0.38
Tyr%	0.34	0.30
Thr%	0.29	0.29
Try%	0.80	0.06
Val%	0.44	0.40

Table (2): Composition of broiler starter diets (0-14 d) with different levels of low tannin sorghum (as- fed basis).

Ingredients	Starter				
	Control	Sorghum inclusion rate			
		25%	50%	75%	100%
Yellow corn (7.5%)	48.421	36.345	24.182	12.133	0.000
Grain sorghum (7.5%)	0.000	11.750	23.582	35.313	47.105
Soybean meal	44.268	44.570	44.881	45.179	45.480
Vegetable oil	3.107	3.150	3.190	3.230	3.280
Dicalcium phosphate	1.965	1.950	1.940	1.930	1.920
Limestone	1.247	1.240	1.230	1.220	1.220
Vit. & min. mixture[1]	0.300	0.300	0.300	0.300	0.300
Choline chloride	0.075	0.075	0.075	0.075	0.075
Salt	0.300	0.300	0.300	0.300	0.300
DL. Methionine[2]	0.267	0.270	0.270	0.270	0.270
L. lysine – HCL[2]	0.050	0.050	0.050	0.050	0.050
Calculated values%					
CP	23.000	23.000	23.000	23.000	23.000
ME (Kcal /Kg)	3000	3000	3000	3000	3000
Lysine	1.400	1.400	1.400	1.400	1.400
Methionine + Cystine	1.040	1.040	1.040	1.040	1.040
Calcium	1.000	1.000	1.000	1.000	1.000
Available P	0.500	0.500	0.500	0.500	0.500

[1] **Vitamin-mineral mixture supplied per Kg diet :Vit. (D3),2000 I.U;VIT.(E),10 mg; Vit.(B1),1mg;Vit.(B2), 5 mg;Vit (B6), 1.5mg; Vit.(B12),10 µg; Biotin, 50 µg; Choline chloride,500mg; pantothenic acid, 10 mg;Niacin,30 mg; folic acid,1mg; manganese, 60mg; ZINC,50mg;Iron,30 mg; Copper, 10mg; Iodine,1mg; Selenium,0.1mgandCopalt,0.1mg Vit.(A),12000 IU.**

[2] **Lysine and Methionine were added according to management recommendation guide data for Cobb broilers.**

Table (3): Composition of broiler grower diets (15-28d) with different levels of low tannin sorghum (as-fed basis).

Ingredients	Grower				
	Control	Sorghum inclusion rate			
		25%	50%	75%	100%
Yellow corn (7.5%)	59.740	44.630	29.439	14.619	0.000
Grain sorghum (7.5%)	0.000	14.662	29.438	43.849	58.065
Soybean meal	33.310	33.702	34.082	34.455	34.823
Vegetable oil	2.840	2.894	2.948	3.002	3.054
Dicalcium phosphate	1.760	1.754	1.742	1.730	1.719
Limestone	1.150	1.146	1.140	1.134	1.128
Vit & mini mixture[1]	0.300	0.300	0.300	0.300	0.300
Choline chloride	0.070	0.070	0.070	0.070	0.070
Salt	0.560	0.562	0.558	0.554	0.550
DL. methionine[2]	0.190	0.200	0.203	0.207	0.211
L. lysine- HCL[2]	0.080	0.080	0.080	0.080	0.080
Calculated values%					
CP	22.000	22.000	22.000	22.000	22.000
ME (Kcal /Kg)	3100	3100	3100	3100	3100
Lysine	1.300	1.300	1.300	1.300	1.300
Methionine + Cystine	1.000	1.000	1.000	1.000	1.000
Calcium	0.900	0.900	0.900	0.900	0.900
Available P	0.450	0.450	0.450	0.450	0.450

[1]Vitamin-mineral mixture supplied per Kg diet :Vit. (D3),2000 I.U;VIT.(E),10 mg; Vit.(B1),1mg;Vit.(B2), 5 mg;Vit (B6), 1.5mg; Vit.(B12),10 µg; Biotin, 50 µg; Choline chloride,500mg; pantothenic acid, 10 mg;Niacin,30 mg; folic acid,1mg; manganese, 60mg; ZINC,50mg;Iron,30 mg; Copper, 10mg; Iodine,1mg; Selenium,0.1mgandCopalt,0.1mg Vit.(A),12000 IU.

[2] Lysine and Methionine were added according to management recommendation guide data for Cobb broilers.

Table (4): Composition of broiler finisher diets (29-35 d) with different levels of low tannin sorghum (as-fed basis).

Ingredients	Finisher				
	Control	Sorghum inclusion rate			
		25%	50%	75%	100%
Yellow corn (7.5%)	63.418	47.229	31.266	15.525	0.000
Grain sorghum (7.5%)	0.000	15.743	31.266	46.574	61.671
Soybean meal	29.685	30.093	30.496	30.893	31.285
Vegetable oil	3.092	3.150	3.207	3.264	3.320
Dicalcium phosphate	1.628	1.615	1.602	1.590	1.578
Limestone	1.120	1.113	1.107	1.099	1.092
Vit & min. mixture [1]	0.300	0.300	0.300	0.300	0.300
Choline chloride	0.075	0.075	0.075	0.075	0.075
Salt	0.441	0.437	0.433	0.428	0.424
dl. Methionine[2]	0.168	0.172	0.176	0.181	0.185
L. lysine – HCL[2]	0.073	0.073	0.072	0.071	0.070
Calculated values%					
CP	20.000	20.000	20.000	20.000	20.000
ME (Kcal /Kg)	3200	3200	3200	3200	3200
Lysine	1.160	1.160	1.160	1.160	1.160
Methionine + Cystine	0.920	0.920	0.920	0.920	0.920
Calcium	0.900	0.900	0.900	0.900	0.900
Available P	0.450	0.450	0.450	0.450	0.450

[1]Vitamin-mineral mixture supplied per Kg diet :Vit. (D3),2000 I.U;VIT.(E),10 mg; Vit.(B1),1mg;Vit.(B2), 5 mg;Vit (B6), 1.5mg; Vit.(B12),10 µg; Biotin, 50 µg; Choline chloride,500mg; pantothenic acid, 10 mg;Niacin,30 mg; folic acid,1mg; manganese, 60mg; ZINC,50mg;Iron,30 mg; Copper, 10mg; Iodine,1mg; Selenium,0.1mgandCopalt,0.1mg Vit.(A),12000 IU.

[2] Lysine and Methionine were added according to management recommendation guide data for Cobb broilers.

RESULTS

The proximate analysis of sorghum compared to corn (Table 1) indicates that unexpectedly the low tannin sorghum sample used in this study was lower in its protein; ether extract (EE), Metabolizable Energy Adjusted for Nitrogen Balance (MEn), True Metabolizable Energy (TME) and Lysine content compared to corn. These differences are expected since the nutritive value of sorghum is greatly affected by the variety of sorghum; climatic and soil conditions and type of fertilizers (Aduku 1993; Tacon, 1995 and Etuk, 2008).

The results of broiler performance in terms of live body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion (FC) for the starter period (1 to 14 days of age); the grower period (15 to 28 days of age) and the finisher period (29 to 35 days of age) are summarized in Table 5.

Starter period: There were no significant differences in body weight, weight gains, feed intake and feed conversion of chicks fed the control diet and those given diets containing 25%, 50%, 75% and 100% sorghum at 14 days of age. However, the lowest feed conversion in the starter period was observed by chicks fed the control diet.

Grower period: Results showed no significant differences in the body weight, weight gain, and feed intake and feed conversion for chicks fed either the control diet or diets containing 25%, 50%, 75% and 100% sorghum.

Finisher period: There were no significant differences in body weight, weight again, feed intake and feed conversion for chicks fed either the control diet or diets containing 25%, 50%, 75% and 100 % sorghum, respectively

The performance of broiler given the low tannin sorghum was encouraging. The growth rates of birds subjected to the different levels of sorghum and those chicks fed control diet were almost similar without any significant differences among treatments. The final bird weight and feed efficiency ratio didn't vary among birds given yellow corn diet or those given diets containing low tannin sorghum (Table 5). These data suggest that low tannin sorghum can replace yellow corn up to 100% without any adverse effects on chick performance.

The mortality rate ranged between 0- 4.7% during the whole experimental period among chicks given the 5 experimental diets.

Carcass characteristics: Table (6) summarizes the percentages of different parts and organs of broiler chicks fed the experimental diets at 35 days of age.

Dressing percentage, breast meat, drum sticks, thigh, liver and gizzard weights were not significantly different among birds given different levels of sorghum or those given the control diet. Dressing percentage of the control group was 75.13% while it was 76.46, 76.15, 76.50 and 76.53% for those fed 25%, 50%, 75% and 100% sorghum, respectively.

Economical evaluation: Data concerning the economical evaluation of feeding broilers different experimental diets to 35 days of age as affected by substituting yellow corn partially or totally by low tannin sorghum are presented in Table (7).

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It is obviously that the inclusion of low tannin sorghum in the dietary treatments decreased production costs as compared to that of control. Average economical efficiency values of different treatments (feed/kg gain) being the best for broiler fed diets contained 50% sorghum followed by those contained 25%. The lowest economic efficiency value was recorded for chicks given diets containing 75% or 100% sorghum grains.

For the relative economical efficiency, averages of improvement due the dietary treatments ranged between 2.67% and 10%, being the best for chicks given diets containing 25% sorghum grains.

DISCUSSION

The present results indicated that low tannin sorghum can safely be used in the starter, grower and finisher broiler rations as a replacement for corn up to 100%, in spite of its slightly low protein content of the sorghum sample used in the present study. Sorghum with high protein content could be included in poultry feeds as a tool to reduce cost of production associated with decreased level of dietary soy meal supplement. These results agreed with those obtained by Titus and Fritz (1971), Gualtieri and Rapaccini (1990), and Subramanian and Metta (2000) who stated that birds fed diets containing high level of sorghum (low tannin) performed similar to those given corn in terms of weight gain, feed consumption and conversion. Also, the present results agreed with those reported by Thakur *et al.,* (1984) and Rama Rao *et al.,* (1995) who stated that low tannin sorghum can replace maize from 50 to 70% without adverse effect on broiler performance. Shelton *et al.,* (2004) stated that pigs fed corn and non-waxy sorghum had similar growth and carcass traits. Douglas *et al.,* (1990) concluded that grain sorghum has nearly similar nutritive value to yellow corn when fed to boilers.

Table (7): Economic efficiency of experimental dietary treatments.

Items	control	T1	T2	T3	T4
Average final L.B.W (g)	1674	1669	1712	1661	1678
Feed intake (kg)	2.747	2.716	2.773	2.793	2.787
Total cost of feed (L.E)	8.53	8.39	8.51	8.51	8.44
Total revenue / chick (L.E)	26.79	26.71	27.39	26.58	26.85
Net revenue / chick (L.E)	18.26	18.32	18.88	18.02	17.91
Economic efficiency	2.14	2.18	2.22	2.12	2.12
Relative economic efficiency (%)	100.00	101.87	103.74	99.07	99.07

The selling price of each kg live body weight (16L.E).

For the carcass yield the present results agreed with those of Subramanian and Metta (2000), who stated that carcass yield, carcass fat, gizzard and liver were not significantly different among chick given corn diets compared to these given low tannin sorghum diets. The dressing percentage values obtained in this study were almost similar to those reported for broiler chicks by Marion and Woodroof (1966).

The present study demonstrated the economic advantage of replacing yellow corn by sorghum in diets for broilers. In this respect, Hala

(1998) found that, low tannin sorghum can be used in the diet of broilers at level up to 100% with no obvious deterioration of economical efficiency.

Conclusions

In spite of, the low protein content of the low tannin sorghum used in the present work, the present results demonstrated that low tannin sorghum could completely substitute corn in broiler diets without any obvious deterioration on broiler productive performance and carcass characteristics. Replacing 50% and 25% yellow corn with low tannin sorghum gave the best results for economic efficiency and relative economical efficiency. More researches are needed however to explore the possibility of using other varieties of sorghum grains in different poultry species.

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إستخدام السورجم منخفض المحتوى من التنينات محل الأذره الصفراء جزئياً أوكلياً في علائق دجاج التسمين

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أجريت تجربه تقييم افضل نسبه إضافه من السورجم منخفض التنينات كمصدر للطاقه في علائق دجاج التسمين محل الأذره الصفراء جزئياً أوكلياً. أجريت التحاليل لمعرفة التركيب الكيماوي والتغذوي للسورجم منخفض التنينات. إستخدم عدد ستمائه وثلاثون كتكوتاً عمر يوم من نوع سلالة Cobb. حيث تم توزيع الكتاكيت على خمس معاملات (عليقه قياسيه و أربع معاملات) إشتملت العلائق التجريبيه على أربع مستويات من السورجم منخفض التنينات وذلك خلال كل مرحله من مراحل النمو الثلاثه(بادي ، نامي وناهي). قسمت كل معامله إلي ثلاث مكررات كل مكرر إحتوى على عدد ٤٢ كتكوتاً والتي وضعت داخل أقفاص. تم تركيب العلائق بحيث كانت كلها متزنه في محتواها من الطاقه والبروتين وتغطي إحتياجات الكتاكيت طبقا لدليل السلاله الخاص بسلاله Cobb . تم تقيم تأثير نسب الإضافه المختلفه لسورجم منخفض التنينات عن طريق أداء النموو صفات الذبيحه.تم حساب الكفاءه الإقتصاديه لإحلال السورجم منخفض التنينات محل الأذره الصفراء. خلال فترة النمو الكليه (بادي، نامي و ناهي) لم يلاحظ أي فارق معنوي من حيث وزن الجسم ، الوزن المكتسب، كمية الغذاء المأكول ومعامل التحويل الغذائي بين الطيور التي تغذت على العليقه القياسيه وتلك المغذاه على علائق إحتوت على سورجم منخفض التنينات حتى مستوى إحلال ١٠٠%. لم يكن هناك فروق معنويه في تصافي الذبيحه عند عمر ٣٥ يوماً بين الطيور التي تغذت على العليقه القياسيه وتلك المغذاه على علائق إحتوت على السورجم منخفض التنينات.أوضحت الدراسه الإقتصاديه أن إحلال٥٠% و ٢٥% من الأذره الصفراء بالسورجم أعطى أفضل كفاءه إقتصاديه و أفضل كفاءه إقتصادية نسبيه.وعليه فأن هذه الدراسه أوضحت أنه يمكن إستخدام السورجم منخفض التنينات في علائق دجاج التسمين في كل من مرحلة البادي، النامي و الناهي بشكل آمن بمعدل إحلال يصل الي ١٠٠% محل الأذره الصفراء وذلك برغم إنخفاض محتواه من البروتين والنتائج الحاليه تؤكد نتائج سابقه يظهر فيها أمكانية إحلال السورجم منخفض التنينات جزئياً أوكلياً محل الأذرة الصفراء في علائق دجاج التسمين.

حقيقة أن السورجم عادةً ما يحتوي على ١٠-١١% بروتين مقارنة بالأذره مما يؤكد على أهمية إستخدام السورجم في العمليه الإنتاجيه والإقتصاديه لدجاج التسمين خاصةً في المناطق التي يكون لون الجلد الأبيض مفضلاً لدى المستهلك.

قام بتحكيم البحث

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Table (5): Effect on broiler performance of partial or complete substitution of yellow corn by low tannin sorghum.

Item	Dietary treatment	Sorghum %			
	Control	25%	50%	75%	100%
Starter stage (1-14 days old)					
Live body weight (g)	348 [a] ±14.22	369 [a] ±12.77	377 [a] ±7.07	355 [a] ±23.18	366 [a] ±18.02
Body weight gain (g)	303 [a] ±14.22	324 [a]±12.77	322 [a]±7.07	310 [a]±23.18	321 [a]±18.02
Feed intake (g)	390 [a] ±14.57	399 [a]±11.36	404 [a]±23.00	392 [a]±4.59	395 [a]±2.83
Feed conversion (feed / gain)	1.29 [a] ±0.06	1.23 [a]±0.03	1.22 [a]±0.04	1.26 [a]±0.03	1.23 [a]±0.06
Grower stage (15-28 days old)					
Live body weight (g)	1223 [a]±43.84	1256 [a]±10.69	1288 [a]±33.37	1243[a]±23.26	1244 [a]±36.10
Body weight gain (g)	866 [a]±43.84	887 [a]±10.69	911 [a]±33.37	888[a]±23.26	879[a]±36.10
Feed intake (g)	1462 [a]±45.76	1463 [a]±47.88	1488 [a]±35.60	1466[a]±15.89	1451[a]±29.70
Feed conversion (feed / gain)	1.69 [a]±0.08	1.65 [a]±0.06	1.63 [a]±0.01	1.65 [a]±0.07	1.65 [a]±0.02
Finisher stage (29-35 days old)					
Live body weight (g)	1674 [a]±36.47	1669 [a]±5.77	1712 [a]±19.14	1661[a]±4.58	1678[a]±11.68
Body weight gain (g)	460 [a]±36.47	413 [a]±5.77	423 [a]±19.14	418 [a]±4.58	434 [a]±11.68
Feed intake (g)	895 [a]±29.60	855 [a]±14.57	902 [a]±21.66	935[a]±10.12	941[a]±25.72
Feed conversion (feed / gain)	2.16 [ab]±0.08	2.07 [a]±0.04	2.13 [ab]±0.11	2.24 [b]±0.10	2.18 [ab]±0.14
Overall experimental period (1-35 days old)					
Live body weight	1674 [a]±36.47	1669 [a]±5.77	1712[a]±19.14	1661 [a]±4.58	1678 [a]±11.68
Body weight gain (g)	1629 [a]±36.47	1624 [a]±5.77	1667[a]±19.14	1616[a]±4.58	1633 [a]±11.68
Feed intake (g)	2747 [a]±51.01	2716 [a]47.78	2773 [a]±41.30	2793[a]±71.53	2787 [a]±107.11
Feed conversion (feed / gain)	1.68 [a]±0.08	1.68 [a]±0.06	1.66[a]±0.04	1.73 [a]±0.11	1.71 [a]±0.13

a,b Means within a row with different superscripts are significantly different (P <0.05).

Table (6): Carcass characteristics of Cobb broilers given diets containing 0.0, 50.0, 75.0 and 100% low tannin sorghum in place of yellow corn.

Item / Treatment	Dressing (%)	Breast (%)	Thigh (%)	Drum stick (%)	Liver (%)	Gizzard (%)
Control	75.13±1.60	18.52[ab]±0.16	7.66 ±0.14	4.89±0.10	2.12±0.18	3.42 ±0.16
Treatment1 (25% Sorghum)	76.46±0.88	19.12[a]±1.32	7.48 ±0.11	5.07±0.25	2.69 ±0.22	3.29 ±0.17
Treatment 2 (50%Sorghum)	76.15±3.20	19.85 [a]±0.67	7.14 ±0.28	4.87±0.13	2.33 ±0.11	3.49 ±0.28
Treatment 3 (75% Sorghum)	76.50±2.20	18.10[b]±0.83	7.60 ±0.25	5.15±0.13	2.24 ±0.18	3.60±0.26
Treatment 4 (100% Sorghum)	76.53±1.13	19.85 [a]±0.76	7.07 ±0.39	4.77±0.04	2.41 ±0.31	3.61±0.09

a, b means within the same column with different superscripts are significantly different at (P<0.5).