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Original Article

Effect of Substituting Yellow Maize for Sorghum on Broiler Performance

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ABSTRACT

An experiment was conducted to study the nutritional value of yellow maize when it substitutes sorghum grain as source of energy at levels 0, 25, 50, 75 and 100% in broiler rations. One hundred and forty unsexed one day old (Ross) broiler chicks were randomly assigned to five approximately isocaloric and isonitrogenous diets labeled as follows: Diet (S0) containing sorghum 100% (control, 60% of the diet), diet (S1) 75% sorghum 25% maize, diet (S2) 50% sorghum 50% maize, diet (S3) 25% sorghum 75% maize and diet (S4) maize (100%) (without sorghum). Each treatment had four replicates with 7 birds/replicate. The experiment lasted for 6 weeks. Feed intake and body weight gain had been recorded weekly. The results showed significant increase ($P < 0.01$) in feed intake (3847.7, 3817.68 and 3734.06gram) and body weight gain (2189.58, 2203.04 and 2078.98gram) for birds fed diets S0, S1 and S2 respectively. No significant differences were observed in feed conversion ratio among all dietary treatments. Moreover, protein efficiency was greater for birds received diet S0 (2.65) and diet S1 (2.62) and lowest for birds received diet S4 (2.45). Birds fed diet S3 and S4 recorded significantly ($P < 0.01$) lowest hot and cold carcass weights (1420.83, 1479.17gram) and (1395.84, 1458.34gram) respectively than other groups. Broiler chicks supplemented with diet S1 and S2 recorded significantly ($P < 0.05$) higher carcass hot dressing percentage (73.66 and 73.36) respectively than those fed diet S0 (72.60) and S4 (72.60) while those fed diet S3 (71.92) recorded the lowest one. The highest serum glucose level was obtained by chicks fed diet S1 (176.33) while those fed on the other four diets were statistically similar. Serum total protein was found to be higher for chicks fed diet S0 (3.10), S1 (3.66) and S4 (3.42) while the lowest level was observed by chicks fed diet S3 (2.31). All the treatments had no significant ($P > 0.05$) effect on cold carcass dressing percentage, liver and abdominal fat weights, serum cholesterol, serum calcium and inorganic phosphorus levels. The cost of production decreased by increasing level of maize.

Key words: Broiler, Maize, Sorghum, Performance

INTRODUCTION

Poultry require a large percentage of cereal grains in their ration to provide protein and energy. Sorghum is the fifth most important crop after wheat, rice, maize (corn), and barley (Bryden et al., 2009). However, in West Africa sorghum is the second most important cereal grain after millet and just before maize. Maize has remained the chief energy source in compounded diets and constitutes about 50% of poultry ration (Ajaja et al, 2002) and has similar nutritive value to that of sorghum grain (Hancock, 2000) and wheat (Mikkelson et al., 2008).

Sorghum had higher values of protein while the energy or fat content of sorghum was slightly lower than that of maize. The amino acid profile of the sorghums compared well to maize, although the average lysine content of sorghum tested to be 0.26% versus maize at 0.30%. The nutrient composition of tested sorghum similar to maize for ME value in a broiler chick assay (Kriegshauser, et al., 2006). It is well established that cereal type (e.g. maize versus sorghum) does not affect gastrointestinal tract or intestinal morphology measurements in poultry (Donald et al., 2008). In Sudan poultry nutrition depends mostly on sorghum as a major source of energy so here is a competition between human and poultry industry since sorghum is a staple food for human. This is reflected in the high price of sorghum which leads to arise in production cost of poultry products (Alkhair, 2000) and in some parts of Sudan two types of maize (yellow and white) are available and cheaper than sorghum.

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Therefore, objectives of this study is to compare the feeding value of yellow maize when it is used as a source of energy as it substitute sorghum (feterita) at different levels and its impact on broiler performance

MATERIALS AND METHODS

Study location

This study was conducted in a poultry house within the premises of Faculty of Animal production University of Khartoum

Experimental diets

Five experimental diets were used in which sorghum (feterita) or maize or both was the main source of energy. Maize was used to replace sorghum in the diet by 0, 25, 50, 75, 100%. The diets were formulated to meet nutrient requirements of broiler chicks as outlined by national research council (NRC, 1994) and they were approximately isocaloric and isonitrogenus. The dietary ingredients as illustrated in Table (1). Diet (S0) was the sorghum based only (control), diet (S1) consist of 75% sorghum 25% maize, diet (S2) 50% sorghum 50% maize, diet (S3) 25% sorghum 75% maize and diet (S4) maize based only. Vegetable oil was added to diet S0, S1 and S3 to balance the caloric requirements. Premixes, common salt, lime stone and vitamins were added to all diets. Calculated analysis of the chemical composition of the experimental diets are illustrated in Table 1.

Experimental birds and management

One hundred and forty one-day old commercial unsexed broiler chicks (Ross) were used for the study. Twenty eight chicks of approximately the same weight were assigned randomly for each dietary treatment with four replicates. They were reared seven birds per pen. Each pen represents a replicate. Feed and water were provided ad-libitum throughout the experimental period, feed intake and live body weight were recorded weekly to obtain the body weight gain, feed and protein efficiency. At the end of six weeks, birds were starved overnight from feed only. Three birds were selected randomly from each replicate (i.e. 12 birds for each treatment), they were weighted, tagged, slaughtered, scalded, manually plucked using boiling water and allowed to drain. Blood samples were taken from jugular vein during slaughtering, three birds from each replicate (12 birds/treatment) and blood serum was separated to be analyzed for glucose, cholesterol, total protein, calcium and inorganic phosphorus. Hot and cold dressing percentages were calculated by expressing them to the live weight. Liver and abdominal fat weights for each carcass was recorded, then carcasses were weighted and chilled for overnight at 4ºC, cold weights were determined.

Chemical analysis

The chemical analysis of sorghum and maize (table 2) and that of the experimental diets (table 3) were carried out according to the method of association of official analytical chemist (AOAC, 1990).

Serum glucose was measured according to Trinder (1969), and serum cholesterol was determined according to enzymatic colorimetric test (CHOD-PAP), Richimond (1973). Serum total protein was analyzed by Biuret colorimetric method as described by Weischselbaum (1946), and serum calcium level was detected as described by Trinder (1969) (colorimetric micro-determination of calcium). Serum inorganic phosphorus was determined by using a Kit (Randox Laboratories, U.K.). Statistical analysis: A complete randomized design was used in this experiment. The experimental data were analyzed by analysis of variance using the computer programme (SAS, 1994) and the mean separation was done according to Duncan's multiple range test at 1 and 5% probability level.

RESULTS

The crude protein content of yellow maize was lower (11.70%) than that of sorghum (13.03%) while the two cereals were almost similar in metabolizable energy (Table 2). The average data on feed intake, weight gain, feed conversion ratio, protein efficiency and feed cost for the production of chickens fed treated diets are presented in Table 4. Feed intake and body weight gain for birds fed diets S0, S1 and S2 were significantly ($P < 0.01$) higher compared to the other treatment groups. Birds fed diets S3 and S4 respectively recorded the lowest feed intake and weight gain. No significant difference was observed between treatment groups for feed conversion ratio (FCR). Protein efficiency ratio (PER) was significantly ($P < 0.05$) higher for birds fed diet S0 and S1 whereas the S4 group recorded the lowest level. The cost of feed for the production was significantly higher for birds fed diet S0 whereas the S4 birds had the least cost of production.

The treatment had a significant effect ($P < 0.01$) on carcass hot and cold weights (Table 5). Chicks fed on diets S1, S0 and S2 were showed the highest hot and cold carcass weight and those fed diets S4 and S3 obtained the lowest hot and cold weights. Dressing percentage was affected significantly ($P < 0.01$) by the dietary treatments. The highest hot dressing percentage was observed on chicks fed diet S2 and S3. While the lowest hot dressing percentage was obtained for that chicks consumed diet S2. Birds fed on S0 and S4 diets gave similar values (Table 5). No significant ($P > 0.05$) difference was observed between treatment groups for cold dressing percentage, liver and abdominal fat weights (Tables 5 and 6).

There was a significant ($P < 0.05$) effect on serum glucose. The highest level of serum glucose was obtained by chicks fed diet S1. Serum glucose level for S0, S2, S3 and S4 birds were comparable ($P > 0.05$).The current study showed that there was a significant ($P < 0.01$) effect on total serum protein. Chicks fed on diet S1 showed a higher serum total protein while those fed on diet S3 obtained the lowest serum total protein value, furthermore, chicks received S0 or S4 diets were similar.

No significant ($P > 0.05$) difference was observed between treatment groups for serum cholesterol, calcium and inorganic phosphorus despite that chicks consumed diet S4 numerically showed the lowest value of serum cholesterol (Table 7).

Table 1. Calculated and determined chemical composition of the experimental diets

Ingredients	Treatment				
	S0	**S1**	**S2**	**S3**	**S4**
Sorghum	60.0	45.0	30.0	15.0	0.0
Maize	0.0	15.0	30.0	45.0	60.0
Groundnut cake	18.0	13.86	15.5	17.5	18.0
Sesame cake	10.0	14.5	14.86	14.86	14.36
Super concentrate*	5.0	5.0	5.0	5.0	5.0
Wheat bran	3.86	4.0	3.0	2.0	2.0
Lime stone	0.14	0.14	0.14	14.0	0.14
Premix	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25
Vegetable oil	2.5	2.0	1.0	-	-
Total	100	100	100	100	100
Calculated analysis					
ME (kcal/kg)	3053	3077	3096	3114	3149
Crude protein	22.5	22.0	22.2	22.2	21.6
Calcium	0.9	1.0	1.0	0.99	0.97
Total phosphorus	0.64	0.63	0.61	0.60	0.60
Lysine	1.2	1.2	1.2	1.2	1.2
Methionine	0.45	0.49	0.5	0.5	0.5
Crude fiber	4.8	4.7	4.7	4.7	4.7

*Composition of super concentrate: crude protein 40%, crude fiber 2%, crude fat 2%, Ca 10%, available P 4%, lysine 12%, methionin 3%, methionin + cystine 3.2%, ME 2100 Kcal/kg, sodium 2.6%. S0) Sorghum 100% (control); S1) Sorghum75% maize 25%; S2) Sorghum 50% maize 50%; S3) Sorghum 25% maize 75%; S4) Maize 100%.

Table 2. Determined chemical composition of sorghum (feterita) and yellow maize

Items	ME Mj/kg	CP %	CF %	EE %	DM %	Ash %	NFE %
Sorghum (Feterita)	14.40	13.03	3.59	2.94	94.3	1.52	73.22
Yellow maize	14.17	11.7	5.3	4.2	94.0	2.2	70.60

ME= Metabolizable energy was calculated according to the equation of Lodhi, et al (1976). CP = Crude protein; CF = Crude fiber; EE = Ether extract; DM = Dry matter; NFE = Nitrogen free extract.

Table 3. Determined chemical composition of the experimental diets

Diet	Components %					
	Dm	**C.P**	**E.E**	**C.F**	**Ash**	**NFE**
S0	94.5	25.9	4.9	9.5	9.6	44.6
S1	94.3	25.4	6.4	6.4	9.2	46.9
S2	94.2	22.1	2.9	11.4	10.5	47.3
S3	93.7	21.0	2.9	11.2	8.5	50.1
S4	93.9	20.0	3.9	10.7	9.9	49.4

DM = Dry matter; CP = Crude protein; EE = Ether extract; CF = Crude fiber; NFE = Nitrogen free extract

Table 4. Effect of feeding different levels of maize on broiler performance and cost of one kg feed

Parameter	Diet					SEM	Sig
	S0	**S1**	**S2**	**S3**	**S4**		
Feed intake (g/bird)	3847.70[a]	3817.68[a]	3734.06[a]	3330.04[b]	3421.79[b]	95.14	**
Body weight gain (g/bird)	2189.58[a]	2203.04[a]	2078.98[a]	1878.21[b]	1842.56[b]	51.31	**
Feed conversion ratio	1.76	1.74	1.80	1.78	1.86	0.03	NS
Protein efficiency	2.65[a]	2.62[a]	2.53[ab]	2.56[ab]	2.45[b]	0.04	*
Cost of kg Feed (SD)	87.62	81.55	72.78	64.05	59.10	-	-

[a,,b]: values within a row with different superscripts differ significantly. ± SEM: Standard error of the mean. **: P < 0.01; *: P < 0.05; NS: Not significant; SD: Sudanese Pound.

Table 5. Carcass hot and cold weight, dressing percentage hot and cold as affected by the dietary treatments

Parameter	Diet					SEM	Sig
	S0	**S1**	**S2**	**S3**	**S4**		
Carcass hot weight (gm)	1712.50[a]	1775.00[a]	1675.00[a]	1420.83[b]	1479.17[b]	42.83	**
Carcass cold weight (gm)	1685.42[a]	1727.08[a]	1652.09[a]	1395.84[b]	1458.34[b]	45.23	**
Dressing % hot	72.60[bc]	73.66[a]	73.36[ab]	71.92[c]	72.60[bc]	0.27	**

Dressing % cold	71.46	71.83	72.15	70.65	71.56	0.41	NS

a, b, c: values within a row with different superscripts differ significantly. ± SEM: Standard error of the mean.

Table 6. Liver and abdominal fat weight as affected by the dietary treatment

Parameter	Diet					SEM	Sig
	S0	S1	S2	S3	S4		
Liver weight (gm)	46.66	44.18	46.81	51.49	50.40	2.96	NS
Abdominal fat weight (gm)	31.54	29.60	34.20	23.76	26.79	2.87	NS

± SEM: Standard error of the mean.

Table 7. Effect of dietary treatment on some blood biochemical factors

Parameter	Diet					SEM	Sig
	S0	S1	S2	S3	S4		
Glucose (mg/dl)	135.94^{b}	176.33^{a}	138.16^{b}	139.59^{b}	141.89^{b}	9.27	*
Cholesterol (mg/dl)	107.33	116.97	139.93	115.01	94.71	13.25	NS
Protein (mg/dl)	3.10^{ab}	3.66^{a}	2.95^{b}	2.31^{c}	3.42^{ab}	0.21	**
Ca (mg/dl)	14.96	16.37	16.47	13.91	14.90	0.86	NS
Phosphorus (mg/dl)	2.79	2.53	2.80	2.60	3.34	0.28	NS

a, b, c: values within a row with different superscripts differ significantly. ± SEM: Standard error of the mean.

DISCUSSIONS

The crude protein content of sorghum is higher than that of maize (Etuk et al., 2012). Moreover the nutrient composition of tested sorghum similar to maize for metabolizable energy value in a broiler chick assay (Kriegshauser et al., 2006). These results were remarkably similar to the results of the current study. Although all diets were approximately isocaloric, hence it was expected that feed intake of the chicks to be similar (Scott et al., 1982), chicks received diets containing sorghum more than 50% showed the highest feed intake. Similar result was reported by Alkhair (2000). The lowest feed consumption was obtained by chicks consumed diet contained maize more than 50%, this difference may be attributed to the level of oil in maize being used that may affect voluntary feed intake. The lower body weight gain for chicks received high levels of maize which observed by the current study was differed from that reported by Rekha-Dixit et al., (1997). This disagreement may be due to the level of maize being used in the diet and the type of the other ingredients that may have different associative effect in the alimentary canal. The inclusion of maize in broiler ration in this experiment had no effect on feed conversion ratio. Similar result was reported by Hulan and Proudfoot, (1982) and Tayler et al., (2003). In the present study the positive response in growth performance and dressing percentage coincided with feed intake of those birds fed maize up to 50% as a source of energy in the ration. Moreover, the greatest efficiency of protein utilization on control group and chicks received diet S1 may related to the presence of a good mixture of essential amino acids in the diet.

The carcass weights (hot and cold) recorded for all the treated groups were differed than the range suggested by Rekha Dixit et al. (1997), this variation may be due to the type and/or level of maize used in the diet or combination of them has different associative effect (Scott et al., 1982). Our results on carcass hot dressing percentage also differed from that reported by Mohamadain et al. (1986) and the reason for this difference is unexplainable. No effect was observed in the treatment concerning liver and abdominal fat weights, this result differed from that reported by Daghir et al. (2003) and this may be attributed to the inclusion of high oil maize being used in their study. There is no explanation for the highest serum glucose level that obtained by chicks received diet S1 than the other four diets which reported similar levels of serum glucose. On the other hand, the different response in serum total protein may be related to the presence of different amino acids required for protein synthesis in the body of the chick which is affected by the source of the amino acids in each ration components (Nesheim et al., 1979). There were no signs of rickets observed and all birds looked apparently healthy.

CONCLUSION

The cereal grain yellow maize can be used successfully in combination with sorghum grain in broiler ration up to 50% improved weight gain and feed efficiency. Inclusion of yellow maize in broiler ration had no adverse effect on serum cholesterol, calcium and inorganic phosphorus. From the standpoint of cost value view maize due to its lower price in some parts of the country (example North of the Sudan) and it contained about 12% crude protein can participates in minimizing production cost in broiler industry.

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