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Feed Intake, Growth Performance and Nutrient Digestibility of Broiler Chicks Fed Diets Containing Varying Levels of Sorghum Dried Brewers' Grains

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Abstract: Three hundred *Dako* broiler chicks of both sexes each having average initial weight of 86.4 g were randomly distributed into five treatments with two replicates each with 30 birds. Five iso-nitrogenous and iso-caloric starter and finisher diets were formulated and fed for a period of four weeks at starter and finisher phases. Sorghum Dried Brewer's Grain (SDBG) was used at the levels of 0% (control), 10%, 20%, 30% and 40% to replace maize grain and groundnut cake (GNC) in the diets at both starter and finisher phases. Feed intake, growth performance of the birds as well as the digestibility coefficients and the gross margins of the diets were measured. Digestibility values were not significantly affected up to a level of 20% SDBG in the diet. Also, cost of feed/kg declined with increasing levels of SDBG. Gross margin was highest at SDBG level of 20%. It was concluded that SDBG inclusion at a level of 20% in broiler diets will reduce the cost of feed and increase profit margin.

Key words: Feed intake, growth performance, nutrient digestibility, broiler diet

Introduction

Sorghum is the world's fifth most important cereal and is grown in semi-arid regions of Africa being well adapted to the harsh climate and naturally resistant to many pests (Belton *et al*., 2003). The usefulness of sorghum by-products has been reported world-wide (Mosimanyana and Kiflewahid, 1987; Mahabile *et al*., 1990; Dowling *et al*., 2003; Macedo and Aguilar, 2005; Nyannor *et al*., 2007). Some varieties of sorghum have phenols concentrated in the outer layers of the kernel which serves as natural source of antioxidants for foods (Awika *et al*., 2001). Taylor and da Silva (2004) reported sorghum bran could be a source of protein for industrial application. Apart from serving as a staple food in Nigeria, sorghum grain is used for the production of beer and local alcoholic drink called *burukutu*. Sorghum dried Brewers Grain (SDBG) is a by-product of beer and *burukutu* production. SDBG is readily available in many parts of Nigeria and has been subject of studies which seek to evaluate its potential as substitute to conventional sources of energy and protein. In this study, SDBG was used as partial replacement to maize, soya bean and groundnut cake in broiler starter and finisher diets.

Materials and Methods

The experiment was carried out in the Teaching Research Farm of the Federal University of Technology, Minna, Niger State, Nigeria. Three hundred (300) day old *Dako* broiler chicks were used for the study. The birds were weighed on arrival at the farm (initial weight) and thereafter weekly. Using Randomized Complete Block Design (RCBD), the birds were assigned to five treatments with two replicates of thirty birds each. Birds were housed in pens on deep litter and were brooded for the first four weeks using electric bulbs (200 watts each) as a source of heat. New Castle Disease vaccine (NDV) was administered intra-ocularly on the birds at the hatchery. At the age of two weeks, the birds were given NDV *Lasota* via drinking water.

Five iso-nitrogenous and iso-caloric diets containing 24% crude protein and 2800kcal/kg energy levels each were formulated at starter phase (Table 1). At finisher phase, the diets were also iso-nitrogenous and iso-caloric formulated to contain 22% crude protein and 3000kcal energy levels (Table 2). Approximately equal levels of crude protein and energy in the five diets were achieved by increasing the proportion of (SDBG) and decreasing the levels of maize grain and groundnut cake (GNC) in the diets. The inclusion rates of SDBG in the five diets were fixed at 0% (control), 10%, 20%, 30% and 40% and these were designated as T_1, T_2, T_3, T_4 and T_5 respectively in both starter and finisher stages. The test ingredient, Sorghum Dried Brewers Grain (SDBG) was obtained from *burukutu* (local beer) houses within Minna metropolis. They were sun-dried to attain about 5% moisture content before being stored in polythene sacs until needed for use.

A known quantity of feed was offered daily at 8.00 am and 4.00 pm local time. Daily feed intake was obtained by difference from the feed offered the previous day and the unconsumed feed collected the following morning.

Two digestibility trials were carried out during the experimental period; one in the fourth week (starter phase) and the other one in the eighth week (the finisher phase). Five birds were picked from each replicate (making a total of ten birds per treatment) and placed in metabolic cage. They were allowed to acclimatize for five days before embarking on collection of the faecal

Table 1: Per cent composition of various items in the ration for starter diet

	Treatments				
	1	2	3	4	5
Ingredients	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG
Maize	57.00	52.00	47.00	43.00	37.00
SDBG*	0.00	10.00	20.00	30.00	40.00
GNC**	31.00	26.00	21.00	15.00	10.00
Fish meal	6.00	6.00	6.00	6.00	6.00
Benni seed	2.00	2.00	2.00	2.00	3.00
Bone	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methestone	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin/Mineral	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

*Sorghum Dried Brewer's Grain, **Ground Nut Cake

Table 2: Per cent composition of various items in the ration for finisher diet

	Treatments				
	1	2	3	4	5
Ingredients	0% SDBG	10% SDBG	20%SDBG	30%SDBG	40%SDBG
Maize	59.00	55.00	47.00	44.00	38.00
SDBG*	0.00	10.00	20.00	30.00	40.00
GNC**	29.00	23.00	21.00	14.00	10.00
Fish Meal	4.00	4.00	4.00	4.00	4.00
Benni seed	4.00	4.00	4.00	4.00	4.00
Bone	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methestone	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin/Mineral	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

*Sorghum Dried Brewer's Grain, **Ground Nut Cake

Table 3: Proximate composition of Sorghum Brewer's Dried Grain (SDBG)

Items	Values
Moisture	6.50
Dry matter (DM)	93.50
Crude Protein (CP)	31.60
Crude Fibre (CF)	7.80
Ether Extract (EE)	13.73
Ash	16.00
Nitrogen Free Extract (NFE)	30.87
Metabolizable Energy Kcal/Kg	3067.00

materials which lasted for seven days. Samples were labeled and dried to constant weight and stored for proximate analysis.

The study lasted for eight weeks. Weekly weight gain and feed to gain ratio were calculated. Samples of SDBG, starter and finishers diets as well as the faecal materials were subjected to proximate analysis (AOAC, 2000). Data obtained were subjected to statistical analysis. One-way analysis of variance was used and Duncan multiple range test (Duncan, 1955) was used to separate the means where there were statistically difference ($p<0.05$).

Results

Table 1 and 2 showed the composition of starter and finisher diets for the five treatments. Table 3 shows proximate composition of SDBG. The values were 31.6% for crude protein, 7.8% for crude fibre, 13.73% for ether extract, 16.00% for ash, 30.87% for Nitrogen Free Extract and energy value of 3067 Kcal/kg. Tables 4 and 5 indicate the proximate composition of the starter and finisher diets respectively. For the starter diets Ash content increased from 6.86 to 14.83%; ether extract values declined from 17.80 to 14.93; crude fibre values increased from 5.53 to 11.19%; and NFE values declined from 45.76 to 34.56% for 0 and 40% diets respectively. For the finisher diets Ash content increased from 7.21 to 14.69%; ether extract values increased from

Table 4: Proximate composition of starter diets containing varying levels of Sorghum Brewer's Dried Grain (SDBG)

	Treatment				
	1	2	3	4	5
Item (%)	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG
Ash	6.86	9.45	10.34	13.48	14.83
Ether Extract	17.80	17.16	17.08	15.00	14.93
Crude Protein	24.05	24.46	24.87	24.93	24.49
Crude Fibre	5.53	6.78	6.96	7.46	11.19
Nitrogen Free Extract	45.76	42.15	40.75	39.13	34.56
Total	100.00	100.00	100.00	100.00	100.00
Metabolizable Energy	3063.78	3066.78	3069.78	3080.72	3107.50

Table 5: Proximate composition of finisher diets containing varying levels of Sorghum Brewer's Dried Grain (SDBG)

	Treatment				
	1	2	3	4	5
Items	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG
Ash	7.21	8.82	10.33	12.94	14.69
Ether Extract	5.05	5.08	6.53	7.14	8.75
Crude Protein	22.28	22.41	22.57	22.56	22.27
Crude Fibre	4.76	5.10	7.31	9.45	11.91
Nitrogen Free Extract	60.70	58.59	53.26	47.91	42.38
Total	100.00	100.00	100.00	100.00	100.00
Metabolizable Energy	3158.73	3181.60	3160.75	3179.66	3206.52

Table 6: Digestibility coefficients of starter diets containing varying levels of Sorghum Brewer's Dried Grain (SDBG)

	Treatment					
	1	2	3	4	5	
Parameter	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG	SEM
Dry Matter (DM)	82.93[a]	80.96[a]	78.75[a]	72.76[b]	65.15[c]	±4.45
Ash	60.39[a]	58.65[a]	56.43[a]	50.97[b]	48.05[c]	±3.09
Ether Extract (EE)	83.01[a]	81.25[a]	78.73[a]	70.68[b]	60.56[c]	±5.61
Crude Protein (CP)	84.98[a]	84.84[a]	82.71[a]	76.35[b]	68.93[c]	±4.01
Crude Fibre (CF)	74.28[a]	72.98[a]	70.17[a]	66.43[b]	60.68[c]	±3.40
Nitrogen Free Extract (NFE)	88.08[a]	86.93[a]	84.46[a]	80. 89[b]	72.16[c]	±3.98

Table 7: Digestibility coefficients of finisher diets containing varying levels of Sorghum Brewer's Dried Grain (SDBG)

	Treatment					
	1	2	3	4	5	
Parameter	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG	SEM
Dry Matter (DM)	84.73[a]	82.66[a]	80.94[a]	74.88[b]	67.41[c]	±4.33
Ash	67.61[a]	65.77[a]	64.75[a]	58.49[c]	57.86[c]	±2.44
Ether Extract (EE)	85.41[a]	82.97[a]	81.29[a]	74.62[b]	65.63[c]	±4.95
Crude Protein (CP)	86.36[a]	85.48[a]	83.14[a]	77.25[b]	70.27[c]	±3.27
Crude Fibre (CF)	76.68[a]	74.31[b]	72.64[a]	67.28[b]	62.40[c]	±3.57
Nitrogen Free Extract (NFE)	89.33[a]	87.55[a]	85.73[a]	81.21[b]	74.21[c]	±3.28

5.05 to 8.75; crude fibre values increased from 4.76 to 11.91% and NFE values declined from 60.70 to 42.38% for 0 and 40% diets respectively.

In both starter and finisher diets, it could be observed that increasing the level of SDBG in diet was followed by increase in Ash and Crude Fibre. However, the reverse was the case with Ether Extract and Nitrogen Extract which tended to decrease with increasing levels of SDBG. As for the energy values, these ranged between 3063.78 Kcal/kg for 0% SDBG and 3088.50 Kcal/kg for 40% SDBG in the starter diets. Energy values of the finisher diets were 3208.73 Kcal/kg and 3290.50 Kcal/kg for 0% SDBG and 40% SDBG diets respectively.

Digestibility coefficients for six items namely, DM, ash, EE, CP, CF and NFE are presented in Table 6 and 7 were similar in both starter and finisher diets although

Table 8: Growth performance, feed intake and cost analysis of diets containing varying levels of Sorghum Brewer's Dried Grain (SDBG) fed to broiler chicks

	Treatment					
	1	2	3	4	5	
Parameter	0% SDBG	10% SDBG	20% SDBG	30% SDBG	40% SDBG	SEM
Growth performance						
Initial weight/bird (g)	86.11^{a}	86.32^{a}	86.49^{a}	86.59^{b}	86.68^{c}	±0.14
Final weight/bird (g)	1750.55^{a}	1689.77^{a}	1649.54^{a}	1471.55^{b}	1308.71^{c}	±110.46
Total weight gain/bird (g)	1664.44^{a}	1603.45^{a}	1563.05^{a}	1384.96^{b}	1222.03^{c}	±104.46
Average daily weight gain day (g)	29.72^{a}	28.63^{a}	27.91^{a}	24.73^{b}	21.82^{c}	±1.98
Feed intake						
Total feed intake/bird (g)	3447.05^{a}	3543.54^{a}	3636.34^{a}	3781.26^{b}	3905.09^{c}	±139.51
Average daily feed intake/day (g)	61.55^{a}	63.28^{a}	64.93^{a}	67.52^{b}	69.73^{c}	±2.49
Feed to gain ratio	2.07^{a}	2.21^{a}	2.33^{a}	2.73^{b}	3.20^{c}	±0.30
Cost analysis						
[1]Feed cost/Kg (₦)[1]	58.99	50.71	42.61	38.01	32.06	
[2]Feed cost/25kg bag (₦)	1474.75	1267.75	1065.25	950.25	801.5	
Cost of total Feed consumed (₦)	203.34	179.69	154.94	143.73	125.20	
Value of weight gain at ₦350.00/Kg	582.55	561.21	547.07	484.74	427.71	
Gross margin	379.21	381.51	392.12	341.01	302.51	

[abcd]Means with different letters on the same row implies significant differences ($p<0.05$), [1]One USA dollar ($) is equivalent to N130.00 at the time of the experiment, [2]A 25 kg bag of commercial broiler feed costs ₦400.00-₦450.00

the values for finisher diets were slightly higher than those obtained for starter diets. The digestibility coefficients for all the components except ash were high and exceeded 60% in both starter and finisher diets. Steady decreases were observed in all the six parameters as the proportion of SDBG increased in the diets. The results indicate that the SDBG inclusion in the diets of broilers up to a level of 20% had no significant effect ($p>0.05$) on the digestibility of DM and the various components considered in the study. However, at 30 and 40% levels of inclusion the digestibility coefficients significantly declined ($p<0.05$).

Table 8 shows the results of the growth performance, feed intake and cost analysis of the birds feed diets containing different levels of SDBG. The initial live weights of the birds were comparable across the five treatments. Final live weight/bird ranged from 1750.55g to 1308.71 g for 0 and 40% SDBG diets. Both total weight gain and daily live weight gain/bird followed a similar trend. The values ranged from 1664.44 to 1222.03 g and from 29.72 to 21.82 g/day for 0 and 10% SDBG diets respectively. From the results, the growth performance of birds fed 0 to 20% SDBG diets did not differ significantly ($p>0.05$). However, at 30 and 40% rate of inclusion of SDBG in broiler diet, there was a significant reduction ($p<0.05$) in growth performance.

Total feed intake, daily feed intake and feed to gain ratio increased with increasing levels of SDBG in the diet. The results therefore showed that as the SDBG content of the diet increase, the amount of feed consumed by the birds also increased. Total feed intake increased from 3347.05 in 0% to 3905.09 in 40% SDBG diets. Similarly, Daily feed intake also increased from 59.77 to 69.73 g while feed to gain ratio increased from 2.01 to 3.2 in 0 and 40% diets respectively. Values for 0, 10 and 20% SDBG diets were not significantly different ($p>0.05$). At 30 and 40% rate of inclusion of SDBG in the diets, there were significant increases ($p<0.05$) in both feed intake and feed to gain ratio.

The cumulative growth and cumulative feed intake are graphically presented in Fig. 1 and 2. From the graphs, the highest growth performance was recorded in birds fed 0% SDBG diet, while the highest feed intake was recorded in birds offered 40% SDBG diet.

Increases of SDBG in the diet brought about decreases in the cost of feed/kg but a reduction in the gross margin. A 40% inclusion of SDBG in the diet reduced the cost of feed by as much as 45.65% compared to 0% SDBG diet. The highest gross margin was obtained on the 20% diet at which level there was a reduction of 27.77% in the cost of feed.

Discussion

The diets used in the study were formulated to provide 24% and 22% CP for the starter and finisher diets. The diets were also formulated to furnish the birds with 3000 and 3200 Kcal/kg at starter and finisher phases. The protein and energy levels of the five diets used in the study were within the recommended levels for broiler chicks. Babatunde and Fetuga (1976), Fetuga (1984) and Oluyemi and Robert (1988) put the protein requirement for broilers raised in the tropics at 23-24% for starter and 19-20% for finisher. Also, Pfizer (1996) put the protein requirement of starter and finisher broiler birds as 23% and 21% in the tropics. Metabolizable energy requirement of 2800-3000 Kcal/Kg has been recommended by Olomu (1976), Olomu and Offiong (1978) and Fetuga (1984) for optimal performance of

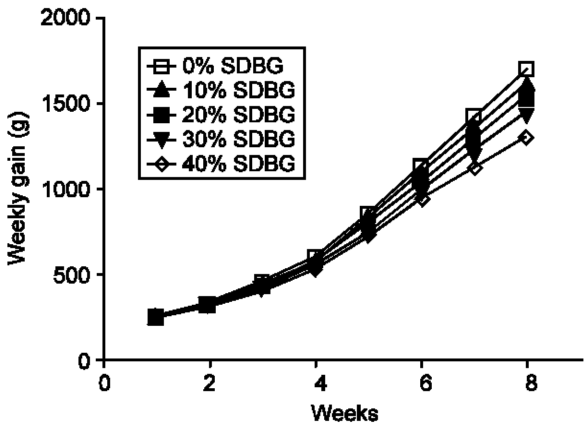

Fig. 1: Cumulative weekly feed intake of broilers fed graded levels of Sorghum dried brewer's grain

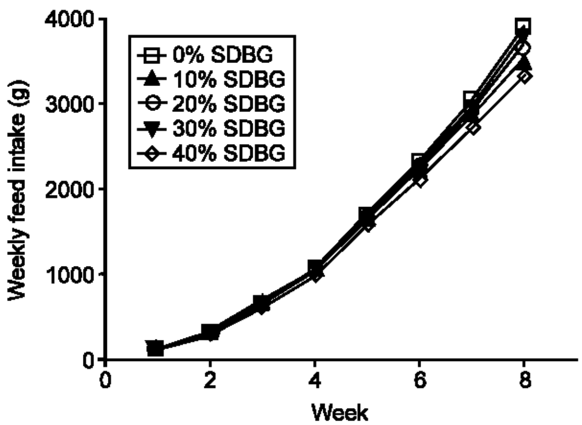

Fig. 2: Cumulative weekly weight of broilers fed graded levels of Sorghum dried brewer's grain

broilers in Nigeria. Pfizer (1996) however, recommended metabolizable energy level of 2900 Kcal/Kg for both starter and finisher rations under local conditions. Recommended energy values for birds raised in the temperate regions appear to be higher. Higher figure have been recommended for broiler chicks under temperate conditions. Thus National Research Council (1994) recommended metabolizable energy level of 3200 Kcal/Kg for both starter and finisher rations while the Agricultural Research Council (1984) gave energy requirement of all broiler diets as 2850 Kcal/Kg.

SDBG used in this study has relatively high energy and protein contents which were comparable to those obtained by Adama and Ribadu (2003) and Olorunnisomo *et al.* (2006). This relatively high protein and energy content of SDBG has been reported to be adequate for promoting good growth performance in ruminants, pigs, rabbit, broilers and layers. Olorunnisomo *et al.* (2006) reported impressive growth performance by goats fed SDBG. Macedo and Aguilar observed that Pelibuey lambs fed sorghum bran-based diets made impressive live weight gains. Dada *et al.* (1999) reported good growth performance when weaner pigs were fed SDBG. Durunna *et al.* (2000) found that the cost of feed/kg as well as feed cost/kg egg, progressively declined while savings in feed cost also increased with increasing levels of SDBG in the diet of layers. In an experiment conducted to evaluate the energy and protein of SDBG Balogun and Olupona (2004) found that SDBG can serve as the only sources of protein and energy in the diets of growing rabbits. Olupona *et al.* (1998) also showed that SDBG from local sources has impressive energy and protein values. Adewusi and Matthew (1994) pointed out the potential use of SDBG because of its high protein content. They however observed that lysine in SDBG was limiting having a low chemical score. Oduguwa *et al.* (2000) found that lysine supplementation of brewer's dried grain improved feed efficiency and daily gain in rats.

Increasing the level of SDBG from 0 to 40% in the ration brought about corresponding increases in crude fibre levels of the diets. SDGB inclusion beyond 20% in the diet brought about significant decline in digestibility coefficient of both DM and other nutrients. It has been reported by Adewusi and Matthew (1994) that as the dietary fiber content increased in the diets of rats, there was a corresponding decrease in true digestibility of diets. In addition, the relatively lower digestibility coefficient of the diets containing 30 and 40% SDBG may be attributable to tannin which is usually present in sorghum grain particularly the red variety which is commonly used in the production of the local beer. Sibbald (1977), Queiroz *et al.* (1978) and Gous *et al.* (1982) have pointed out the adverse effects of tannin on digestibility of sorghum grains. Tannins are reported to cause a binding and precipitation of dietary proteins and digestive enzymes (Butler *et al.*, 1984) and may reduce both the amino acid (Armstrong *et al.*, 1974) and the energy digestibility (Gous *et al.*, 1982) of the diet.

SDBG based diets were acceptable to broilers chicks even at high levels of inclusion SDBG. This can partly be explained because of the good aroma of the product. As a product of fermentation, SDBG has a good aroma and which improves feed intake as observed in this study. Cameron and Hafvander (1971) reported that fermentation improves the nutritive value and digestibility. Dirar (1993) reported fermentation led to increases in vitamin and essential amino acid content. Bouvey (1979) found that biological value and net protein utilization improved significantly with fermentation. Adewusi and Matthew (1994) found that feed intake and weight gain were highest in rats fed 26.3% SDBG. Olorunnisomo *et al.* (2006) reported that increasing the levels of SDBG in the diets of West African Dwarf goats stimulated higher intakes. They attributed this to the high protein content of SDBG.

Supplementation of broiler diets with high protein and energy product such as SDBG is a practical approach for reducing the high cost of feeding livestock and poultry in Nigeria. The cost of feed/bag was considerably reduced with the inclusion of SDBG in the diet. SDBG is widely available in Nigeria. The result of this study indicated that SDBG inclusion in the diet at the level of 20% has not affected growth performance rather it reduced the cost of feeding thereby increasing the profit margin. The results of this study showed that there is a tremendous potential in the utilization of agro-industrial by-products which will result in a significant increase in animal production. Scarr (1987) estimated that dried brewers grains alone could cater for an annual increase of over 8,000 tonnes of beef in Nigeria. This will help to reduce Nigeria's animal protein deficit.

Conclusion: SDBG is an abundant waste product of both local and industrial beer production in Nigeria. It can replace conventional grains in situation of acute shortage because of its high nutrient content which can meet the protein and energy requirements of broiler chicks. Inclusion of SDBG at 20% level gave maximum financial returns. Above 20% level of inclusion, feed growth performance and gross profit margin declined. Based on the results of this study, the use of SDBG in the diets of broilers chicks is recommended to broiler producers in order to maximize their profit.

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