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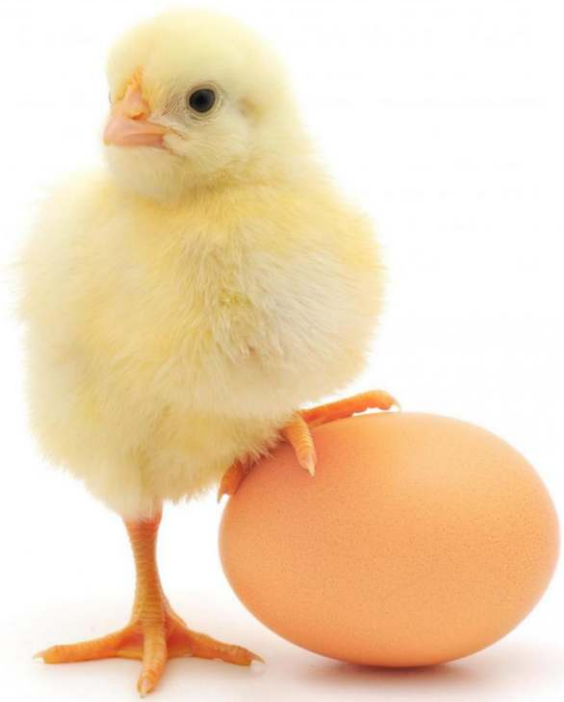

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Maize-Sorghum Based Brewery By-Product as an Energy Substitute in Broiler Starter: Effect on Performance, Carcass Characteristics, Organs and Muscle Growth

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Abstract: Maize-Sorghum brewers' dried grains (MSBDG) is a by-product of beer production. Proximate composition studies were conducted as a prelude to MSBDG incorporation in broiler starter diet. Four broiler starter diets were formulated such that MSBDG were fed at 0, 10, 20 and 30% inclusion levels at the expense of maize. A batch of 240 starter-chicks was randomly assigned in triplicate to these dietary treatments. Each diet was fed to 60 birds/treatment from day old for 35 days. The final weight, average weight and Nitrogen retention of the chicks fed MSBDG at 10% and 20% dietary levels were similar to those fed the control diet; both being significantly (P = 0.05) higher that those fed diet 4 (30% dietary inclusion). The weight gain, average feed consumption as well as feed efficiency declined in diet 4 (at 30% inclusion level). At the end of the feeding trial, the chicks were sacrificed for carcass characteristics, relative organ and muscle measurements. The relative weights of the heart and belly fat were significantly ($P \leq 0.05$) influenced by dietary treatments. Among the muscles weighed, only the relative weight of *Pectorialis thoracicus* was significantly ($P \leq 0.05$) influenced. The weight of *P. thoracicus* was highest in chicks fed diet 2 (10% MSBDG inclusion level). It was concluded that MSBDG can act as an energy substitute for maize at inclusion levels of about 20% in broiler starter diets without any adverse effect on performance, carcass characteristics and muscle development in broiler chicks.

Key words: Maize-sorghum brewers' dried grains, beer production, carcass characteristics

Introduction

The high level of competition between man and livestock for available feed ingredients has posed a great concern to nutritionists over the years particularly in developing countries. The fact that feed alone accounts for up to 70-80% of the recurrent production inputs in intensive monogastric animal production also makes the sourcing for alternative feed ingredients expedient (Ravindran and Blair, 1992; Fasuyi, 2005). The high cost of the conventional ingredients used in feed formulation contributes immensely to the high cost of the finished feed. This is a major obstacle to the expansion of the poultry industry in Nigeria and by extension most developing countries in the world (Ademosun, 1973; Obioha, 1976; Balogun, 1988; Tewe, 1988). Cereal grains always account for up to 50 percent and over in poultry feed formulation. In Nigeria, the most popularly incorporated cereal grain in feed formulation is maize where it supplies more than half of the metabolizable energy requirement of poultry. Although maize is a staple crop in Nigeria, it is also a seasonal crop where its growth is timed with the raining period of the year making year-round availability impossible. The high cost of maize as an energy source in feed formulation has generated a lot of controversy as to its economic justification. Beer production has been on the increase in Nigeria with the attendant shift in imported barley to local grains as the major raw material. Maize and sorghum thus became ready substitutes in the beer making industry. The use of maize and sorghum in beer making further exacerbated the scarcity of the cereal grains and thus its inclusion in feed formulation. Maize/sorghum-based brewers' dried grains (MSBDG) is the extracted residue of maize and sorghum malt resulting from the manufacture of beer and contains small amounts of spent hop. It is produced in large quantity from the breweries. The objective of this research is to ascertain the level at which MSBDG can supplement for energy in practical diets for broiler starter chicks.

Materials and Methods

Collection of MSBDG: Maize/sorghum brewers' dried grains (MSBDG) were obtained in the wet form from Nigeria Brewery Limited (NBL), Ife Road, Ibadan, South Western part of Nigeria. The MSBDG were obtained fresh after discharge and allowed to gradually dry in the sun for 3 days until the moisture content became 9.53% of dry matter. The MSBDG was then ground in a hammer mill. The MSBDG composition was 20% maize and 80% sorghum. Samples of the dried MSBDG were later analyzed for proximate chemical composition (AOAC, 1995).

Table 1: Proximate composition (g/100g) and amino acid content (%) of maize/sorghum brewer's dried grains (MSBDG) and maize used as control diet

Nutrients	MSBDG	Maize (Control)
Dry matter	90.8	87.0
Crude protein	28.7	11.4
Ether extracts	11.1	7.2
Crude Fibre	5.0	1.7
Ash	11.4	3.1
Nitrogen free extract	30.5	65.7
Amino acids		
Arginine	2.11	1.87
Histidine	0.57	0.63
Isoleucine	1.08	1.12
Leucine	1.87	1.48
Lysine	1.31	0.37
Methionine	0.42	0.35
Cystine	0.18	0.24
Methionione + Cystine	0.60	0.59
Phenylalanine	1.20	1.10
Threonine	0.86	0.94
Tyrosine	1.04	1.54
Valine	1.26	1.02
Glycine	0.34	0.71
Tryptophan	0.72	0.21

Experimental diets: Four iso-nitrogenous and iso-caloric diets were formulated using diet 1 as control in which maize was used at 55% of the diet and the major source of energy. MSBDG was graduated at 10, 20 and 30% inclusion levels in diets 2, 3 and 4 respectively. The four diets were analyzed for their amino acid contents and presented in Table 2.

Management of chicks and experimental layouts: Two hundred day-old broiler chicks (100 males + 100 females) were used for the experiment. They were electrically brooded at Gabof Model Farms, Km 14 Ilu-Abo, Owo Road, Ondo State, Nigeria. They were brooded on the floor for the first 4 days after which they were sexed (according to the method described by Laseinde and Oluyemi, 1997) and transferred into a metabolism cage and allowed to acclimatize for another 3 days before the commencement of the experiment. During the 7-day acclimatization period, the chicks were fed on a commercial broiler starter mash and water provided ad libitum. Completely randomized design (CRD) was adopted for the trial with a total of 50 birds per treatment. Each treatment was replicated five times giving 10 birds per replicate. At the start of the experiment, the chicks were weighed and 25 males and 25 females (total = 50) were assigned to each of the four dietary treatments. The chicks were thereafter fed with the experimental diets ad libitum for 28 days during which the daily feed consumption and group weight changes were measured. Faeces voided during the last five days were collected, weighed, dried at 55-60°C in an air-circulating oven for 72 hrs, and preserved while the corresponding feed consumed was recorded.

Carcass characteristics and organ measurement: After slaughtering and bleeding the chicks, the carcasses were scalded at 65°C in water both for 30 seconds before defeathering. The dressed chicks were later eviscerated. Ten eviscerated carcasses per treatment were used for the measurement of the carcass characteristics viz: dressed weight %, eviscerated weight %, thigh, drumstick, shank, chest, back, neck, wing, belly fat and head. Organs measured include the liver, kidneys, lungs, pancreas, heart, spleen, bursa of fibricus and gizzard. All the carcass characteristics and organ measurements were expressed in gkg^{-1} body weight except the dressed and eviscerated weights, which were expressed in percentages of the live weight.

Muscle measurement: The ten eviscerated carcasses per treatment were weighed and cooled under the fan for 3 mins before dissection. The dressed and eviscerated weights were taken before dissecting out the chest as well as the thigh muscles. The inner chest muscle (*Supra coracoideus*), outer chest muscle (*Pectoralis thoracicus*) and thigh muscle (*Gastrocnemius*) were carefully dissected out from their points of origin and insertion measurements of the fresh weights, length and breadth of these muscles were taken. The muscle weights were expressed in gkg^{-1} body weight, while the length and breadth were expressed in $cmkg^{-1}$ body weight.

Chemical and statistical analysis: The proximate composition of the ingredients, diets and faecal samples were determined by the method of AOAC (1995). Nitrogen retained was calculated as the algebraic difference between feed nitrogen and faecal nitrogen (on dry matter basis) for the period. The amino acid contents of the MSBDG and maize were analyzed using amino acid analyzer (AAA). Data collected on the performance indices, carcass characteristics, muscle and organ measurements were subjected to analysis of variance (Steel and Torrie, 1980). Where significant differences were found, the means were compared using the Duncan's Multiple Range Test (DMRT) (Duncan, 1955). Data on muscle growth were subjected to coefficient of variation analysis (Snedecor and Cochran, 1973).

Results

Performance of chicks and nitrogen utilization: Table 3 shows that average weight gain, feed consumption

Table 2: Ration formulation of the treatment diets (g/100g)

Ingredients	Diets			
	1	2	3	4
	% MSBDG inclusion in diets			
	0	10	20	30
Maize	55.0	45.0	35.0	25.0
MSBDG	0.0	10.0	20.0	30.0
Soyabean meal SBM	30.0	30.0	30.0	30.0
Palm Kernel Cake PKC	10.0	10.0	10.0	10.0
Blood meal	2.0	2.0	2.0	2.0
Bone meal	2.5	2.5	2.5	2.5
Salt	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25
TOTAL	100.0	100.0	100.0	100.0

*Contained vitamins A (10,000,000iu); D(2,000,000 iu); E (35000 iu); K (1900mg); B_{12} (19mg); Riboflavin (7,000mg); Pyridoxine (3800mg); Thiamine (2,200mg); D Pantothenic acid (11,000mg); Nicotinic acid (45,000mg); Folic acid (1400mg); Biotin (113mg); and Trace elements as Cu (8000mg); Mn (64,000mg); Zn (40,000mg); Fe (32,000mg) Se (160mg); I_2 (800mg) and other items as Co (400mg); Choline (475,000mg); Methionine (50,000mg); BHT (5,000mg) and Spiramycin (5,000mg) per 2.5kg.

Table 3: Chemical composition (% DM) of the treatment diets

Ingredients	Diets			
	1	2	3	4
Crude protein	23.0	23.0	23.0	23.0
ME (MJ/kg)	13.0	13.0	13.0	13.0
Ether extract	3.34	3.12	2.89	2.34
Crude fibre	4.01	4.43	5.76	5.52
Calcium	0.87	0.88	0.89	0.92
Phosphorus	0.39	0.47	0.49	0.51

and feed efficiency were significantly affected by the dietary treatments. The feed intake of birds on MSBDG at 10 and 20% dietary levels were significantly ($P < 0.05$) higher than the groups on 0% and 30% MSBDG. This same pattern was observed for average weight gain (g/chick/day) where the values for the birds on diets 2 (10% MSBDG inclusion) and 3 (20% MSBDG inclusion) were significantly higher than values obtained for diets 1 (0% MSBDG inclusion) and 4 (30% MSBDG inclusion). This also reflected in their feed efficiency values where diets 1 and 3 had better feed efficiency values ($P > 0.05$) that were significantly lower than for diets 2 and 3. However, the nitrogen retention (g/chick/day) values indicated that birds on diets 1, 2 and 3 had similar values ($P > 0.05$) but vary significantly from the nitrogen retention value of birds on diet 4 ($P < 0.05$). The carcass traits of birds on all diets (1, 2, 3 and 4) did not show any significant variation in their dressed weight (%), eviscerated weight (%), thigh (gkg^{-1} body weight), drumstick (gkg^{-1} body weight), shank (gkg^{-1} body weight), wing (gkg^{-1} body weight), chest (gkg^{-1} body weight), back (gkg^{-1} body weight) and head (gkg^{-1} body weight). However, there were significant differences ($P = 0.05$) in the values obtained for belly fat (gkg^{-1} body weight) and neck (gkg^{-1} body weight) with similar values for birds on diets 1 and 4 on one hand and diets 2 and 3 on the other hand. Birds on diets 2 and 3 had more belly fat and bigger necks than birds on diets 1 and 4 ($P = 0.05$). The relative organ weight (gkg^{-1} body weight) showed no significant difference in values obtained for lungs, liver, spleen, pancreas, gizzard, kidney and bursa of fabricius in all experimental birds on the different diets. However, there were significant differences ($P = 0.05$) in values obtained for heart in birds on diets 1 and 4 on one hand and diets 2 and 3 on the other hands with birds on diets 2 and 3 showing superior values. The effect of varying levels of dietary MSBDG on relative weight (gkg^{-1} body weight), length and breadth ($cmkg^{-1}$ body weight) of some muscles *Supra coracoideus*, *Pectoralis thoracicus* and *Gastrocnemius* did not show any significant variation ($P > 0.05$).

Discussion

The feed intake of birds on MSBDG at 10 and 20% dietary levels were significantly higher than the groups on 0% and 30% MSBDG and this adequately translated into increased body weight in the groups of birds on diets containing MSBDG at 10 and 20% dietary inclusion levels. The feed intake, weight gain and feed efficiency values for birds on diets 2 and 3 (10 and 20% MSBDG inclusion respectively) were all in agreement with recommended standard values in tropical warm wet climates (Oluyemi, 1983; Aduku, 1993). The significant drop in feed intake in the group of birds on diet 4 (30% MSBDG inclusion) may be due to its energy-protein imbalance and its attendance high fibre level. High dietary fibre has been identified as one of the factors militating against nitrogen utilization by chicks (Nwokolo *et al.*, 1985). The gross energy level of maize is notably higher than MSBDG and this partially explains why

Table 4: Performance and Nitrogen utilization of broiler - starter feed experimental diets

Diet	Initial weight (g)	Final weight (g)	Average weight gain (g)/chick/day	Average feed consumption (g)/chick/day	Feed efficiency	N-retention (g/chick/day)
1	35.5±4.0	592.5±14.6[a]	15.1±0.7[a]	38.9±4.7[a]	2.6±0.1[b]	0.8±0.3[a]
2	35.5±4.2	620.2±15.2[b]	15.8±1.6[b]	43.7±1.7[b]	2.8±0.3[a]	0.7±0.4[a]
3	35.5±0.2	635.5±33.4[b]	16.2±1.6[b]	46.8±5.3[b]	2.9±0.2[a]	0.8±0.1[a]
4	35.5±3.4	589.1±5.8[a]	15.0±1.2[a]	38.1±1.4[a]	2.5±0.1[b]	0.6±0.3[b]

Means with differing superscripts in the same column are significantly different (P = 0.05)

Table 5: Carcass traits of broiler-chicks fed experimental diets from age 7-28 days

Traits	Diets			
	1	2	3	4
Dressed weight %	89.6±1.6	90.1±0.4	91.1±1.3	87.1±5.3
Eviscerated weight %	83.8±18.0	83.3±0.7	82.6±5.1	79.1±4.6
Thigh (gkg^{-1} body weight)	49.3±3.3	49.1±5.4	44.8±7.9	44.9±16.0
Drumstick (gkg^{-1} body weight)	102.7±10.2	94.7±3.7	96.8±7.9	97.6±9.0
Shank (gkg^{-1} body weight)	31.3±5.1	40.2±0.5	38.5±9.0	40.2±1.8
Wing (gkg^{-1} body weight)	36.8±2.1	38.5±9.5	39.1±0.7	37.2±1.2
Chest (gkg^{-1} body weight)	137.3±18.7	138.4±15.0	141.1±12.3	140.0±9.1
Back (gkg^{-1} body weight)	66.8±4.2	67.8±10.2	71.2±22.4	65.1±0.6
Head (gkg^{-1} body weight)	46.2±2.2	46.6±1.6	48.7±8.6	45.4±4.8
Belly fat (gkg^{-1} body weight)	2.34±1.2[a]	7.2±1.4[b]	7.1±1.6[b]	2.1±2.0[a]
Neck (gkg^{-1} body weight)	36.3±6.3[a]	53.4±6.0[b]	51.7±10.9[b]	38.2±7.0[a]*

Mean are for 50 chicks/diet (mean ± SD). *Means with differing superscripts in the same column are significantly different (P = 0.05).

Table 6: Relative organ weight (gkg^{-1} body weight) of broiler chicks fed experimental diets from age 7-28 days

Organs	Diets			
	1	2	3	4
Heart	5.1±0.9[a]	7.1±1.2[b]	6.3±0.8[b]	5.6±1.2[a]
Lung	6.3±0.2	7.1±1.6	7.2±1.2	6.5±1.5
Liver	20.6±3.0	20.3±4.6	21.1±2.2	21.9±1.4
Spleen	1.9±0.1	1.8±0.1	1.9±0.2	2.1±0.7
Pancreas	2.9±0.2	3.2±1.1	4.1±6.1	4.0±1.9
Gizzard	35.7±0.7	36.8±1.7	38.5±7.0	36.2±1.0
Kidney	8.3±0.5	8.1±1.4	9.1±2.0	10.4±3.7
Bursa	3.7±0.1	3.2±1.1	3.4±0.5	3.8±1.2*

Means are for 50 chicks/diet (mean±SD)
*Means with differing superscripts in the same column are significantly different (P = 0.05)

Table 7: Effect of varying levels of dietary MSBDG on relative weight (gkg^{-1} body weight) length and breadth ($cmkg^{-1}$ body weight) of some muscles in broiler-starter

Diets	Weight		
	Supra coracoideus	Pectoralis thoracicus	Gastrocnemius
1	8.2±2.3	31.7±6.4	35.7±4.6
2	9.1±0.9	27.4±1.0	34.8±5.2
3	9.5±1.2	29.2±2.0	33.4±7.1
4	8.4±1.8	25.4±2.0	32.1±6.8
Mean	8.8	28.4	34.0
SD	0.6	2.7	1.6

MSBDG may not serve as a total substitute for maize as an energy source in practical livestock diets. However, efforts may be geared towards the inclusion of concentrated energy sources (palm oil and groundnut oil) to augment the shortfall in metabolizable energy in diets where maize has been completely removed if this would be found economical. The increased body weight of the groups of birds on MSBDG at 10 and 20% agreed with the reports of Ademosun (1973) that the crude protein content and amino acid profile of MSBDG may have an added nutritional advantage when MSBDG is incorporated in poultry diets. MSBDG may also serve as an alternative source of protein in poultry diets. The carcass traits showed no significant differences except in belly fat and neck (gkg^{-1} body weight) in all the experimental diets. The adipose depositions in diets 2 and 3 (10% and 20% MSBDG inclusion) were highest indicating that the high intake of these diets had a direct influence on their adipose deposition. Since birds primarily eat to satisfy their energy requirement, excess energy consumption would most likely be stored as fat in birds on diets 2 and 3.

The relative organ weight (gkg^{-1} body weight) indices also showed no significant differences except for the heart which had significantly high values in birds on diets 2 and 3 (10 and 20% MSBDG inclusion). The relative weight (gkg^{-1} body weight), length and breadth ($cmkg^{-1}$ body weight) of some muscles like *Supra coracoideus*, *Pectoralis thoracicus* and *gastrocnemius* were all relatively similar with no significant difference indicating that the various inclusion levels of MSBDG at 10, 20 and 30% did not affect muscle development.

Conclusion: The result obtained from the laboratory analytical studies of MSBDG and experimental trials with different diets containing varying levels of MSBDG on broiler starter birds clearly indicated the nutritional potential of MSBDG as a part replacement of maize as an energy source in poultry diet. The replacement of maize or any other conventional concentrated energy sources (wheat, sorghum, barley, rye etc) by MSBDG may not be total as MSBDG may not satisfy the energy-protein ratio requirement in practical poultry diets. However, inclusion level not exceeding 20% is recommended in broiler starter rations for optimum growth performance, muscle development and carcass characteristics.

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