Growth Performance and Economics of Production of Broiler Chickens Fed Three Partially Sprouted Sorghum Varieties as a Replacement for Maize

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Abstract
An experiment was conducted to evaluate the effect of replacing maize with three partially sprouted local sorghum (PSLS) varieties which include red sorghum (Jardawa), yellow sorghum and white sorghum (farfara) as energy sources on growth performance and economics of production of broiler chickens. One hundred and twenty broiler chicks were randomly allotted to the four dietary treatments, each containing thirty chicks, replicated three times (ten chicks per replicate) in a completely randomized design (CRD). Results showed that there were significance difference in daily feed intake, daily weight gain and feed conversion ratio between the treatments in the starter, finisher as well as the overall phases (P<0.05). The feed cost was lower in white sorghum (₦ 66.83) while the feed cost naira per kg gain was lowest in broiler chickens fed red sorghum (₦170.81). It can be concluded that sprouted red sorghum varieties can replace maize in the diet of broilers without adverse effect on growth performance with concomitant reduction in price.

Keywords: *maize, sorghum, varieties, sprouting, broiler chickens*

Introduction

Poultry birds especially broilers play a significant role in the provision of animal protein required by man to meet his daily protein intake (Maidala and Istifanus, 2012). They have high growth rate, high feed conversion ratio, short generation interval (5-6 months), short intestinal feed transit of 2-3 hours and traits that respond to feeding and nutritional manipulations within few days (Atteh, 2003). The energy level of the feed is the major factor influencing feed intake as birds will under normal circumstances eat to satisfy their energy needs (Akinola and Sese, 2011). In poultry nutrition energy is used for the provision of body heat, maintenance, growth and production (Inaku *et al.*2011). The other dietary nutrients usually vary in relation to dietary energy content of the diet if they are not to become deficient with low feed intake or consumed more with low energy diet. Maize is the major source of energy in poultry feeds and constitutes 50-70% of broilers ration (Ojowola and Olugbemi, 2011). It constitutes 40-60% of the feed of monogastric animals (Ayenor 1985; Ogbanna, 1991). Maize also serves as staple food for good proportion of Nigerians. The ever growing demand for maize for human consumption, livestock feeds and some industrial uses has pushed its market price to an alarming height (Odukwe, 1994). This is because maize is high in energy and forms the standard (100) against which other cereals grains is compared (Atteh, 2002). Maize has a fat content of about 4% and this fat is high linoleic acid (about 50%) making it excellent source of this essential fatty acid. The increasing competition between man and animals for available grains (Tegbe, *et al*., 1984; Egbunike and Achibang, 2002), the inadequate production of farm crop to meet the needs of man and his livestock (Babatunde *et al*., 1990) and ever increasing cost of maize had made it necessary to critically re-evaluate some other grain like sorghum for alternative energy source in poultry production. *Sorghum bicolor* (L) Moench is widely grown in the semi-arid and arid savannah regions of Nigeria. Maunder (2002) reported that sorghum is a traditional crop of much of Africa and Asia and an introduced and hybridized crop in the western hemisphere. It benefits from an ability to tolerate drought, soil toxicities and temperature extremes effectively than other cereals. In terms of the nutritive value, cost and availability, sorghum grain is the next alternative to maize in poultry feed (Subramanian and Metta, 2000). Sorghum grains contain antinutritional factor that affect feed intake and utilization (Medugu *et al*., 2010). Germination is one of the methods used in elimination of various anti-nutritional factors present in foods (Maidala, 2015). It is a natural process in which dormant but viable seeds are induced to start growing into seedlings. This is the process by which amylase degrade starches into dextrin and maltose. Germination of seed is a simple process that does not require sunlight or soil and requires only short sprouting time. However, its yield is high. It is characterized by a changing array of enzymatic activities. Some of these activities increase dramatically from an initially low or even undetected state to a moderate level. Later these activities then decline to an activity lower than initially present. Another group of enzyme activities are found in dry seed at an intermediate level which remain constant throughout germination (Enwere, 1998). The enzymes convert the stored foods such as insoluble carbohydrates and proteins to soluble components (Enwere, 1998). Nout and Ngoddy (1997) reported that germination of seeds triggers the enzyme systems that cause breakdown of complex macromolecules of proteins, carbohydrates and lipids into simpler forms that are much easily assimilated. Proteins are broken down to peptides and amino acids by protease activity. Nitrogen is transferred to developing axis, carbohydrate to simpler sugars by amylase, phytic acid to inositol and phosphoric acid by phytase and breakdown of tannin-protein enzyme- mineral complexes. Sprouting seeds of most cereals and legumes have shown improvements in nutrients in human diet and compare well with their fresh counterparts if not better (Nout and Ngoddy, 1997; Maidala, 2015). From the foregoing, it is imperative that effort should be made to explore comparative and cheaper alternative to this scarce feed resource. This study aimed at feeding (PSLS) varieties grown in Bauchi state on growth performance and economics of production of broiler chickens.

Materials and methods

Experimental site

Katagum local government is situated on the northern part of Bauchi state, Nigeria. It is located between latitudes 11^0 42' and 11^0 40^0 and longitude 10^0 31' and 10^0 11' east (Anon, 2009). It shares common boundary with Itas/Gadau local government in north west, Jama'are to the west, Dambam to the east, Misau to the south west, Giade to the south and Shira to the southwest (Azare, 2013). It has a landmass of 1,120 square kilometers (NPC, 2009). The climate of the study area is controlled by the inter tropical convergent zone (ITCZ) which is marked by the rainy and dry season. The major climate elements that influence the climate of the study area and affecting the farming system are temperature and precipitation (rainfall), the annual temperature ranged between 22-33^0 C from April to May (Bashir *et al*., 2001). The mean annual rainfall ranged between 615.6-985mm with peak between July- Augusts. The study area is in the Sudan savanna, the vegetation is greatly determined by the nature of the soil. The soil in the study area is aerosol with sandy and loamy sand texture and a high percolation rate

Sources and processing of Ingredients

The three sorghum varieties are purchased in Azare central market. The collected seeds were cleaned by winnowing and hand picking of stones and debris. The sorghum varieties were sprouted on jute bags for three days, they are washed and suns dried for four days and milled and are used to formulate the experimental diets. The diets were isonitrogenous and isocaloric and meet the nutritional requirements of broilers in the tropics. The percentage composition of the experimental diets is shown in Table 1 and 2, for broiler starter and finisher respectively.

Management Practices:

One hundred and twenty (120) Anak 2000 day old broiler chicks were used for this study. Before the arrival of the chicks, the pens were cleaned washed and disinfected. Three days to the arrival of the chicks and fresh dry wood shavings were placed on the flour to serve as litter. Two days before the chicks arrived, the brooding pen was arranged. Heat and lightening were provided using 200 watts electric bulb but in the case of electric failure, a lantern and kerosene stove were used to supply the required heat. After brooding, the chicks were individually weighted and randomly assigned to 4 experimental diets at 2 weeks of age (14 days), the experimental diets include; treatment 1 (control) maize based diet, treatment 2 sprouted red sorghum (Jardawa), treatment 3 sprouted yellow sorghum (kaura), treatment 4 sprouted white sorghum (fara-fara) each treatment was replicated three times consisting of ten birds per replication in a completely randomized design (CRD). The birds were given feed and water *adlibitum*. Newcastle disease and infectious bursa disease (Gumboro) vaccines were administered as when due.

Data collection

The initial weight and final weight were taken at the beginning and end of the experiment. Data on feed intake and weight gain were recorded and feed conversion ratio and feed efficiency were computed. The economics of production was done at time of the experiment based on prevailing market conditions.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) balanced technique (Steel and Torrie, 1980) while different treatment means were separated for significance using Duncan's multiple range test. Duncan's (1955).

Results and discussion

The percentage composition of the experimental is shown in Table 1 and 2, for broiler starter and finisher respectively. The crude protein and metabolisable energy are adequate for broiler production in the tropics (Oluyemi and Robert, 2000; Aduku, 2004). The growth performance of broiler chickens fed the three sorghum varieties as replacement of maize were shown in Table 3, Table 4 and Table 5, respectively. Broiler chickens on sorghum based diet significantly consumed more feed in the starter phase, finisher phase and overall phase than the control diet

(P<0.05). Broiler chickens consumed more feed to balance their energy requirements (Olomu, 1995; Akinola and Sese, 2011). The daily weight gain are affected by the different energy sources in the starter phase, finisher phase and overall phases (P<0.05), birds on the control diets and red sorghum gained similar body weight (P>0.05), birds fed yellow sorghum and white sorghum significantly gained less weight, this is in lined with the earlier reports of Yakubu *et al*. (2007) who reported significant difference in broiler chickens fed partially sprouted masakwa sorghum in place of maize diet (P<0.05). On the other hand Medugu *et al*. (2010) and Ibitoye *et al*. (2012) reported similar body weight gain in broiler chickens fed unprocessed sorghum varieties (P>0.05). The variation between the results can be attributed to sprouting of sorghum which is known to destroy most of the antinutritional factors and increase bioavailability of nutrients to broiler chickens (Maidala, 2015). Feed conversion ratio is significantly affected by the three energy sources at starter phase, finisher and overall phases (P<0.05). Broilers on control diet and red sorghum have similar feed conversion ratio (P>0.05). Birds on yellow sprouted sorghum and white sorghum varieties have reduced feed conversion ratio (P<0.05). Bashar *et al*. (2012) and Medugu *et al*. (2010) reported similar weight gain in maize, unprocessed sorghum and millet (P>0.05), the variation with this result can be attributed to the sprouting of the sorghum varieties and cultivars of the sorghum used, accompanied by the geographical location of the experiment. The feed conversion ratio reported in this work is lower than (1.96-2.10) reported by Oladipo *et al*. (2015) on broiler chickens fed kaura sorghum supplemented with enzymes. The economics of production of broiler chickens fed sorghum as replacement for maize is presented in Table 6. The cost per kg feed was higher in maize based diet (₦ 75.21) than the cost of different sprouted sorghum varieties (₦ 66.83- ₦ 68.21), this is because the cost of maize is higher in the market compared to sorghum. FAO, 1996 and ICRISAT, 1996 reported that the cost of maize in international market is 5% higher compared to sorghum. The total feed cost per kg gain is highest in yellow sorghum (₦ 209.72) and this can be attributed to poor weight gain of broiler chickens fed yellow sorghum. The lowest feed per kg gain is observed in red sorghum (₦ 170.81) which can be attributed to higher deposition of tissues in broiler chickens fed red sorghum (1.04kg) which is slightly lower than the feed cost per kg gain in the control diet (₦ 189.61). The sprouted red sorghum diet is the least cost ration. It can be concluded that sprouted red sorghum variety can replace maize among the three sorghum varieties without adverse effect on growth performance with concomitant reduction in price.

Table 1: Percentage composition of experimental diets fed to starter diets (1-4 weeks of age)

Ingredients	1 Maize	2 Red sorghum	3 Yellow sorghum	4 White sorghum
Maize	39.17	00.00	00.00	00.00
Sorghum	00.00	42.18	42.18	42.18
Soya bean	42.18	38.92	38.92	38.92
Fish meal	5.0	5.0	5.0	5.0
Wheat offal	10.00	10.0	10.0	10.0
Bone meal	3.0	3.0	3.0	3.0
Lysine	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20

Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated analysis				
Crude protein %	23.96	23.03	23.03	23.03
Crude fibre %	4.27	4.04	4.04	4.04
MEkcal/kg	3057	3827	3827	3827

*Each kilogram contains; vit. A, 10,000,000 IU, vit. D_3 2,000,000 IU, Vit. E 23,000mg, Vit. K_3 2.000mg, Vit, B_1 1,800mg, Panthothenic Acid 7,500mg, Vit. B_6 3,000mg, Vit. B_{12} 15mg, Folic acid 750mg, Biotin 11260mg, Choline Chloride 300,000mg, Cobalt 200mg, Copper 3,000mg, Iodine 1,000mg, iron 20,000mg, Manganese 40,000mg, Selenium 200mg, Zinc 30,000mg, Antioxidant 1,250mg

Table 2: Percentage composition of experimental diets fed to finisher diets (5-8 weeks of age)

Ingredient	1 Control	2 Red sorghum	3 Yellow sorghum	4 White sorghum
Maize	28.04	00.00	00.00	00.00
Sorghum	00.00	34.90	34.90	34.90
Soya bean	48.64	40.98	40.98	40.98
Fish meal	5.00	5.00	5.00	5.00
Wheat offal	15.00	15.00	15.00	15.00
Bone meal	3.00	3.00	3.00	3.00
Lysine	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Crude protein %	20.21	20.27	20.27	20.27

Crude fibre %	5.21	5.72	5.72	5.72
ME/kal/kg	2897	2843	2843	2843

*Each kilogram contains Vit A 3600, 000iu. Vit. D_3 600.000 IU. Vit E 4.000.000mg. Vit B_1-B_6 640, 1600, 600, 4.00mg. Panthothenic acid 2000mg, Biotin 300mg. Manganese 16000mg. Manganese 16000mg. Selenium 80mg. Vit. K_3 600mg. Cobalt 80mg. Copper 1200mg. Zinc 12,000mg. Folic acid 200mg. Choline chloride 700000mg. Antioxidant 500mg.

Table 3: Performance characteristics of broilers fed three sprouted sorghum at the starter phase (1-4 weeks of age)

Parameters	1 Maize based	2 Red sorghum	3 Yellow sorghum	4 White sorghum	SEM
Daily feed intake (g)	43.67 ^{b}	51.84 ^{a}	48.40 ^{a}	57.32^{a}	*10.65
Daily weight gain (g)	17.23 ^{a}	16.84 ^{a}	9.57 ^{c}	15.50 ^{b}	7.55*
Feed conversion ratio	2.54 ^{a}	3.15 ^{a}	4.08 ^{c}	3.70 ^{b}	*1.16
Feed efficiency	0.40 ^{a}	0.39 ^{a}	0.23 ^{c}	0.27 ^{b}	*0.13
Mortality (%)	2.97	2.90	2.92	3.34	-

SEM: Standard error of means, abc: means bearing different superscripts within the same row are statistically different (P<0.05)

Table 4: Performance characteristics of broilers fed three sprouted sorghum at the finisher phase (5-8 weeks of age)

Parameters	1 Maize based	2 Red sorghum	3 Yellow sorghum	4 White sorghum	SEM
Daily feed intake (g)	97.64 ^{a}	104.23 ^{a}	98.87 ^{b}	114.64^{a}	13.68*
Daily weight gain (g)	38.46 ^{a}	34.67 ^{a}	21.62 ^{b}	31.63 ^{b}	8.27*
Feed conversion ratio	3.28 ^{a}	3.82 ^{a}	4.57 ^{b}	4.26 ^{b}	*1.57
Feed efficiency	0.52 ^{a}	0.48 ^{a}	0.42 ^{b}	0.39 ^{b}	*0.13
Mortality (%)	2.00	2.11	2.90	1.67	-

SEM: Standard error of means, abc: means bearing different superscripts within the same row are statistically different (P<0.05)

Table 5: Pooled Performance characteristics of broilers fed three sprouted varieties sorghum (1-8 weeks)

Parameters	1 Maize based	2 Red sorghum	3 Yellow sorghum	4 White sorghum	SEM
Daily feed intake (g)	70.68 ^{b}	78.13 ^{a}	97.85 ^{a}	85.98 ^{a}	*10.21
Daily weight gain (g)	27.85 ^{a}	25.76 ^{a}	16.00 ^{b}	23.58 ^{b}	*8.67
Feed conversion ratio	2.94 ^{a}	3.50 ^{a}	4.32 ^{b}	4.08 ^{b}	*0.85
Feed efficiency	0.48 ^{a}	0.44 ^{a}	0.35 ^{c}	0.34 ^{b}	*0.35

Mortality (%)	2.48	2.51	2.91	2.54	-

SEM: Standard error of means, abc: means bearing different superscripts within the same row are statistically different (P<0.05)

Table 6: Economics of production of broiler chickens fed three sorghum varieties as energy sources

Parameters	1 maize based	2 red sorghum	3 yellow sorghum	4 white sorghum
Initial weight (g)	620	622	618	621
Final weight (kg)	1660.00	1660.21	1350.92	1400.98
Cost per kg feed (₦/kg)*	75.21	68.21	67.15	66.83
Total feed cost (₦)	197.19	177.64	209.72	191.53
Total weight gain (kg)	1.04	1.04	0.73	0.78
Cost per kg gain (₦/kg gain)	189.61	170.81	287.29	245.56

*= Prevailing market price at the time of the experiment

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