IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 11, Issue 10 Ver. I (October 2018), PP 87-92
www.iosrjournals.org

Growth Performance and Economics of Production of broiler chickens fed Agro Industrial by-products

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Abstract: *An experiment was conducted to evaluate the growth performance and economics of broiler chickens fed diets containing different agro industrial by-products. Five diets containing wheat offal, millet offal, sorghum offal, rice offal and maize offal were formulated and coded diet 1, 2, 3, 4 and 5 respectively. 500 day old Anak 2000 broiler chicks were randomly allotted to five dietary treatments in a completely randomized design and each treatment was replicated five times. Feed and water were provided ad libitum and the feeding trial lasted for eight weeks. At the starter phase, daily feed intake (62.46-67.17 g; P<0.001), daily weight gain (22.16-25.23 g; P<0.05) and feed conversion ratio (2.49-3.02; P<0.001) were affected by dietary treatment. At the finisher phase daily weight gain (141.21-145.26 g) was significantly (P<0.05) influenced while daily weight gain and feed conversion did not differ significantly. The best feed cost in naira per kilogram body gain was obtained on diet 5 (Maize offal) with a value of ₦175.22 kg^{-1}. It can be concluded that that maize offal, sorghum offal, rice offal and millet offal are suitable substitutes for wheat offal in the diet of broiler chickens without compromising performance attributes. However, maize offal is more economical as fibre source.*
Keywords: *Performance, broiler chickens, fibre and economics of production*

Date of Submission: 16-10-2018 Date of acceptance: 31-10-2018

I. Introduction

Broiler is a domesticated feathered bird reared mainly for meat production. It reaches market weight about 1.5-3.0kg at 6 – 10 weeks of age depending on feed quality, health and other management practices (Omole, *et al.,* 2006). The meat is tender, juicy, tasty, and generally appealing and generally accepted when processed. In poultry farming, feed accounts for 65- 80% of the production cost and the poultry industry has suffered more than any other livestock industry as a result of problem arising from inadequate supply of feed (Lepaideur, 2004). Poultry production relies mainly on maize as the main energy source but it suffer intense competition as food for humans resulting in higher demand than supply, higher cost and thus lower profit margin for poultry producers (Olaiya *et al*., 2015). This trend has necessitated the use of agro industrial byproducts such as wheat offal, millet offal, sorghum offal, rice offal and maize offal.

II. Materials And Methods

Experimental Site

This experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Aminu Saleh College of Education, Azare Bauchi State, Nigeria. Azare is in Katagum local government area of Bauchi state. Katagum 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 the North west, Jamma're to the west, Danbam to the east, Misau to the South west, Giade to the southwest (Azare, 2013). It has a land mass 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 rainfall, the annual rainfall ranged between 22-33^0 C from April to May (Bashir *et al*., 2001).The study area is in the Sudan Savannah and the soil in the study area is aerosol with sandy and loamy sand texture and a high percolation rate.

Sources of Experimental Materials

The Agro industrial by-products used for the study were wheat offal, millet offal, sorghum offal, rice offal and maize offal which were purchased within Azare market in Katagum Local Government Area of Bauchi state

Experimental Birds and their management

Five hundred day old Amor breed of broiler chicks were obtained from Amor Limited Ibadan, the chicks were brooded for the period of one week on deep litter. They were fed *ad libitum* on commercial diet throughout the brooding period. Water and feed were supplied *ad libitum* during the whole period of the trial. Routine management, vaccines and medications were administered according to the methods of (Oluyemi and Roberts, 2007). After brooding period of about one week the birds were randomly allotted to five dietary treatments with 100 birds per treatment and each treatment was replicated five times with 20 birds per replicate, in a completely randomized design (CRD). The birds were fed experimental diets for four weeks during the starter phase and four weeks during the finisher phase.

Experimental diets

Five diets containing different agro industrial by-products with wheat offal as a control were formulated; other diets consist of millet offal, sorghum offal, rice offal and maize offal. The diets were designated as diets 1,2,3,4 and 5, respectively. The diets were formulated to supply approximately 3000Kcal/kg ME, 23 and 20% crude protein for both starter and finisher phases respectively, methionine and lysine were used as supplement in the diet. The ingredients and calculated analysis of the experimental diet for both starter and finisher phases are shown in Tables 1 and 2, respectively.

Table 1: Proximate Composition of different agro industrial by products

Nutrients	T1(WO)	T2 (MILO)	T3 (SO)	T4 (RO)	T5 (MO)
Moisture	5.60	7.25	8.05	3.60	5.90
Crude Protein	11.78	12.44	6.70	4.25	8.76
Crude fibre	20.83	5.80	10.20	27.01	17.18
Lipids	4.85	11.35	3.00	7.15	10.05
Ash	5.20	4.10	3.25	16.85	3.20
NFE	51.74	59.06	68.80	41.14	54.91
Calcium	0.39	0.30	0.25	0.38	0.38
Phosphorus	0.05	0.02	0.02	0.04	0/03

NFE- Nitrogen free extract

Table 2: Ingredients Composition and Calculated Analysis of Broiler Starter Experimental Diets

	Diets				
Ingredients	**T1 (WO)**	**T2(MIO)**	**T3(SO)**	**T4(RO)**	**T5(MO)**
Maize	43.60	43.27	42.06	39.65	42.03
Soybean	33.85	34.18	35.39	37.79	35.42
Fibre Type	12	12	12	12	12
Fishmeal	5.0	5.0	5.0	5.0	5.0
Limestone	1.5	1.5	1.5	1.5	1.5
Bonemeal	2.00	2.00	2.00	2.00	2.00
Common Salt	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	1.25	1.25	1.25	1.20	1.20
Methionine	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100
Calculated analysis					
Crude protein	23.00	23.00	23.00	23.00	23.00
ME(Kcal/kg)	2907	3057	3151	2909	3021
Crude fibre	4.60	3.7	2.10	3.40	3.10
Ether Extracts	8.80	8.60	8.80	9.50	8.60
Calcium	1.55	1.50	1.54	1.56	1.54
Phosphorus	0.91	0.81	0.80	0.83	0.80
Lysine	1.23	1.20	1.21	1.24	1.21
Methionine	0.40	0.41	0.41	0.42	0.43

*Vitamin-Mineral premix (Bio-mix) provided per Kg the following: Vitamin A 12,000,000iu, Vitamin D_3 ,3,000,000iu; Vitamin E,30,000mg; Vitamin K_3,2,500mg; Vitamin B_1,2,000mg; Vitamin B_2, 5,000mg; Vitamin B_6, 3,500mg; Vitamin B_{12}, 20mg; Folic acid 1,000mg; Niacin, 40,000mg; Calpan,10,000mg; Biotin,80mg; Antioxidant, 125,000mg; Cobalt, 250mg; Selenum, 250mg; Iodine,1,200mg; Iron,40,000mg; Manganese, 70,000mg; Copper, 8,000mg; Zinc, 60,000mg; Choline chloride, 200,000mg

Table 3: Ingredients Composition and Calculated Analysis of Broiler Finisher Experimental Diets

Ingredients	Diets				
	T1 (WO)	**T2(MO)**	**T3(RO)**	**T4(SO)**	**T5(MIO)**
Maize	37.80	47.47	45.80	42.47	45.80
Soybean	36.80	27.13	28.80	32.13	28.80
Fibre Type	17	17	17	17	17
Fishmeal	3	3	3	3	3
Limestone	1.5	1.5	1.5	1.5	1.5
Bonemeal	2	2	2	2	2
Salt	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	1.10	1.10	1.10	1.10	1.10
Methionine	0.30	0.30	0.30	0.30	0.30
Total	100	100	100	100	100
Calculated analysis					
Crude protein	20	20.00	20.00	20.00	20.00
ME(Kcal/kg)	2810	3036	3170	2828	2986
Crude fibre	4.70	3.70	3.10	3.40	4.50
Ether Extracts	9.20	7.60	7.70	8.60	750
Calcium	1.50	1.47	1.47	1.49	1.47
Phosphorus	0.93	0.75	0.64	0.68	0.74
Lysine	1.02	0.95	0.95	1.03	0.98
Methionine	0.36	0.34	0.35	0.33	0.35

*Vitamin-Mineral premix (Bio-mix) provided per Kg the following: Vitamin A 12,000,000iu, Vitamin D_3 ,3,000,000iu; Vitamin E,30,000mg; Vitamin K_3,2,500mg; Vitamin B_1,2,000mg; Vitamin B_2, 5,000mg; Vitamin B_6, 3,500mg; Vitamin B_{12}, 20mg; Folic acid 1,000mg; Niacin, 40,000mg; Calpan,10,000mg; Biotin,80mg; Antioxidant, 125,000mg; Cobalt, 250mg; Selenum, 250mg; Iodine,1,200mg; Iron, 40,000mg; Manganese, 70,000mg; Copper, 8,000mg; Zinc, 60,000mg; Choline chloride, 200,000mg.

Performance data

The amount of feed given and left over was recorded on daily basis and it was used to calculate the feed intake. At the commencement of the experiment, the initial weight of the birds was taken and the birds were weighed weekly thereafter to obtain weekly weight gain. Feed intake and weight recorded were used to calculate feed conversion ratio (FCR) using the formula below:

$$Feed\ conversion\ ratio = \frac{Feed\ intake}{\text{weight gain}}$$

Chemical analysis

Proximate composition of experimental diets was analysed using the methods described by AOAC (2000).

Statistical analysis

Data collected were subjected to analysis of variance using SAS software (SAS 2008) while significant means were separated with Duncan multiple range test at 5% level of significance.

III. Results

The result of the proximate analysis is shown in Table 1. The result showed that rice offal and wheat offal are high in fibre (27.01 and 20.83%) this makes them a potential source of fibre for broiler chickens. Table 4 shows the result of the broiler chickens fed diet containing different agro industrial by-products. There were significant ($P<0.001$) and ($P<0.05$) difference in the daily feed intake, daily weight gain and feed conversion ratio at the starter phase. The highest feed intake (67.17g) was recorded on diet 5 while diets 1 and 2 were similar. The highest weight gain of 25.23 kg was recorded among the birds fed diet 1 (control diet), while the lowest weight gain of 22.16 kg was obtained among the birds fed diet 3 (rice offal). However, chicks fed diets 2 and 5 have similar weight gains.

There was significant ($P<0.001$) difference in the feed conversion ratio of the chicks fed different agro industrial by-products at the end of the starter phase. The highest feed conversion ratio of 3.02 was recorded among the birds fed diet 4 (rice offal). However, birds fed diet 3 and 5 has similar values, while the lowest feed conversion was recorded in birds fed diet 1 (control). The mortality observed at the starter phase ranged from 1-4 (number) on diets 2 and 4, respectively. The daily feed intake at the finisher phase, showed that there was significant ($P<0.05$) difference among the treatment groups. Highest feed consumption 145.26 g was observed in birds fed diet 4 (rice offal), while birds fed diets, 3 recorded lowest values. Similarly, no significant difference was observed for daily weight gain and feed conversion ratio of the birds at the end of the finisher phase (Table 4). The mortality recorded in this phase of the experiment was low. The daily feed intake (Table 4) observed at the overall phase varied from (102.86 – 106.01 g) on diets 4 and 5, respectively. There was significant ($P<0.01$) difference for birds fed experimental diet at the overall phase. However, the daily weight

gain ranged from 37.30 – 40.97 g. There was no significant difference observed across the dietary treatments in the overall performance. Similarly, no significance difference was observed for feed conversion ratio in the overall performance. The mortality observed at the overall performance ranged from 1-4 (Number) across dietary treatments.

Table 4: Productive performance of Broiler chickens Fed Different Agro industrial by-products Diets

	Diets					
Parameters	**TI (WO)**	**T2 (MIO)**	**T3 (SO)**	**T4 (RO)**	**T5 (MO)**	**SEM**
Starter phase (0-4 weeks						
Daily feed intake (g)	62.87^{c}	62.46^{c}	64.99^{b}	66.76^{ab}	67.17^{a}	3.48^{***}
Daily weight gain (g)	25.23^{a}	24.34^{b}	23.62^{c}	22.16^{d}	24.54^{b}	1.09^{*}
Feed conversion ratio	2.49^{c}	2.58^{c}	2.76^{b}	3.02^{a}	2.74^{b}	0.40^{***}
Mortality (No)	0.00	1.00	1.00	1.00	1.00	-
Finisher phase (5-8 weeks)						
Daily feed intake (g)	144.61^{b}	143.24^{c}	141.21^{d}	145.26^{a}	143.63^{c}	1.59^{*}
Daily weight gain (g)	52.08	54.64	50.98	55.49	57.39	3.26^{NS}
Feed conversion ratio	2.81	2.66	2.79	2.62	2.51	0.16^{NS}
Mortality (No)	0.00	1.00	2.00	2.00	0.00	-
Overall (1-8 weeks)						
Daily feed intake (g)	103.74^{b}	102.86^{c}	103.10^{b}	106.01^{a}	105.40^{ab}	1.75^{**}
Daily weight gain (g)	38.64	39.49	37.30	38.83	40.97	1.66
Feed conversion ratio	2.65	2.62	2.78	2.82	2.63	0.40
Mortality (No)	0.00	2.00	2.00	3.00	0.00	-

a,b,c = means with different superscripts on the same raw are significantly different.
*= significant (P>0.05, ***p<0.001),NS = Not significant, SEM = Standard error of Means.
WO = Wheat offal, MO = Maize offal, RO = Rice offal, SO = Sorghum offal, MIO = Millet offal.

Table 5: Economic Analysis of Broiler Chickens Fed Fibre Sources Dietary treatments

Parameter	**T1 (WO)**	**T2 (MIO)**	**T3 (SO)**	**T4 (RO)**	**T5 (MO)**
Total feed intake (kg/bird	5.88	6.22	6.02	6.20	6.22
Feed cost (₦/kg)	71.26	66.69	65.26	63.26	64.51
Cost of total feed intake (₦)	419.01	414.81	392.87	392.21	401.25
Total weight gain (kg)	2.16	2.21	2.09	2.17	2.29
Feed cost/kg gain (₦)	193.98	187.69	187.97	180.74	175.22

WO = Wheat offal, MO = Maize offal, RO = Rice offal, SO = Sorghum offal, MIO = Millet offal.

The results of the economic analysis showed that the total feed intake was higher in diet 2 and 5 (6.22 and 6.22 kg) respectively, and the lowest was recorded on diet1 (control). Lowest feed cost was found on diet 4 (₦ 63.26) while diet 1 (control), recorded the highest feed cost (₦ 71.26). Highest total weight gain was observed on diet 5 (2.29 kg) while diet 3 (2.09 kg) recorded the lowest. Highest value of feed cost per kg gain was observed in diet 1 (₦ 193.98 kg) while the lowest was diet 5 (₦ 175.22 kg).

IV. Discussion

The results from Table 4 indicated that, there were significant differences (P<0.001) in the Daily Feed Intake, (P<0.05) Daily Weight Gain, Feed Conversion Ratio among the treatment means. Implying that there have been a wide variations in responses of Chickens to the use of Agro industrial by-products in poultry diets. The results agreed with (Vantsawa, 2007; Makinde and Inuwa, 2015) in their separate studies using locally processed maize offal (Dusa), rice offal, maize offal and wheat offal as AIBs in the diet of broiler chickens. The values of Daily Feed Intake during the starter phase are higher than (44.50 - 45.00g) reported by (Oladunjoye and Ojebiyi, 2010) who fed broiler chickens with rice bran with or without Roxazyme G2G as a fibre source. Similarly, the results obtained in this study is in line with the observations made by Fadugba (1989), reported that, the diets with 34.3, 68.8 and 100% replacement of maize by industrial maize offal gave significantly (P<0.05) heavier birds than those that were fed on the control diet. The author explained that by increasing the percentage of the industrial maize offal in the rations, the fibre contents of the rations were increased and consequently their energy densities lowered which was compensated for by increased feed intake and hence

higher weights. The values obtained in this study are still higher at finisher phases. In combined phases feed intake was also significantly influenced by dietary treatments, with T4 (RO) having high feed intake. These values (102.86 – 106.01g) are similar to (99.43 – 111.57g) reported by (Makinde and Sonaiya, 2011). The daily weight gain was significantly influenced by the dietary treatment during the starter phase. The values of Daily Weight Gain obtained in this study are in disagreement with the earlier reports of Makinde and Sonaiya, (2011) when broiler chickens fed Sun-dried maize offal with blood meal (30.36 – 34.82g). No significant difference was observed in Daily Weight Gain at the end of finisher phase. In the overall phase (1 – 8 weeks) the result showed no significant difference across dietary treatment for weight gain, this result vary with the report of (Iyayi *et al*.,2005) who observed a significant difference in weight gain of broiler chickens fed various diets containing corn bran, palm kernel meal and BDG as a source of fibre. The result for feed conversion ratio in starter phase showed a significant difference ($P<0.001$) across the dietary treatments. This value (2.49 – 3.02) vary with the report of (Maidala and Bello, 2016; Shaheem, *et al*., 2015) when broiler chickens were fed various levels of Cowpea shells and processed rice bran as fibre sources respectively. No significant difference observed in feed conversion at both finisher and overall phases. These value contradicts the earlier report of (Abdel-Hafeez *et al*., 2016) when broiler chickens were fed potato peels and sugar beet pulp with and without enzyme supplementation as Agro industrial by-products.

The highest feed cost (₦71.26) was observed in diet 1 control (wheat offal based diet) while the lowest value (₦ 63.26) was recorded in diet 4 (rice offal based diet), this could be attributed to difference in prices of these Agro industrial by-products as of the time of experiment. The cost of total feed intake was also higher (₦ 419.01) in diet 1 control (wheat offal based diet) while the lowest value (₦ 392.87 and ₦392.21) were recorded in diet 3 (SO) and diet 4 (RO) based diets respectively. These values are at variance with the report of Isikwenu *et al*., (2008) when broiler chicks fed groundnut cake with urea fermented brewer's dried grain. This could be attributed to low feed consumption of the diets due to presence of anti-nutritional factors tannin which affect palatability of the diet. Higher feed cost ₦ per kg gain (193.98 ₦ kg^{-1}) was observed in diet 1 (WO) based diet compared to diet 5 (MO) based diet which recorded the lowest value (175.22 ₦ kg^{-1}). These values were higher than those (82.62-113.02₦ kg and 157.18-179.75₦ kg) reported by (Grace *et al*.,2007; Ezieshi and Olomu, 2011) on broiler chickens fed diets containing maize replaced with wheat offal and varying levels of palm kernel cake with maize offal respectively. However, the total feed cost ₦/kg (63.26 – 71.26₦) obtained in this study were at variance to (628.04 -771.24₦) those reported by (Odeh *et al.*, 2016; Nnenna, *et al*., 2006) when broiler chickens fed graded levels of rice milling waste and maize offal based diets supplemented with Roxazyme G Enzyme. They concluded that, maize offal can replaced maize in the diet at 20% level of inclusion without any deleterious effects on the performance of the birds and enzyme supplementation of the diets reduced the cost of production.

V. Conclusion

Based on the results of the performance and economic analysis in this study, it can be concluded that maize offal, sorghum offal, rice offal and millet offal are suitable substitutes for wheat offal in the diet of broiler chickens without compromising performance attributes. However, maize offal is more economical as fibre source.

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Ajighjigh, D. T, " Growth Performance and Economics of Production of broiler chickens fed Agro Industrial by-products." IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 11.10 (2018): 87-92.