Growth performance of broiler chickens fed diets containing graded levels of cereal processing offal as a replacement for maize

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Abstract

The effects of feeding diets containing graded levels of cereal processing offal as a replacement for maize on growth performance of broiler chickens was evaluated in this study. One hundred and ninety-five (195) day old broiler chicks were divided into five (5) groups of forty (39) birds. Each group was further divided into three replicates of thirteen (13) birds in a Completely Randomized Design. Five experimental diets were formulated such that offal obtained from processing of cereal grains replaced maize at 0 (control), 15, 30, 45 and 60 % in the diets given to the five groups of birds. The birds were brooded for 2 weeks using commercial broiler starter feeds after which they were allotted the various dietary treatment groups and fed the experimental diets for 6 weeks. For the overall pooled performance, results show that Average Daily Feed intake (159.96, 159.60, 158.97, 157.55, 161.23 g), Average Daily weight gains (65.94, 63.92, 64.33, 63.53, 63.24 g), Feed Conversion Ratio (2.27, 2.34, 2.32, 2.48, 2.39) and Feed Cost/Kg Gain (₦ 264.40, 266.44, 257.72, 269.92, 252.02) did not differ (P>0.05) between dietary treatment groups. However, feed cost per unit weight gain, though not significant between treatments was reducing with increasing levels of replacement of maize with cereal processing offal. Therefore, cereal processing offal can replace maize by up to 60 % in broiler diets without negative effect on growth performance.

Key words: Broilers, cereal processing offal, growth performance, replacement

Performances de croissance des poulets à griller nourris avec des régimes contenant des niveaux gradués d'abats de transformation de céréales en remplacement du maïs_

Résumé

Les effets des régimes alimentaires contenant des niveaux gradués d'abats de transformation des céréales en remplacement du maïs sur les performances de croissance des poulets à griller ont été évalués dans cette étude. Cent quatre-vingt-quinze (195) poussins de chair âgés d'un jour ont été divisés en cinq (5) groupes de quarante (39) oiseaux. Chaque groupe a ensuite été divisé en trois répétitions de treize (13) oiseaux dans un plan entièrement randomisé. Cinq régimes expérimentaux ont été formulés de manière à ce que les abats issus de la transformation des grains de céréales remplacent le maïs à 0 (témoin), 15, 30, 45 et 60 % dans les régimes donnés aux cinq groupes d'oiseaux. Les oiseaux ont été couvés pendant 2 semaines en utilisant des aliments de démarrage pour poulets de chair commerciaux, après quoi ils ont été répartis dans les différents groupes de traitement diététique et nourris avec les régimes expérimentaux pendant 6 semaines. Pour la performance globale regroupée, les résultats montrent que l'apport alimentaire quotidien moyen (159,96, 159,60, 158,97, 157,55, 161,23 g), les gains de poids quotidiens moyens (65,94, 63,92, 64,33, 63,53, 63,24 g), le taux de conversion alimentaire (2,27, 2,34 , 2,32, 2,48, 2,39) et le coût des aliments/gain de kg (₦ 264,40, 266,44, 257,72, 269,92, 252,02) ne différaient pas (P> 0,05) entre les groupes de traitement diététique. Cependant, le coût de l'alimentation par unité de gain de poids, bien que non significatif entre les traitements, diminuait avec l'augmentation des niveaux de remplacement du maïs par les abats de transformation des céréales. Par conséquent, les abats de transformation des céréales peuvent remplacer le maïs jusqu'à 60 % dans l'alimentation des poulets de chair sans effet négatif sur les performances de croissance.

Mots-clés : Poulets de chair, abats de transformation des céréales, performances de croissance, remplacements

Introduction

Cereal grains have for long been used as conventional energy sources in poultry diets and maize especially, serves as the basis against which other energy grains are compared (Atteh, 2002; Jacob, 2015). The escalating cost of maize is a result of increased competition for its usage by man (as food and for many other industrial purposes) and livestock species (Egbunike and Achiobong, 2002) and its inadequate production to meet the need of man and his livestock (Babatunde*et al*, 1990; USDA, 2022)) has led to a lot of pressure being placed on it.

Feed accounts for 70 to 80 % of the total cost of poultry production in Nigeria and other developing countries (Olasuyi*et al*., 2019). The replacement of expensive conventional feed ingredients such as maize, with cheaper and available substitutes (Durunna, *et al*., 1999; Kwari*et al*, 1999; Okah, 2004; Dafwang, 2006; Fanimo*et al*, 2007; Nsa*et al*, 2007; Olubunmi and Ahmed, 2018) in feed formulation is an appropriate strategy for reducing the total feed cost of poultry production in Nigeria since maize and other energy sources contribute the highest percentage of feed ingredients in poultry feeds (Aduku, 2004; Ezieshi*et al*., 2011). Cereal processing offal, an agro-industrial by-product is an important energy and fibre source which at present has few alternative uses, cheap with a stable price that can be incorporated in poultry diets. Cereal processing offal have been investigated to be useful for livestock feeding; Brewers dried grain (BDG), wheat offal, maize offal, rice bran and broken rice have been widely tested and incorporated into livestock diets (Farinu, 2004; Ajayi*et al*, 2005; Aderemi*et al*, 2006; Afolabi*et al*., 2006). These ingredients have been incorporated in the diets of monogastric animals without any detrimental effects on the performance and health of the animals. This study was therefore, conducted to evaluate the effects of replacing yellow maize with cereal processing offal on growth performance of broiler chickens

Materials and methods

Experimental site

The research was conducted in the poultry unit of the College Farm, Livestock Investigation Department, Federal College of Animal Health, and Production Technology, NVRI, Vom located about 15 km from Bukuru in Jos South Local Government Area of Plateau State. Its coordinates are 9°43'60" N and 8°46'60" E in DMS (Degrees, Minutes, Seconds) with an elevation of about 1285 metres above sea level (getamap.net 2018). Mean relative humidity ranges from 14 – 72 %, ambient temperatures fluctuate between 16 – 28 ^{o}C but gradually rises to 38^{o}C in April just before the beginning of the rains, annual rainfall of between 1,300 - 1,500 mm lasting from April to October (Knudsen and Sohail, 1970; NVRI, 2006)

Source of cereal processing offal

Cereal processing offal were obtained from local cereal processing mills in Bukuru and environs in Jos South Local Government Area of Plateau State. The cereal processing offal comprised of the cortex (seed coat) a small portion of the endosperm and the germ of maize, guinea corn and millet which did not undergo any further form of processing before inclusion in the experimental diets.

Experimental birds, diets and design

Two hundred day- old Arbor Acres breed of broiler chickens were brooded for two weeks and then allotted to 5 dietary treatments of 40 birds. Each treatment was further divided into 3 replicates of 13 birds, in a completely randomized design. Experimental diets are shown in Tables 1 and 2. The diets were formulated to contain 0 (control), 15, 30, 45 and 60 % of the cereal processing offal as a replacement for maize. Other ingredients in the diets were obtained from commercial feed mills and agro-millers within the same area.

The poultry house was washed and disinfected and left to dry after which wood shavings was spread on the floor as litter material. The birds were reared in experimental pens measuring 2.5 (l) x 1.5(w) x 1.0 (h) metres. The birds were vaccinated against infectious bursal disease (gumboro) on their 11th and 28th day and against New castle disease (NCDV lasota) on the 18th day of age.

Table 1: Percentage ingredient composition of broiler starter diets containing graded levels of cereal processing offal as a replacement for maize

Ingredients	Levels of replacement of Maize with Cereal Processing Offal (%)				
	0	15	30	45	60
Yellow maize	44.56	39.35	34.14	28.92	23.70
Wheat offal	6.68	5.90	5.12	4.34	3.55
Rice bran	4.46	3.94	3.41	2.89	2.37
Cereal Processing Offal	0.00	6.68	13.36	20.05	26.73
Soya bean cake	39.00	38.83	38.66	38.50	38.34
Fish meal (54 % CP)	2.00	2.00	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00	1.00
Common salt	0.25	0.25	0.25	0.25	0.25
Premix[R]	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition					
M E (kcal/kg) **	2,700.51	2,762.28	2,766.11	2,770.85	2,774.35
Crude Protein	23.01	23.00	23.00	23.00	23.01
Crude fibre	4.01	4.22	4.42	4.63	4.83
Crude fat	3.32	3.32	3.31	3.31	3.30
Calcium	1.16	1.16	1.15	1.15	1.14
Phosphorus	0.75	0.75*	0.72*	0.69*	0.66*
Lysine	1.65	1.62*	1.59*	1.56*	1.53*
Methionine	0.37	0.36*	0.35*	0.34*	0.33*

** ME (Pauzenga, 1985) = 37 x %CP + 81 x %EE+ 35.5 x %NFE.

* = All values for Calcium, Phosphorus, Lysine and Methionine are calculated without their contents in the Cereal Processing Offal

[R] Mineral/Vitamin premix Bio-organics supplied/kg. Vit A = 4,000,000.00 IU; Vit D_3 = 8000.00mg; Vit E = 9,200.00mg; Niacin = 11,000.00mg; Vit B_1 = 720.00mg; Vit B_6 = 1200.00mg; Vit B_{12} = 6.00mg; Vit K_3 = 800.00mg; Pantothenic acid = 3,000.00mg; Biotin = 24.00; Folic acid = 300.00mg; Choline Chloride = 120,00.00mg; Cobalt = 80.00mg; Copper = 1,200.00mg; Iodine = 400.00mg; Iron = 8,000.00mg; Manganese = 16,000.00; Selenium = 80.00mg and Zinc = 12,000.00mg; anti-oxidant = 250mg.

***Daily feeding and weight gains data collections*:**

Average daily feed intake value for a bird in each treatment was obtained by subtracting the weight of left over from the feed given to the birds the previous day, and then divided by the number of birds in each replicate. Average initial weights for all treatments and replicates were obtained by dividing the total weighs by the total number of birds for each treatment and replicate at the beginning of the experiment. The average daily weight gains were obtained by subtracting the average initial weights from the average final weights and dividing the value by the number of days.

Statistical analysis

Data obtained were subjected to Analysis of Variance using SPSS version 23 (2017) and where applicable significant differences between means were separated using Duncan's Post Hoc Tests option in the same package.

Table 2: Percentage ingredient composition of broiler finisher diets containing graded levels of cereal processing offal as a replacement for maize

Ingredients	Levels of replacement of Maize with Cereal Processing Offal (%)				
	0	15	30	45	60
Yellow maize	48.57	42.86	37.19	31.50	25.82
Wheat offal	7.29	6.43	5.58	4.73	3.87
Rice bran	4.86	4.29	3.72	3.15	2.58
Cereal Processing Offal	0.00	7.29	14.57	21.86	29.14
Soya bean cake	34.99	34.83	34.64	34.46	34.29
Fish meal (54 % CP)	1.00	1.00	1.00	1.00	1.00
Bone meal	1.50	1.50	1.50	1.50	1.50

Limestone	1.00	1.00	1.00	1.00	1.00
Common salt	0.25	0.25	0.25	0.25	0.25
Premix[R]	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition					
M E (kcal/kg) **	2,774.40	2,778.51	2,783.08	2,787.52	2,792.10
Crude Protein	21.00	21.00	21.00	21.00	21.00
Crude fibre	4.05	4.27	4.49	4.72	4.94
Crude fat	3.49	3.48	3.48	3.47	3.47
Calcium	1.04	1.03	1.03	1.02	1.02
Phosphorus	0.76	0.73*	0.73*	0.72*	0.71*
Lysine	1.49	1.47*	1.45*	1.40*	1.37*
Methionine	0.35	0.33*	0.32*	0.31*	0.29*

[R]Vitamin and mineral premix by Bio-organics supplied/kg. Vit A = 3,400,000.00 IU; Vit D_3 = 6000.00mg; Vit E = 4,000.00mg; Niacin = 8,000.00mg; Vit B_1 = 640.00mg; Vit B_2 = 1600.00mg; Vit B_6=600; Vit B_{12} = 4mg; Vit K_3 = 600.00mg; Pantothenic acid = 2,000.00mg; Biotin H-2 = 300.00; Folic acid = 200.00mg; Choline Chloride = 70,000.00mg; Cobalt = 80.00mg; Copper = 1,200.00mg; Iodine = 400.00mg; Iron = 8,000.00mg; Manganese = 16,000.00; Selenium = 80.00mg and Zinc = 12,000.00mg; anti-oxidant= 500mg.

** ME (Pauzenga, 1985) = 37 x %CP + 81 x %EE+ 35.5 x %NFE.

* = all values for Calcium, Phosphorus, Lysine and Methionine are calculated without their contents in the Cereal Processing Offal

Results and discussion

Table 3: Proximate composition Cereal Processing Offal (%)

	Moisture	Crude protein	Crude fat	Ash	Crude Fibre	Nitrogen Free Extracts	Ca	P
CPO	8.67	10.35	4.28	3.81	8.72	66.17	0.23	0.13

Table 4: Proximate compositions of broiler starter diets containing graded levels of cereal processing offal

	Levels of replacement of maize with cereal processing offal (%)				
Nutrients	0	15	30	45	60
Moisture	6.88	7.49	6.33	7.51	7.11
Crude protein	23.01	22.99	23.01	22.98	23.03
Crude Fat	5.42	5.26	5.60	5.52	5.54
Ash	7.61	7.41	7.24	6.69	6.03
Crude fibre	5.37	5.81	6.09	5.93	5.52
Calcium	0.95	1.03	1.13	1.08	1.22
Phosphorus	0.69	0.59	0.69	0.71	0.67
NFE	55.95	56.13	52.28	55.06	57.84

CPO = Cereal Processing Offal NFE = Nitrogen Free Extracts

Table 5: Proximate compositions of broiler finisher diets containing graded levels of cereal processing offal

	Levels of replacement of maize with cereal processing offal's (%)				
Parameters	0	15	30	45	60
Moisture	8.65	8.45	9.16	8.71	9.71
Crude protein	20.62	20.22	20.58	20.73	20.47
Crude Fat	5.65	5.84	5.36	5.24	5.75
Ash	4.97	7.62	8.87	9.43	8.32
Crude fibre	5.64	5.61	5.82	6.64	6.69
Calcium	1.02	1.00	0.98	0.98	1.05
Phosphorus	0.53	0.49	0.48	0.48	0.45

NFE	66.26	62.96	62.37	60.55	60.54

NFE – Nitrogen Free Extracts

Table 6: Growth performance of broiler starter chickens fed diets containing graded levels of cereal processing offal

Parameters	Levels of replacement of maize with Cereal Processing Offal (%)					
	0	15	30	45	60	SEM
Av. Initial Weights (g)	269.23	271.80	272.53	267.44	267.95	3.85
Av. Weight at 4 weeks (g)	1,001.28	949.10	1,005.13	1,007.69	988.03	19.54^{NS}
Av. Daily feed intake (g)	89.38^{c}	91.99^{bc}	94.74^{ab}	99.22^{a}	93.50^{bc}	0.71*
Av. Daily weight gain (g)	56.04	55.50	55.77	54.45	54.92	0.87^{NS}
Feed Conversion Ratio	1.60^{b}	1.66^{b}	1.70^{ab}	1.82^{a}	1.70^{ab}	0.07*
Feed cost/kg (₦)	120.49	118.19	115.49	112.26	110.82	
Feed Cost/Kg Gain (₦)	192.79	196.19	196.34	204.32	188.40	5.68^{NS}

^{a,b,c} Means in the same row with different superscripts are significantly different (P<0.05)
SEM = Standard Error of the Mean, NS = Not significant (P<0.05)

Table 7: Growth Performance of broiler finisher chickens fed diets containing graded levels of cereal processing offal

Parameters	Levels of replacement of maize with Cereal Processing Offal (%					
	0	15	30	45	60	SEM
Av. weights at 4 weeks (g)	1,001.28	949.10	1,005.13	1,007.69	988.03	19.54^{NS}
Av. Final weights (g)	3,037.18	2,930.77	2,974.36	2,935.90	2,924.15	101.76^{NS}
Av. Daily feed intake (g)	189.76	189.66	184.97	196.97	188.78	2.19^{NS}
Av. Daily weight gains (g)	72.76	70.77	70.33	68.87	69.15	1.30^{NS}
Feed Conversion Ratio	2.60	2.68	2.63	2.86	2.73	0.44^{NS}
Feed cost/kg (₦)	115.46	112.52	109.67	106.33	103.97	
Feed Cost/Kg Gain (₦)	300.20	301.56	288.42	304.12	283.83	7.29^{NS}

SEM: Standard Error of the Mean. NS = Not significant (P<0.05)

Table 8: Combined growth performance of broiler chickens fed graded levels of cereal processing offal as a replacement for maize.

Parameters	Levels of replacement of maize with Cereal Processing Offal (%)					SEM
	0	15	30	45	60	
Av. Initial weights (g)	269.23	271.80	272.53	267.44	267.95	3.85^{NS}
Av. Final Weights (g)	3,038.46	2,930.77	2,974.36	2,935.90	2,924.15	1.76^{NS}
Av. Daily feed intake (g)	159.96	159.60	158.97	157.55	161.23	0.73^{NS}
Av. Daily weight gains (g)	65.94	63.92	64.33	63.53	63.24	2.41^{NS}
Feed Conversion Ratio	2.27	2.34	2.32	2.48	2.39	0.23^{NS}
Feed cost/kg (₦)	116.48	113.86	111.09	108.94	105.45	
Feed Cost/kg Gain (₦)	264.40	266.44	257.72	269.92	252.02	5.92^{NS}

SEM: Standard Error of the Mean. NS = Not significant (P<0.05)

Discussion

Nutrient compositions of Cereal Processing Offal and experimental diets

The levels of Crude protein and Crude fibre of CPO in this study are within the range of 8 – 13 % CP (Aduku, 2004) and 7 – 14 % CF reported by Olubunmi and Ahmed (2018) respectively. The calculated nutrient values of the experimental diets presented in Table 1, show that Crude protein, Crude fat, Crude fibre, Calcium and phosphorus levels of the calculated values are slightly different from the analyzed values in the starter diets in table 4. The same can be said for the finisher diets in tables 2 and 5. However, the diets contained enough nutrients to meet the requirements for crude protein (23 – 24 %), Crude fat (3 – 6 %), Crude fibre (3 – 7 %), Calcium (1.0 – 1.25 %)

and Phosphorus (0.70 – 0.85 %) levels recommended for broiler chickens by Aduku (2004), Oluyemi and Roberts (2007), and Olomu (2011). However, Metabolizable Energy values (calculated) are slightly below the range of 2,800 – 3,000 kcal/kg recommended by the same authors. This however, has been reported not to affect performance of broilers negatively as broilers have been reported perform optimally on energy levels 10 – 15 % below recommended values (Farrel, 2005; Olomu, 2011). The calculated lysine levels for the control and other diets are higher than the recommended range of 0.95 – 1.20 % given by the same authors. Feeding lysine levels higher than what is recommended may not be of any significant effect on growth performance of the birds (although, this is yet to be ascertained) save for the fact that it will increase the overall cost of the feed since protein ingredients are usually the most expensive materials in poultry diets. Methionine levels for all starter and finisher diets are slightly below the 0.40 – 0.55 % recommended by Olomu (2011).

Growth performance

The average daily feed intake values for broiler starter in table 6 showed that the birds fed diets containing 45 % CPO as replacement for maize was significantly higher ($P<0.05$) than feed intake of birds fed diets containing 0 (control), 15 and 60 % CPO replacement of maize. Only the birds fed diets having 30 % CPO as replacement for maize was not significantly different ($P>0.05$). Average daily weight gain values for all treatments were statistically similar. However, FCR values were significantly different ($P<0.05$); the birds fed diets where CPO replaced maize at 45 % level recorded higher FCR value compared to the birds fed diets where CPO replaced maize at 0 and 15 % but not significantly different ($P>0.05$) from birds fed diets containing 30 and 60 % CPO level as replacement for maize. The cost of feed per kilogram decreased in value with increasing levels of replacement of maize with CPO. Feed cost per kilogram gain ranging from ₦ 118.40 in birds fed diets having 60 % of maize replaced with CPO to ₦ 204.32 in birds fed diet containing CPO replacing maize at 45 % level were not significantly different ($P>0.05$) between treatments.

A slightly different result was obtained for the finisher phase (Table 7) as average daily feed intake, weight gains, FCR and feed cost per kilogram gain values did not differ ($P>0.05$) between treatment groups. Nonetheless, the average daily weight gains and FCR values showed slightly better performance for the birds fed the 0 (control), 15 and 30 % CPO compared to birds fed diets with 45 and 60 % CPO as replacement for maize.

The cost of feed per kilogram decreased with increasing levels of replacement of maize with CPO at both starter and finisher phases. It was also observed that feed cost per kilogram was higher with the starter than those of the finisher feeds. This is so because the starter feeds contain higher levels of protein ingredients which are the most expensive ingredients in poultry diets. Generally, results reveal that FCR and feed cost per kilogram gain values are better in the starter compared to the finisher phase. In the starter phase, it was observed that FCR values were better in birds fed lower levels (0 and 15 %) CPO compared to those fed higher levels (30, 45 and 60 %) of CPO at the expense of maize. This suggests possibly, that ability of broiler starters (2 – 4 weeks) to convert diets containing CPO replacing maize above 15 % is lower than those at the finisher phase.

All growth performance values for average daily feed intake, weight gains, feed conversion ratio and feed cost per kg gains did not differ ($P>0.05$) between treatments at the finisher and the pooled (combined) phases (Table 8) of growth. The values of average daily weight gains, final weights and FCR by Christopher *et al* (2007) and Idris *et al* (2018) were not significantly different ($P>0.05$) between treatments just as was obtained in this study. The feed costs per kg gains obtained in this study were not significantly different between treatments, in agreement with reports of Christopher *et al* (2007) and Idris *et al* (2018) using by-products of processing of cereal grains replacing maize in broiler diets. These results also corroborate the findings of Ezieshi*et al* (2011), Olubunmi and Ahmed (2018) and Rabo*et al* (2021) that obtained no significant differences in performance of broiler chickens and concluded that offal of cereal grains such as maize, sorghum, and millet can effectively replace maize partly or

wholly as a source of energy without any adverse effects on growth performance. Generally, from this study and those of aforementioned authors, feed cost per unit weight gain tends to decrease with increasing levels of cereal processing by product contents in the diets (this is expected to be so as by-products of processing of grains are generally cheaper than the grains they are obtained from); indicating possibly, that at larger scales of production, replacing maize with CPO by 60 % or more in broiler diets will result in significantly lower cost of feeding.

Conclusion and recommendation

The replacement of yellow maize with offal obtained from machine grinding of cereal grains in broiler diets did not have any significant effect on growth performance parameters. However, feed cost per unit weight gain, though not significant between treatments was reducing with increasing levels of replacement maize with cereal processing offal. It is therefore recommended that by-products of cereal processing can replace maize by 60 % in broiler diets without any negative effects growth performance.

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