Nig. J. Anim. Prod. 2017, 44(5): 135 - 140
Nigerian Journal of Animal Production
© Nigerian Society for Animal Production

Effect of replacing maize with sorghum, millet or 'acha' on the growth and carcass characteristics of broiler

[1]Haladu, S. and [2]Sonaiya E.B
[1]Centre for Entrepreneurship Development, Federal Polytechnic, Ede, Osun State, Nigeria
[2]Department of Animal Sciences, Faculty of Agriculture,
Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria, 220005
Corresponding author email: fsonaiya@gmail.com

Abstract

Maize, which supplies most of the energy in poultry feeds, has low yields in Nigeria and there is competition for the limited harvest of maize between industrial, livestock and human needs. Thus, this study was carried out to evaluate the effects on the growth and carcass characteristics of broiler chickens of replacing the high inputs grain, maize, with a low inputs grain, 'acha', or medium inputs grains, sorghum and millet. Four isocaloric and isonitrogenous diets for both the starter and finisher phases were formulated with maize, sorghum, millet and 'acha' as the main source of energy and were used as treatments 1, 2, 3 and 4, respectively. Marshall broiler birds were brooded up to 2 weeks before the treatments were introduced that lasted six weeks. Up to 8 weeks of age, body weight, average daily gain, feed conversion ratio and mortality were recorded weekly. The results of the study show no significant differences (P>0.05) between the four treatments in final body weight and average daily gain but birds on treatment 4 ('acha') had significantly lower feed intake and superior feed conversion ratio than the other experimental diets. It was concluded that maize can be replaced with sorghum, millet and 'acha' without adverse effects on the performance of broiler chickens.

Keywords: 'acha', broiler, maize, millet, sorghum

Introduction

Maize has high requirements for fertilizer and moisture when compared to sorghum, millet and acha (NAS, 1996). Maize, which supplies most of the energy in poultry feeds, has low yields (7.3 million metric tonnes) in Nigeria and there is competition for the limited harvest of maize between industrial, livestock and human needs (Oluyemi and Robert, 2000). The sudano-sahelian zone of West Africa is more conducive for sorghum, millet and acha production (Clement et al., 2010; NAS, 1996). Therefore, in order to sustain poultry production in the sudano-sahelian zone, there is need to replace maize (a high inputs grain) with sorghum and millet (medium inputs grains) or acha (low inputs grain) in poultry diets.

Materials and Methods

The study was carried out at the Poultry Unit of the Teaching and Research Farm and the Poultry Meat Research Laboratory of the Department of Animal Sciences of Obafemi Awolowo University. The four grains were analysed for proximate composition according to AOAC (1990) and tested for three mycotoxins (aflatoxin fumonisin and ochratoxin) using the method of Bragulat *et al.* (2001). A total of 120, 2-weeks old Marshall broiler chicks were allotted into four treatments, each with three replicates of 10 birds per replicate in a randomized complete block design. Four isocaloric and isonitrogenous starter (2800 kcal, 23%CP) and finisher (2900 kcal, 20% CP) diets with maize,

sorghum, millet and acha were formulated for treatments 1, 2, 3 and 4, respectively. For six weeks, data were collected on feed intake, body weight, mortality and average daily gain and feed conversion ratio were calculated. The experimental diets were analysed for two anti-nutritional factors: oxalate, by the titrimetric method of Oke (1966) as modified by Falade *et al.* (2004), and tannin, by the modified vanillin-hydrochloric acid method of Price *et al.* (1978). At eight weeks, three birds per treatment were randomly selected, slaughtered and dressed. Immediately after dressing, the carcasses were chilled and stored in a chest freezer (-18^{0}C) for three days before carcass analysis. Frozen carcasses were thawed and the abdominal fat thickness and weight were measured according to the method of Sonaiya and Benyi (1983). Carcass proportions of thigh, breast, back, neck, wings, heart, liver, and gizzard were determined. All data collected were subjected to analysis of variance and means were separated by Duncan's multiple range test.

Results and Discussion

The results of the proximate, anti-nutritional and mycotoxin analysis of the experimental grains obtained in this study (Table 1) are within the range reported previously (Clement *et al.*, 2010; Ballogou *et al*., 2012 and Bulus *et al.*, 2014). The compositions of experimental diets are on Tables 2 and 3. Table 4 shows the performance of broilers fed the experimental diets.

The results showed no significant differences in growth among the experimental diets. Adamu *et al*. (2006) reported no depressive effect on growth when sorghum completely replaced maize in poultry diets. Birds on the acha diet recorded the lowest (P< 0.05) feed intake and superior (P<0.05) feed conversion ratio. This may be due to the high ME (3939 kcal/kg), the acha grains were on the other hand rich in methionine and cysteine, two amino acids almost deficient in the major cereals like sorghum, rice, wheat or barley as reported by Ballogou *et al* (2012). Birds on the sorghum diet recorded the poorest feed conversion ratio. Sorghum has the highest fibre and tannin content (Table 1) which agrees with the report of Clement (2010). Table 5 showed that there was no significant (P>0.05) differences in live and carcass weight among birds on the four treatments.

Table 1: **Proximate, anti-nutritional and mycotoxin analyses of the experimental grains**

Parameters	**Maize**	**Sorghum**	**Millet**	**Acha**	**MEAN**	SEM
Moisture content (%)	10.1^{b}±0.14	9.7^{b}±0.42	11.0^{a}±0.16	11.0^{a}±0.04	10.5	0.27
Crude protein (%)	9.3^{ab}±0.13	10.0^{a}±0.20	10.0^{a}±0.14	8.0^{b}±0.04	9.31	0.44
Crude fibre (%)	2.3^{b}±0.22	4.7^{a}±0.25	4.5^{a}±0.05	2.1^{b}±0.29	3.4	0.15
Ether extract (%)	4.5^{b}±0.74	2.7^{ab}±0.35	5.0^{a}±0.32	1.6^{c}±0.12	3.2	0.44
Ash (%)	2.2^{c}±0.7	2.6^{bc}±0.06	3.0^{a}±0.13	2.7^{ab}±0.04	2.6	0.13
Nitrogen free extract	71.6±0.03	70.3±0.88	66.5±0.52	74.6±0.74	71.2	0.82
Tannin (mg/g)	0.3^{b}±0.2	3.1^{a}±2.2	0.6^{b}±0.4	0.9^{b}±0.1	1.2	1.06
Oxalate (mg/100g)	18^{a}±0.6	11^{c}±0.3	18^{a}±0.4	15.6^{b}±0.3	15.8	0.50
Aflatoxin (µg/100g)	0.80^{a}	0.93^{a}	0.03^{b}	0.02^{b}	0.4	0.12
Ochratoxin (µg/100g)	0.01^{b}	1.50^{a}	0.04^{b}	0.01^{b}	0.4	0.05
Fuminosin (mg/kg)	0.01^{c}	7.83^{a}	0.01^{c}	3.00^{b}	2.7	0.14

^{abc}Means in the same row having different superscripts differ significantly at P<0.05.

Table 2: Composition of different energy grains-based diets for starter broiler chickens

	Experimental diets			
Ingredients	**Treatment 1 (Maize)**	**Treatment 2 (Sorghum)**	**Treatment 3 (Millet)**	**Treatment 4 (Acha)**
Test grain	50.00	52.00	53.00	45.00
Soybean meal	34.60	34.00	33.00	32.00
Wheat offal	6.00	5.00	5.00	5.00
Palm kernel cake	2.00	2.00	2.00	3.00
Fish meal	3.00	3.00	4.00	6.50
Bone meal	3.00	2.85	2.00	4.90
Limestone	0.50	0.50	0.40	3.00
Vit. Premix	0.45	0.20	0.20	0.20
Common salt	0.25	0.20	0.20	0.20
Methionine	0.15	0.20	0.10	0.10
Lysine	0.05	0.05	0.10	0.10
Calculated values (%)	**100**	**100**	**100**	**100**
ME (kcal/kg)	2893	2856	2880	2884
Crude protein	23.07	23.37	23.25	23.11
Crude fibre	4.02	3.95	4.97	3.48
Ether extract	3.68	3.70	3.75	2.71
Calcium	1.55	1.49	1.21	3.34
Phosphorus	0.81	0.79	0.69	1.22
Lysine	1.55	1.32	1.47	1.43
Methionine	0.52	0.57	0.48	0.58

Premix provided with chicks: vitamin A: 1000 IU; vitamin D_3: 500 IU; vitamin E: 5.75 IU; vitamin K_3: 0.5 mg; vitamin B_1: 0.45 mg; vitamin B_2: 1.25 mg; vitamin B_6: 0.75 mg; vitamin B_{12}: 0.00375 mg; Niacin: 6.875 mg; Pantothenic acid: 1.875 mg; Folic acid 0.1875 mg; Biotin H_2: 0.015 mg; C Choline chloride: 75 mg; Cobalt: 0.05 mg; Copper: 0.75 mg; Iodine: 0.25 mg; Iron: 5 mg; Manganese: 10 mg; Selenium: 0.05 mg; Zinc: 7.5 mg and Antioxidant: 0.3125mg.

Table 3: Composition of different energy grains-based diets for finisher broiler chickens

	Experimental diets			
Ingredients	**Treatment 1 (Maize)**	**Treatment 2 (Sorghum)**	**Treatment 3 (Millet)**	**Treatment 4 (Acha)**
Test grains	60.00	62.00	62.00	54.00
Soybeans meal	25.00	25.00	25.40	22.40
Wheat Offal	5.45	5.00	4.00	4.00
Palm Kernel Cake	2.00	2.00	2.00	4.00
Fish meal	3.40	3.00	3.25	7.00
Bone meal	3.00	2.00	2.00	3.00
Limestone	0.50	0.45	0.50	3.00
Vitamin/ mineral premix	0.25	0.20	0.25	2.00
Common salt	0.25	0.20	0.20	0.20
Methionine	0.10	0.10	0.20	0.20
Lysine	0.05	0.05	0.20	0.20
Total (%)	**100**	**100**	**100**	**100**
Calculated values				
Metabolizable energy Kcal/kg	2978	2943	2930	2977
Crude protein (%)	20.23	20.69	20.24	20.17
Crude fibre (%)	3.56	3.56	4.74	3.00
Ether extract (%)	3.74	3.17	3.78	2.61
Calcium (%)	1.56	1.16	1.18	2.65
Available phosphorus (%)	0.77	0.76	0.63	0.90
Lysine (%)	1.11	1.15	1.34	1.29
Methionine (%)	0.43	0.38	0.53	0.66

Premix provided to chicks with: vitamin A: 1000 IU; vitamin D_3: 500 IU; vitamin E: 5.75 IU; vitamin K_3: 0.5 mg; vitamin B_1: 0.45 mg; vitamin B_2: 1.25 mg; vitamin B_6: 0.75 mg; vitamin B_{12}: 0.00375 mg; Niacin: 6.875 mg; Pantothenic acid: 1.875 mg; Folic acid 0.1875 mg; Biotin H_2: 0.015 mg; C Choline chloride: 75 mg; Cobalt: 0.05 mg; Copper: 0.75 mg; Iodine: 0.25 mg; Iron: 5 mg; Manganese: 10 mg; Selenium: 0.05 mg; Zinc: 7.5 mg and Antioxidant: 0.3125mg

Table 4: Performance of broilers fed different energy grains-based experimental diets

	Experimental Diets					
Parameters	**Treatment 1 (Maize)**	**Treatment 2 (Sorghum)**	**Treatment 3 (Millet)**	**Treatment 4 (Acha)**	**Mean**	**SEM**
BW($_{2\ wks)}$, g	223±6	217±2	218±1	218±1.7	219.5	3.8
BW($_{8\ wks)}$, g	1481±103	1297±68	1428±153	1449±87	1414.0	107
ADG, g	30.0±2.56	25.7±1.67	28.8±3.64	29.3±2.28	28.5	2.6
ADFI, g	96.6^{a}±0.85	92.0^{a}±5.04	93.4^{a}±5.72	77.2^{b}±10.90	89.8	4.8
FCR	3.2^{ab}±0.30	3.6^{a}±0.10	3.3^{ab}±0.60	2.7^{b}±0.57	3.2	0.37
Mortality (%)	3.0^{b}±5.77	13.0^{ab}±5.77	20.0^{a}±0.00	13.0^{ab}±11.55	12.3	5.8

^{ab}Means in the same row having different superscripts differ significantly at P<0.05.
BW (2 wks): Body weight at two weeks, BW(8 wks): Body weight at eight weeks, ADG: Average daily gain, ADFI: Average daily feed intake, FCR: Feed conversion ratio.

Table 5: Carcass characteristics of broilers fed different energy grains-based experimental diets

Parameters	Experimental Diets				Mean	SEM
	1	2	3	4		
LW (g/bird)	1533±124	1323±108	1397±205	1456±19	1427.8	107.54
WCW (g/bird)	1291±107	1119±112	1165±170	1218±46	1198.6	95.50
Fat thickness (mm)	4.3±0.53	2.3±0.58	3.7±2.08	2.3±0.58	3.2	1.04
Fat weight (%)	1.3±0.06	1.1±0.51	1.0±0.46	0.8±0.13	1.04	0.38
Thigh weight (%)	21.0±0.93	21.1±0.59	23.1±1.83	21.2±1.35	21.61	1.42
Breast weight (%)	16.1^{ab}±1.45	14.6^{b}±0.28	15.3^{ab}±1.01	17.3^{a}±1.38	15.81	1.17
Wing (%)	7.8^{b}±0.45	8.8^{a}±0.21	8.5^{ab}±0.49	9.2^{a}±0.53	8.59	0.45
Neck (%)	5.6±0.31	5.5±0.56	5.6±0.47	4.9±0.43	5.42	0.51
Heart (%)	0.56±0.06	0.48±0.07	0.53±0.07	0.54±0.06	0.53	0.07
Liver (%)	2.5±0.52	2.4±0.18	2.5±0.18	2.9±0.28	2.61	0.33
Gizzard (%)	2.3±0.18	2.4±0.52	2.2±0.49	1.9±0.14	2.22	0.34

^{ab}Means in the same row having different superscripts differ significantly at P<0.05.
LW: Live weight, WCW: Whole carcass weight.

There was no significant difference among the treatments in all the carcass parameters except breast weight. Rama Rao *et al.* (2001) and Reddy *et al*. (2008) reported no significant difference in carcass characteristics when maize was replaced in poultry diets with sorghum at 100% or 50%, respectively. Bulus *et al*. (2014) reported a significant decrease in carcass measures when maize was totally replaced by millet in poultry diets. In this study, higher breast weight was observed in birds fed the acha diet as compared with those fed the maize diet. This agrees with the report of Ukim *et al*. (2012).

Conclusion

The findings of this study showed that maize can successfully be replaced with sorghum, millet or acha without adverse effects on performance of broiler chickens.

Acknowledgement

The support of the African Chicken Genetic Gains, Nigeria (ACCG-NG) project in paying for this publication is appreciated

References

Association of Official Analytical Chemistry AOAC, 1990. Official Method of Analysis, 15th Edn. Washington D.C., USA.

Adamu, M. S., Nafarnda, W. D., Iliya, D. S. and Kubkomawa, H. I., 2006. Replacement value of yellow sorghum (*Sorghum bicolor*) for maize in broiler diets. *Global Journal of Agricultural Science,* 5(2): 151-154.

Ballogou, V.Y., Soumanou, M.M., Toukourou, F. and Hounhouigan, J.D., 2013. Structure and nutritional composition of fonio (Digitaria exilis) grains: A review. *Intern. Res. J. of Bio. Sci. Vol.* 2(1): 73-79

Bragulat, M. R., Abarca, M. L. and Calanes F. J., 2001. An easy screening method for fungi producing ochratoxin-A in pure culture. *International Journal of food microbiology* 71:139-144.

Bulus, E. D., Ibe, E. A., Dodo, S. T., Samuel, I. and Makinde, O. J., 2014. Performance of broiler chickens fed two varieties of

guinea corn and millets as replacement for maize. *Iranian Journal of Applied Animal Science*, 4(3): 541-547.

Clement I. M., Ibrahim D. K., Joseph I., Iro N., Ibrahim D. M., and Bruce H., 2010. Performance and economics of production of broiler chickens fed sorghum or millet as replacement for maize in the semi-arid zone of Nigeria. *Agriculture and Biology Journal of North America*, ISSN Online: 2151-7525

Clement I. M., Ibrahim D. K., Joseph I., Iro N., Ibrahim D. M., and Bruce H., 2010. Performance and economics of production of broiler chickens fed sorghum or millet as replacement for maize in the semi-arid zone of Nigeria. *Agriculture and Biology Journal of North America*, ISSN Online: 2151-7525

Falade, O. S., Dare A. F., Bello, M. O., Osuntogun, B. O., and Adewusi, S. R. A., 2004. Varietal Changes in Proximate Composition and the Effect of Processing on the Ascorbic acid Content of some Vegetables. *Journal food Technology* 2:103-108.43.

National Academy of Science, 1996. *"Fonio (Acha)". Lost Crops of Africa: Volume I: Grains.* Lost Crops of Africa, 1. National Academies Press. ISBN 978-0-309-04990-0. http://books.nap.edu/openbook.php?record_id=2305&page=59. Retrieved 14th October, 2015.

Oke, O. L., 1969. Oxalic Acid in Plants and in Nutrition. *World Review of Nutrition and Dietetics*, 10: 263-303.

Price, M. L., Scoyoc, S. V., and Butler, L. G., 1978. A Critical Evaluation of the Vanillin Reaction as an Assay for Tannin in Sorghum Grain. *Journal of* A*griculture and Food Chemistry* 26: 1214-1218.

Rama Rao, S. V; Shyam Sunder, G. I; Reddy, M. R; Praharaj, N. K; Raju, M. V. and Panda, A. K., 2001. Effect of supplementary choline on the performance of broiler breeders fed on different energy sources. *Journal of British Poultry Science*, 42: 362-367.

Reddy V. K., Malathi, V., Venkatarami, B. S., Reddy, K., Pratap Kumar, S., and Jayanaik, B., 2008. Effect of finger millet and sorghum replacing corn in presence of soy oil/ fish oil and enzymes on performance of broilers. *International Journal of Poultry Science*, 7 (6): 560-546.

Sonaiya E. B. and Benyi K., 1982. Abdominal fat in 12 to 16 week-old broiler birds as influenced by age, sex, and strain. *Br. Poultry. Sci. 62:1793-1799.*

Ukim, C. I., Ojewola G. S., Obun, C. O. and Ndelekwute, E. N., 2012. Perfomance, carcass and organs weight of broiler chicks fed graded levels of acha grains *(Digitaria exilis). Journal of Agriculture and Vet.Sci.* 1(1): 28-33.

Received: 287h October, 2017
Accepted: 30th November, 2017