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EFFECT OF SORGHUM AND MAIZE ON FINAL BODY WEIGHT, FEED CONVERSION RATIO, FEED COST, WEIGHT GAIN AND MORTALITY IN BROILERS

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Abstract

A two-month trial conducted to investigate the effect of replacing maize with sorghum on the performance of broiler finisher using four sorghum varieties in 2015 on a total 675, 3 weeks broiler chickens. Data analysis included variance and Duncan Multiple Range Test. The varietal effect showed a significant difference in final body weight, feed conversion ratio, feed cost per kilogram weight gain and mortality at $p < 0.05$. The interaction effect showed a significant difference in final body weight, total weight gain, feed conversion ratio and feed cost per kilogram weight gain at $p < 0.05$. Experimental birds fed *Red Sorghum* at 50% level of inclusion gave the best performance in terms of final weight gain, feed conversion ratio and feed cost per kilogram weight gain. Therefore, *Red Sorghum* at 50% inclusion at the finisher phase recommended as the best factor combination in broiler nutrition for enhanced growth performance.

***Key words**:* Sorghum, Maize, Broiler finisher and Performance.

Introduction

Intensifying the production of highly reproductive livestock with short generation intervals can enhance the problem of inadequate consumption of animal protein in Nigeria. Poultry producers are interested in their profit margin from the broiler enterprise. According to Diaw et al 2014, high energy diets promote more rapid growth and better utilization of feed than low energy diets. However, in terms of total cost of feed, energy is the main factor influencing diet cost. Maize is the primary energy source in poultry diet contributing up to 60% of complete poultry ration in Nigeria. To reduce the feed costs, other alternatives such as sorghum, pearl millet are available (Issa *et al.,* 2015, Issa *et al.,* 2016). Sorghum is the fifth most important cereal crop in the world in terms of production and harvested area. This drought-tolerant crop is grown on 45 million hectares, with 75% of the area concentrated in ten countries: Sudan, India, Nigeria, Niger, USA, Mexico, Ethiopia, Burkina Faso, Mali and Chad. Sorghum is a staple crop in Africa and is grown for both food and industrial purposes (Cropdiversity, 2020).

Thus, the present study was designed in Nigeria to establish the replacement value of different sorghum varieties as a replacement for maize in the diet of finisher broiler for reducing cost.

Materials and Methods

This experiment was conducted in the pens of a commercial poultry farm in Imawa, Kura Local Government Area, Kano, Nigeria. Kano falls within the Sudan Savannah Zone bordering the Guinea Savannah Vegetation in the south. The area has a wet season from May to September and dry season from October to April. The area has an annual rainfall of 787mm to 960mm and

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temperature between 21^{0}C to 30^{0}C. A total of 675, day-old broiler chicks (Arbor acre plus strain) of mixed sexes were purchased from Obasanjo Farms, Otta, Ogun State and Nigeria for the study. The different sorghum varieties (Farfara, Kaura and ICSV400) used for the study were obtained from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) while Red sorghum was obtained from the local markets in Kano State. The proximate analysis of the experimental diets carried according to the method of AOAC for dry matter (%DM), crude protein (%CP), Crude Fiber (%CF), Ether extract (% EE), Nitrogen free extract (NFE) in the Animal Science Biochemical Laboratory, Faculty of Agriculture, Ahmadu Bello University, Zaria. Also, anti-nutritional factors present in the sorghum varieties and formulated experimental diets analyzed using AOAC method at the Animal Science Biochemical Laboratory, of Faculty of Agriculture, Ahmadu Bello University, Zaria. The tannin content of the sorghum grains determined by AOAC (2005) slightly modified method while the saponin content determined by AOAC method. The Munro and Bassir method to determine the total oxalic acid present in the different sorghum grain. Besides phytate content determination by Sutardi and Buckle method. Gravimetric method for alkaloids determination. A total of 675 three weeks broiler chickens were used in this study after 7 days adjustment period, during which they were fed the control diet. The birds were subsequently allotted to nine finisher diets in a Completely Randomized Design (CRD) in 4×2 + 1 factorial arrangement. The experimental diets

Table 1: Gross composition of the finisher diets (5-9 wks) with sorghum varieties replacing maize.

Ingredients (%)	Diets								
	D1	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**
Maize	54.89	27.45	-	27.54	-	27.54	-	27.54	-
Farfara	-	27.45	54.89	-	-	-	-	-	-
Kaura	-	-	-	27.54	54.89	-	-	-	-
ICSV400	-	-	-	-	-	27.54	54.89	-	-
Red sorghum	-	-	-	-	-	-	-	27.54	54.89
Soybean	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71	15.71
Groundnut cake	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Lysin	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100	100	100	100
Unit cost									

1 Kg of premix contains vitamins A (5,000,000 I.u), vitamins D3 (1,000,000 i.u), vitamins E (16,000mg), vitamins K3 (800mg), vitamins B1 (1,200mg), vitamins B2 (22,000mg), Niacin (22,000mg), Calcium pentothenate (4,600mg), Vitamins B6 (2,000 mg), vitamin B12 (10mg), Folic acid (400mg), Biotin (32mg), Choline chloride (200,000mg), Manganese (948,000mg), Iron (40,000mg), Cobalt (120mg), Zinc (32,000mg), Copper (3,400mg), Iodine (600mg), Selenium (48mg), Anti-oxidant (48,000mg).

Table 2: Proximate composition of the experimental finisher diets (5-8wks).

Parameters %	Diets								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
DM	93.55	92.83	92.73	92.13	94.64	93.29	93.79	92.28	92.13
ME(kcal/kg)	2856.9	2849.0	2853.5	2859.45	2863.04	2844.99	2859.46	2850.80	2850.95
CP	20.61	21.17	21.38	20.62	20.89	21.03	21.15	21.10	21.22
CF	5.65	6.14	5.50	5.88	6.35	6.50	5.98	5.83	6.08
EE	5.88	5.66	6.13	5.88	6.35	5.97	5.66	5.79	5.88
Ash	8.00	8.00	8.12	8.26	7.92	8.00	7.96	8.13	8.24
NFE	59.62	59.24	58.81	59.36	58.99	58.86	59.15	58.93	59.12

DM = Dry matter, CP = Crude Protein, EE= Either extract, CF= Crude fibre, ME= Metabolisable energy and NFE= Nitrogen Free Extract.

Table 3: Anti-nutritional Constituents of the evaluated sorghum varieties and maize.

Parameters (g/100mg)	Maize	Sorghum Varieties				SEM
		Farfara	*Kaura*	*ICSV -400*	*Red Sorghum*	
Tannin	ND	0.13^{d}	0.11^{b}	0.09^{a}	0.12^{c}	0.01
Saponin	0.08^{a}	0.10^{a}	0.09^{b}	0.08^{a}	0.15^{c}	0.02
Oxalate	0.41^{c}	0.19^{a}	0.22^{b}	0.20^{a}	0.45^{d}	0.02
Flavonoid	0.32^{c}	0.29^{a}	0.29^{a}	0.30^{b}	0.45^{d}	0.01
Trypsin inhibitors	0.14^{b}	0.20^{e}	0.19^{d}	0.13^{a}	0.16^{c}	0.01
Phytate	0.19^{c}	0.09^{a}	0.17^{b}	0.18^{b}	0.19^{c}	0.02

^{abc}: Means on the same row with different superscripts differ significantly ($p<0.05$) NS: Not significant ($p>0.05$) SEM: Standard error of means ND: Not detected.

comprised of four sorghum varieties (*Farfara, Kaura, ICSV400* and *Red sorghum*) at 50% and 100% levels of inclusion respectively. Each treatment group had 72 birds which were sub-divided into three replicates of 24 birds each in a 4×2 factorial arrangement with a fixed control.

The treatments (diets) evaluated include the following

D1. 100% maize (control), D2. Farfara at 50% level of inclusion, D3. Farfara at 100% level of inclusion, D4. Kaura at 50% level of inclusion, D5. Kaura at 100% level of inclusion, D6. ICSV400 at 50% level of inclusion, D7. ICSV400 at 100% level of inclusion, D8. Red sorghum at 50% level of inclusion and D9. Red sorghum at 100% level of inclusion. A total of 648 birds from the starter phase were fed a common diet for 7 days adjustment period. The birds were then randomized and allotted to the nine experimental treatment groups. All routine management and recommended health practices were strictly adhered to. The necessary vaccinations were carried out at as at when due. Feed and water were provided *ad-libitum*. The amount of feed given and left over was recorded on daily basis. The experimental birds were weighed initially and weekly up to the end of the experiment. Feed intake, weight gain, feed conversion ratio and feed cost per gain were calculated. Mortality was calculated in percentage. A cost appraisal of the study was carried out to show the efficiency of the ration in terms of cost per live weight gain. This was calculated using the formulae.

Cost of feed = price per kg of feed

Total cost of feed = feed intake × cost per kg

Total cost of feed intake

Cost per kg body weight = Final body weight in kg

Data obtained were subjected to one - way analysis of variance in a 4×2 factorial arrangement with a fixed control using SAS version 9. Significant ($p<0.05$) differences among treatments means was separated using Duncan Multiple Range Test.

Experimental Model

$c_{ijk} = \mu + V_i + L_j + (VL)_{ij} + E_{ijk}$

c_{ijk} = observed value of the dependent variable

μ = population mean

V_i = Effect of i^{th} varieties (*Red Sorghum*, *Kaura*, *ICSV 400* and *Farfara*)

L_j = Effect of j^{th} level(s) of inclusion (50% and 100%)

$(VL)_{ij}$ = Interaction of sorghum varieties and inclusion level(s)

E_{ijk} = Experimental Error

Results

Anti-nutritional Factors in the sorghum varieties and maize: The values obtained for tannins were within the range of 0.00-0.13 g/100 mg for low,

Table 4: Main effect of sorghum varieties and inclusion levels on the performance of broiler finisher (5-8wks).

Parameters	Maize	Farfara	Kaura	ICSV400	Red Sorghum	SEM	50%	100%	SEM
IWT (g/bird)	1076.63	1074.28	1074.20	1073.17	1047.05	47.72	1061.06	1073.29	67.69
FWT (g/bird)	2271.53^{b}	2269.62^{b}	2280.32^{b}	2262.07^{b}	2387.63^{a}	41.47	2332.13	2267.70	115.55
WG (g/bird)	1194.90	1195.34	1206.12	1189.53	1340.58	85.75	1294.13	1194.53	121.63
AWT (g/bird)	56.90	56.92	57.43	56.64	63.84	4.08	61.65	56.88	5.80
TFI (g/bird)	3407.64	3230.10	3074.30	2964.40	3152.20	100.95	3074.61	3136.88	143.18
AFI (g/bird/day	121.70	115.36	109.80	105.62	112.65	17.37	109.68	112.03	5.12
FCR	2.28^{c}	1.91^{b}	1.86^{b}	1.86^{b}	1.76^{a}	0.13	1.78	1.91	0.18
FC/G (¦)	297.77^{c}	239.07^{b}	233.09^{b}	224.81^{b}	201.86^{a}	17.37	216.94	232.47	24.80
Mortality (%)	5.33^{b}	3.33^{a}	3.33^{a}	6.00^{b}	3.33^{a}	1.83	3.66	4.33	2.59

^{abc}: Means on the same row with different superscripts differ significantly ($p<0.05$) NS: Not significant ($p>0.05$) SEM: Standard error of means IWT =Initial weight, WG= weight gain, FWT= final weight, AWT=average weight gain, AFI= average feed intake, FCR= Feed conversion ratio and TFI=total feed intake.

Table 5: Interaction effect of sorghum varieties and level of inclusion on the performance of broiler chickens (5-8wks).

Parameters	Maize	*Farfara*		*Kaura*		*ICSV400*		Red sorghum		SEM
	100%	50%	100%	50%	100%	50%	100%	50%	100%	
IWT (g/bird)	1076.63	1074.07	1074.50	1074.03	1072.30	1075.03	1073.37	1071.10	1073.00	40.86
FWT (g/bird)	2271.53^{b}	2357.50^{a}	2181.77^{c}	2298.27^{b}	2225.87^{b}	2267.47^{b}	2293.17^{b}	2405.27^{a}	2370.00^{a}	57.42
WG (g/bird)	1194.90^{c}	1283.43^{b}	1107.27^{c}	1224.24^{b}	1153.57^{c}	1192.44^{c}	1219.80^{b}	1334.17^{a}	1297.00^{b}	100.05
AWT (g/bird/day)	56.90	61.12	52.73	58.30	54.93	56.78	58.09	65.91	61.77	20.98
TFI (g/bird)	3407.64	3093.03	3367.21	2867.97	3060.74	3131.54	3017.08	3205.89	3102.48	121.34
AFI (g/bird/day)	121.70	110.47	120.26	101.93	109.31	111.84	107.75	114.49	110.80	56.76
FCR	2.28	1.77	2.04	1.68	2.03	1.88	1.84	1.78	1.74	1.27
FC/Gkg/₦	297.77^{b}	225.87^{a}	252.27^{a}	213.16^{a}	236.46^{a}	239.43^{a}	226.76^{a}	189.30^{a}	214.41^{a}	43.35
Mortality(%)	5.33	2.67	4.00	5.33	6.67	4.00	2.67	2.67	4.00	3.21

^{abc}: Means on the same row with different superscripts differ significantly ($p<0.05$) NS: Not significant ($p>0.05$), SEM: Standard error of means, IWT =Initial weight, FWT= final weight, WG= weight gain, AWT=average weight gain, TFI=total feed intake, AFI= average feed intake, FCR= Feed conversion ratio and FC/G= Feed cost per gain.

medium and high tannin sorghum varieties respectively. Phytate was within the range of 0.09-0.20 g/100gm. Saponin was within the range of 0.08-0.15 g/100mg. Maize was found to be significantly ($p<0.05$) higher in oxalate and flavoniod compared to the sorghum varieties. The observed differences reasons were difference in the cultivars, soil type and condition under which the crop was grown. The tannin content of sorghum is often thought to be closely related to darkness of seed color as reported by Sultan *et al.,* 2014.

Main effect of sorghum varieties and inclusion levels on the performance of broilers finisher: The proximate composition of the broiler finisher diets showed similarities between the nutrient composition of the maize based diets, maize-sorghum diets and the sorghum -based diets which supports the findings of Ravindran (2014) that sorghum has similar nutrient composition to maize. There were significant ($p<0.05$) differences across the treatments means for final body weight, feed conversion ratio, feed cost (₦) per kg gain and mortality. Feed intake did not differ ($p>0.05$) significantly across the treatments Birds fed *Red Sorghum* had the highest final body weight, better feed conversion ratio and feed cost per kg gain compared to those fed other diets. This finding is in contrast with the report of Aladeen *et al.,* 2013 who fed maize, millet and sorghum to finishing broiler birds as energy source and reported no significant ($p>0.05$) differences in terms of performance and mortality. Non-significant ($p>0.05$) difference was observed across the treatments for feed intake. This observation perhaps may be due to the fact that the metabolizable energy concentration of the diets were similar and also because the birds fed to satisfy their energy requirements. This finding is in agreement with that of Issa *et al.,* 2015, who reported that replacement of maize with low tannin sorghum did not reduce the final body weight, body weight gain, feed intake and feed conversion ratio compared to maize based diet. The Feed conversion ratios and feed cost per kilogram weight gain was better in birds fed red sorghum diets while birds fed maize-based diet (control) had the lowest value.

Interaction effect of sorghum varieties and inclusion levels on the performance of broiler finisher: Birds fed 50% *Red Sorghum* were significantly higher in final body weight and total weight gain which was statistically similar to birds fed 100% *Red Sorghum* and 50% *Farfara*. This indicates that the anti-nutritional contents in the diets did not compromise the broiler finisher performance, which is likely due to their better developed organs. Another possible reason may be due to the saponin content of the sorghum varieties. Feed cost per kilogram gain was cheaper in birds fed the sorghum varieties at 50% and 100% level of inclusion. This indicates that the birds on the sorghum diets were able to utilize the required nutrients from the diets as the levels of ant-nutritional factors were not detrimental to the birds. This implies that the four sorghum varieties can totally replace maize in broiler finisher diets with better efficiency in terms of feed conversion ratio and feed cost per kilogram gain. However *Red Sorghum* fed at 50% level of inclusion gave the cheapest value. This may be due to the capacity of the digestive tract to utilize carbohydrate digestion and absorption to a greater extent when fed the mixed starch sources than when fed only a single source. Hence, starch digestibility also varies depending on the combination of starch sources in the diets as reported by Yunus *et al.,* 2015. Since at finisher phase energy becomes more critical and at the same time protein requirement decreases. In this study it appears that, in a neglected level of tannin content, sorghum can substitute maize while leading to a superior body weight.

Conclusion

From the result of this study it is concluded that. The sorghum varieties used in this study can totally replace maize in broiler finisher diets without negative effects on the bird's performance. However, bird fed red sorghum at 50% level of inclusion gave the best performance. Therefore, *Red Sorghum* at 50% inclusion at finisher phase is recommended as the best factor combination in broiler nutrition for enhanced growth performance.

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