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Growth performance, carcass characteristics and cost benefit of feeding broilers with diets containing high quality cassava peel (HQCP)

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A feeding trial was conducted to evaluate the effect of isonitrogenous and isocaloric diets containing varying levels of high-quality cassava peel (HQCP) fine mash on broilers' performance, carcass characteristics, and cost benefit. A feeding trial was carried out using four hundred (400) 21-day old Arbor Acres broiler chicks weighing 570 – 630 g (live weight). The chicks were randomly allocated to five dietary treatments (T); (T1- 0 kg/t of HQCP, T2- 150 kg/t of HQCP, T3- 200 kg/t of HQCP, T4- 250 kg/t of HQCP and T5- 300 kg/t of HQCP) for 21 days in a completely randomized design. Data on live performance, carcass characteristics, and feeding costs were collected. The results showed significant ($P < 0.05$) differences in final live weight, feed conversion ratio/feed efficiency ratio (FCR/FER), dressing percentage, total feed cost, and feed cost per weight gain across the treatments. T2 and T4 produced birds with the highest live weights of 2.08 and 1.98 kg, respectively. The dressing percentage ranged from 63.2% (T5) - 70.0% (T1). T5 had the lowest total feed cost (0.97 \$/kg) while T2 had the lowest feed cost per body weight gain (\$0.74), and best cost savings (\$0.22). It was concluded that replacement of maize with 150 kg/t high quality cassava peel (HQCP) in broiler finisher diets improved production performance and save cost.

Key words: HQCP, broilers, live weight, dressing percentage, feed cost, finisher diet.

INTRODUCTION

In the poultry industry, feeds and feeding account for about 50 -70% of total production cost (Babiker et al.,

2009, Makinde et al., 2014). Energy sources contribute the largest quantity in poultry ration particularly maize,

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which usually contributes 40 -70 in poultry feeds (Skinner et al., 1992; Van der Klis et al., 2010). In Nigeria, there is a continual increase in the price of feed ingredients, which is as a result of the gap in the supply and demand of these ingredients, thus resulting in high price, especially for maize. The stiff competition for maize by human and animal coupled with high cost of foreign exchange to import maize during the period of scarcity has necessitated the need for alternatives.

The challenge posed during these periods of scarcity could be addressed by the utilization of agro-industrial by products. FAO (2014) had reported on the potentials and utilization of agro-industrial by-products as feed ingredients in the reduction of feed cost and enhancement of sustainable feed resources for poultry production. One of such agro-industrial by-products with potentials replacing maize in livestock feed is cassava peel and was estimated to be about 15million MT in Africa in 2015 (Okike et al., 2015). Cassava is produced in abundance in Nigeria and its tuber products are among the highly consumed for food by animals and humans in sub-Saharan Africa (Ayasan, 2010). Most of the products produced from cassava are usually without its peels which contribute up to 13% of the cassava tuber (Omotosho and Sangodoyin, 2013).

Against this background is the need to explore locally available, alternative feed resources that can replace maize at a lower cost without any deleterious impact on the production and performance of birds (De Vries et al. 2012; Oladimeji et al., 2019). Cassava peel is less competed for by humans and animals, when well processed will lower cost of feed, increase gross income of farmer and increase consumption of poultry based protein in Nigeria.

Cassava peel has been used for decades to feed livestock, particularly ruminants and pigs (Egbunike et al., 2009; Adesehinwa et al., 2016). Aside from the lower protein in cassava peel, its utilization in poultry has been limited due to a large amount of cyanogenic glycoside, high phytate content and quick spoilage if left unprocessed (Ogunwole et al., 2017; Omode et al., 2018). Different approaches to combat these constraints had been reported, while sun-drying remains the most common method of processing (Adeyemo and Sani, 2013; Abu et al., 2015). However, sun-drying is slow and takes more than 3 days particularly in the wet season for the product to be properly dried. Longer period of sun-drying often encourages the growth of mould and other pathogenic microorganisms such as *Aspergillus flavus* (Clerk and Caurie, 1968) which exposes livestock to aflatoxicosis and/or mycotoxic infection following feeding. The longer drying period results in reduction in quantity and quality of cassava peel that could be produced within short interval. Reducing the drying time of cassava peels drastically will promote the rapid production of a safe and hygienic product for poultry.

The technical and economic feasibility of the

transformation of cassava peels within 6 to 8 h to a stable product as an animal feed ingredient has already been reported (Okike et al., 2015). These methods involve a combination of different physical methods such as grating, dewatering, pulverizing, and sun-drying. Considerable evidence points to the possibility of using this processed and aflatoxin free cassava peel, which is referred to as high-quality cassava peel mash (HQCP) as an energy source in livestock feed. Ananda et al. (2017) reported the mixture of the HQCP with full-fat soy, oil and methionine to match the nutrients profile of maize, at 100kg/t in broiler feed. Ogunwole et al. (2017) also reported the effect of replacement of maize with HQCP on chicken egg quality characteristics. Therefore, the objective of this study is to evaluate the effect of varying levels of replacement of maize with HQCP on profitability, growth performance and carcass characteristics in broiler chickens' production.

MATERIALS AND METHODS

Experimental site and description

This trial was conducted at the Research and Demonstration farm of International Livestock Research Institute (ILRI), located within the campus of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. The area is located on latitude 7°3'8" and longitude 3°54'37" in the rain forest zone of the country.

Test materials

The major test ingredient was the High Quality Cassava Peel, a processed cassava peel produced within 6 to 8 h to a stable product as an animal feed ingredient following the methods of Okike et al. (2015). These methods involve a combination of different physical methods such as sorting, grating, dewatering, pulverizing, and drying.

Experimental birds and management

A total of 500 day-old Arbor Acre broiler chicks were sourced from a reputable hatchery in Awe, Oyo State. They were raised on commercial feed for 21days. At day 21, four hundred (n=400) healthy broiler chicks were individually weighed and birds with weight close to group mean were randomly assigned to five iso-nitrogenous and iso-caloric experimental dietary treatments (T). Control diet (T1) – was a maize based diet with 522 kg/t of maize while T2, T3, T4 and T5 had maize in T1 replaced at 150, 200, 250 and 300 kg with HQCP respectively. Each treatment consisted of 80 birds in quadruplicate of 20 birds each. The birds were offered diets and water *ad-libitum* throughout the experimental period. Standard management practices and routine vaccination were strictly observed. A floor space density of 0.3 m² per bird was maintained.

Performance characteristics

Daily feed intake (g/bird) was recorded while body weights were taken at the start and end of the feeding trial, for initial (W1) and final weight (W2). Weight gain was calculated as W2-W1. Feed

Table 1. Gross composition of the experimental diets (kg/t).

Ingredients	Diets				
	T1	T2	T3	T4	T5
Soya oil	24	25	25	25	25
White Maize	522	372	322	272	222
Wheat Bran	70.4	35	23.2	12.5	0.7
Soya Bean Meal (45%)	172	172	172	172	172
Full fat Soya	172	207	219	230	242
Limestone (35%)	2.6	2.6	2.6	2.6	2.6
Bone Meal	25.6	25.6	25.6	25.6	25.6
Salt	3.7	3.7	3.7	3.7	3.7
Lysine HCL	1.8	1.2	1	0.7	0.5
DL-Methionine	1.9	1.9	1.9	1.9	1.9
Toxin Binder	1	1	1	1	1
Cibenza®	0.5	0.5	0.5	0.5	0.5
**Broiler Premix 0.25%	2.5	2.5	2.5	2.5	2.5
†HQCP Fine	0	150	200	250	300
Total	1000	1000	1000	1000	1000
Calculated Value					
Crude Protein (%)	19.51	19.51	19.51	19.52	19.52
Metabolizable Energy (kcal/kg)	3107.35	3106.51	3106.34	3101.97	3101.64
Ether extract (%)	7.64	7.75	7.79	8.03	8.06
Crude Fiber (%)	3.23	3.61	3.73	3.92	4.04
Calcium (%)	0.91	0.90	0.90	0.90	0.90
Av. Phosphorus (%)	0.46	0.47	0.46	0.46	0.45
Lysine (%)	1.16	1.16	1.16	1.16	1.16
Methionine (%)	0.47	0.47	0.467	0.463	0.47

** Each 2.5 Kg contains: Vitamin A =12,000,000i.u, Vitamin D3 =2,500,000i.u, Vitamin E =30,000 mg, Vitamin K3 =2,000 mg, Vitamin B1 =2,250 mg, Vitamin B2 =6,000 mg, Vitamin B6 =4500 mg, Vitamin B12 =15 mcg, Niacin =40,000 mg, Pantothenic Acid =15,000 mg, Folic Acid =1,500 mg, Biotin =50 mcg, Choline Chloride =300,000 mg, Manganese =80,000 mg, Zinc =50,000 mg, Iron =20,000 mg, Copper =5000 mg, Iodine =1000mg, Selenium =200 mg, Cobalt =500 mg, Antioxidant =125,00 0mg.

†Aflatoxin concentrations ($\mu\text{g}/\text{kg}$) using high performance liquid chromatography = <0.5.

conversion ratio (FCR) was calculated as feed intake per unit weight gain. Daily mortality records were taken and the percentage (%) mortality was determined at the end of each feeding trial. Feeding cost was determined to evaluate the economics of HQCP inclusion by dividing the total feed cost by the total feed intake per bird.

Carcass characteristics

At day 42, five birds from each replicate with weight closest to the group average were selected for carcass analysis. Feed was withdrawn from the birds four hours before slaughtering and standard operating procedures were adopted during pre-slaughter and slaughter processes (OIE, 2011). The birds were slaughtered manually by severing both the carotid arteries and the jugular veins at once using a sharp knife. The slaughtered birds were scalded at 70°C for 1-2 min, and manually de-feathered. The carcass was carefully eviscerated and split open to remove the entire gastrointestinal tracts. Live weight, bled weight, de-feathered weight, dressed weight, eviscerated weight were taken and recorded. Organ weights such as abdominal fat, crop, empty gizzard, full gizzard, gall bladder, heart, and kidney, liver, large and small

intestines (in cm), lung, proventriculus, and spleen were separated and weighed accordingly. Cut parts including back, breast, drumstick, head, neck, shank, thigh, and wing were cautiously removed and weighed, then expressed as a percentage of their respective live body weight. Individual cut weight obtained was expressed as a percentage of the bird's live weight.

Chemical analysis

Proximate composition and metabolizable energy of the experimental diets (Table 1) were carried out using Near-infrared spectroscopy (NIRS) instrument of FOSS Analyzer 2500 installed with software package WinISI II.

Statistical analysis

The experimental design was a completely randomized design and data generated were subjected to analysis of variance using SPSS (V25) (SPSS, 2017) package. Means separation was done by Duncan's New Multiple Range Test following the procedure outlined by Steel and Torrie (1980).

Table 2. Chemical composition of the experimental diets.

Diets	Nutritional profile (%)						ME (kcal/kg)
	Dry matter	Crude Protein	Crude Fibre	Total Ash	Ether Extract	NFE	
T1	89.57	19.03	5.13	8.47	7.29	49.65	3,024.95
T2	89.28	19.05	5.11	8.55	7.58	48.99	3,025.94
T3	89.26	19.00	5.19	8.09	7.93	49.05	3,054.95
T4	89.51	19.01	6.00	7.71	7.76	49.03	3,040.68
T5	89.57	19.02	5.63	7.14	7.24	50.54	3,052.10
SEM	0.07	0.01	0.18	0.26	0.13	0.30	6.30
HQCP	95.70	4.90	6.49	1.96	0.73	nd	2,987.57

T1= (control- no HQCP), T2 = (HQCP 150 kg/ton), T3 = (HQCP = 200 kg/ton), T4= (HQCP = 250 kg/ton), T 5 = (HQCP = 300 kg/ton), NFE=Nitrogen Free Extract, ME=Metabolizable Energy, nd=not determined

Table 3. Performance characteristics of the experimental birds of birds fed diets containing HQCP.

Parameter	T1	T2	T3	T4	T5	SEM
Initial body Weight (kg/bird)	0.57	0.57	0.63	0.56	0.56	0.00
Final body Weight (kg/bird)	1.74 ^{ab}	2.08 ^a	1.80 ^{ab}	1.94 ^a	1.55 ^b	1.01
Weight gain(kg/bird)	1.16 ^{ab}	1.46 ^a	1.17 ^{ab}	1.38 ^a	0.99 ^b	0.1
Feed intake (kg/bird)	2.36 ^a	2.36 ^a	2.40 ^a	2.40 ^a	2.17 ^b	0.00
Feed conversion ratio (FCR)	2.06 ^{ab}	1.63 ^b	2.05 ^{ab}	1.78 ^{ab}	2.24 ^a	0.08
Feed Efficiency ratio (FER)	0.49 ^{ab}	0.61 ^a	0.49 ^{ab}	0.58 ^{ab}	0.45 ^b	0.00
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00

T1, T2, T3, T4 and T5 are as defined in the above table.

Mean with different superscript on the same row are significantly different ($p < 0.05$)

SEM= standard error of mean.

RESULTS

The chemical composition of the experimental diets is presented in Table 2. The dry matter, crude protein, crude fibre, ether extract, total ash, nitrogen free extract and metabolizable energy were similar ($P > 0.05$). The ranges obtained were dry matter (89.26-89.57%), crude protein (19.00-19.03%), crude fibre (5.11-6.00%), total ash (7.14-8.55%), ether extract 7.24-7.93), nitrogen free extract (48.99-50.54%) and metabolizable energy (3024.95 – 3054.95 Kcal/kg).

Performance characteristics of the experimental birds fed graded levels of HQCP are presented in Table 3. The final body weight and weight gain recorded from birds fed T2 (containing 150 kg/t of HQCP) and T4 (containing 250 kg/t of HQCP) were similar ($P < 0.05$). Birds on diets T2 and T4 recorded the highest final body weights of 2.08 and 1.94kg respectively while the lowest was recorded for birds on T5 (1.55kg). Birds fed T5 (containing 300 kg/t of HQCP) had the least ($P < 0.05$) final body weight, weight gain, feed intake and feed efficiency ratio. Lowest feed intake was recorded from birds fed T5 (containing 300 kg/t of HQCP), while birds fed T1, T2, T3, and T4 had similar feed intake.

Carcass primal cuts of the birds fed diets containing

HQCP are shown in Table 4. It is shown that live weight of birds fed T2 and T4 recorded a significantly higher weight ($P < 0.05$) when compared with birds on other diets. The results were significant ($P < 0.05$) for all cut-parts except for breast, drumstick, neck and thigh. Highest back value (27 %) was recorded from birds fed control diet while T5 (containing 300 kg/t of HQCP) produced birds with highest shank (8%). The result of relative organ indices of birds fed dietary treatment containing varying levels of HQCP is presented in Table 5. The small intestine length, heart and liver weight were significantly ($P < 0.05$) influenced by the varying inclusion of HQCP. The abdominal fat, bile, crop, empty gizzard, full gizzard, kidney, long intestine, lungs, proventriculus and spleen were not influenced by inclusion of diets containing HQCP. The values obtained ranges are abdominal fat (1.94-2.87%), bile (0.09-1.24%), crop (1.15-1.70%), empty gizzard (2.50-3.30%), full gizzard (4.42-5.30%), kidney (0.07-0.09 need to be confirmed), long intestine (145.67-181.00 cm) and spleen (0.001-0.002%). The results for the economics of feeding broilers with diets containing HQCP are shown in Table 6. The result showed that cost of feed per kg body weight gain was least in T2 (\$0.74). The total feed cost consumed was lowest with birds on T5 ($P < 0.05$).

Table 4. Carcass primal cuts of the experimental birds fed diets containing HQCP.

Parameter	T1	T2	T3	T4	T5	SEM
Bled weight (%)	93.77	94.04	92.83	94.37	92.38	2.01
Defeathered weight (%)	90.61	90.32	90.57	90.45	88.83	3.00
Dressed Percentage	70.03 ^a	66.59 ^{ab}	69.48 ^a	68.03 ^{ab}	63.20 ^b	9.83
Back	27.03 ^a	24.66 ^{ab}	24.23 ^{ab}	25.78 ^{ab}	22.19 ^b	4.49
Breast	28.77	29.65	30.88	30.89	30.47	6.75
Drum stick	14.67	15.08	14.18	14.48	15.40	1.16
Head	4.16 ^{ab}	4.14 ^{ab}	4.16 ^{ab}	3.96 ^b	5.62 ^a	0.59
Neck	5.67	5.30	5.18	5.72	4.99	0.43
Shank	6.16 ^a	7.41 ^a	5.70 ^b	5.45 ^b	8.30 ^a	0.25
Thigh	16.13	17.23	16.77	16.88	17.75	1.06
Wing	13.40 ^{ab}	13.38 ^{ab}	13.94 ^{ab}	11.96 ^b	14.18 ^a	1.21

T1, T2, T3, T4 and T5 are as defined in the above table.

a,b= means in the same row with different superscripts differ significantly ($p < 0.05$)

SEM= standard error of mean.

Table 5. Relative organ weight of the experimental birds fed diets containing HQCP.

Parameter	T1	T2	T3	T4	T5	SEM
Abdominal fat (%)	2.01	2.86	2.87	2.19	1.94	0.894
Bile (%)	0.26	0.09	0.18	0.93	1.24	0.726
Crop (%)	1.70	1.50	1.15	1.37	1.39	0.457
Empty gizzard (%)	3.27	3.13	2.86	2.50	3.30	0.206
Full gizzard (%)	5.06	4.57	4.42	4.74	5.30	0.280
Heart (%)	0.89 ^{ab}	0.72 ^c	0.78 ^{bc}	0.75 ^c	1.00 ^a	0.006
Kidney (%)	0.09	0.07	0.10	0.07	0.10	0.000
Liver (%)	2.37 ^c	2.90 ^{bc}	2.34 ^c	2.99 ^b	3.62 ^a	0.094
Long intestine (cm)	145.67	144.00	144.33	155.00	181.00	10.45
Lungs (%)	0.01	0.01	0.01	0.01	0.01	0.000
Proventriculus (%)	0.01	0.01	0.01	0.01	0.01	0.000
Small intestine (cm)	78.67 ^c	99.00 ^a	78.33 ^c	87.00 ^b	90.00 ^b	2.354
Spleen (%)	0.002	0.002	0.001	0.001	0.001	0.000

T1, T2, T3, T4 and T5 are as defined in the above table.

a,b,c = means in the same row with different superscripts differ significantly ($p < 0.05$)

SEM= standard error of mean.

Table 6. Economics of feeding broilers with diets containing HQCP.

Parameter	Treatments					SEM
	1	2	3	4	5	
Total feed intake, kg	2.36 ^a	2.36 ^a	2.40 ^a	2.40 ^a	2.17 ^b	0.003
Total feed cost, \$ /kg	0.8 ^a	0.79 ^a	0.8 ^a	0.8 ^a	0.72 ^b	0.02
Total weight gain, kg	1.11 ^{ab}	1.42 ^a	1.13 ^{ab}	1.33 ^a	0.95 ^b	0.029
Feed cost per kg gain, \$	0.96 ^{ab}	0.74 ^b	0.93 ^{ab}	0.80 ^{ab}	1.05 ^a	0.07
Cost savings, \$	-	0.22	0.02	0.15	-0.09	-

a,b= means in the same row with different superscripts differ significantly ($p < 0.05$), SEM= Standard Error of mean.

DISCUSSION

Experimental diets

The crude protein (CP) and metabolizable energy (ME) recorded was within the range recommended for CP (19 - 25%) and ME (3010 – 3225 kcal/kg) for the adequate performance of broiler chicken (Olomu, 1995). Abubakar and Ohiaegbe (2011) reported CP of 20% and ME of 3000 kcal/kg when cassava peel was used to replace maize in broiler finisher in Northern Nigeria. Final body weight and weight gain recorded in this study were higher than those reported for broiler finishers by Abubakar and Ohiaegbe (2011) when unprocessed cassava peel was used to replace maize up to 100% in Northern Nigeria. The disparity might have resulted from the nature of the peel due to processing differences and different agro-ecological conditions. The final weight obtained did not follow a consistent pattern and was within the values given by Sunmola et al. (2019) who reported a final weight range of 1.73 -2.44 kg when broiler chickens were fed diets containing sweet cassava peel meal. There seems to be a notable positive trend between feed intake and final body weight of the birds. Higher body weight was recorded from birds with higher feed intake. This is a strong indication that birds do not only consume these diets but also productively utilize them. Lower feed intake recorded in birds fed T5 compared to the birds on other diets may be responsible for lower feed conversion ratio (FCR) recorded from the birds. The higher quantity of HQCP (300 kg/t) in the diet (T5) could result in the lower palatability, poor acceptability and thus lower feed intake, thereby leading to the lower weight gain recorded from bird fed the diet. Broiler birds are known to eat more when diets are palatable and coarse when compared to finely ground and unpalatable diets (Leeson, 2008). Gillette et al. (1983) opined that birds are more responsive to weakly flavored foods than strongly flavored foods. The lower FCR recorded could also be attributed to higher inclusion level of HQCP which will result in higher starch contribution from HQCP. Weurding et al. (2003) have reported that starch from cassava (1.7/h) is digested slowly compared to starch from corn (1.0/h).

Though, the diets were similar in their compositions, the birds respond differently to them. Higher feed efficiency was recorded when 150 kg of HQCP was included per ton of feed. This may justify the reasons for higher final body weight recorded by birds on this diet (T2). The higher feed efficiency in birds on (T2) could be due to lower fibre in the diet. Mateos et al. (2012) considered fibre as nutrient diluent, with lower feed intake and nutrient digestibility.

The effect of dietary changes on carcass primal cuts of broiler chickens has been well documented (Okeudo et al., 2005; Oladimeji et al., 2019). The similarities in the bled and defeathered weight suggested that the birds had

similar blood production and feathering. The dress percentage is not linearly correlated to live weight. Birds on T2 had the highest live weight (2.08 kg) but did not translate to higher dressed percentage when compared with birds fed T1 that recorded a dressing percentage of 70.83%. Similar observation was also documented by Olajide et al. (2019), when beni seed hull was used to replace maize in diets of monogastric. The values obtained are however within the range of 69.63-74.02% reported by Oladimeji et al. (2019) when cassava peel based diet was offered to broiler chickens.

The work of animal nutritionist and genetics in development modern broiler was to achieve a significant increase in overall body and parts in a shorter time. Schmidt et al. (2009) submitted that the overall body muscle mass is more expressed in breast muscle of broiler chickens. The similar values obtained for the breast and drumstick of the broiler chicken showed that HQCP does not have negative effect on the choice part. The breast meat (28.77-30.89%) and thigh (16.13-17.75%) ranges obtained were higher than the values reported by Dayal et al. (2018) for breast meat (14.22%) and thigh (11.81%) when broiler chickens were fed 400 g/kg cassava peel meal. The highest percentage weight for head (5.62%), shank (8.30%) and wings (14.18%) and the wing (14.18%) was obtained from birds on 300 g/Kg of HQCP. The results showed that higher level of HQCP supported the development of the parts.

The heart, liver and small intestine relative weights were influenced by the dietary treatments. Higher heart and liver weight is an indication of metabolic stress or toxicity. Heart weight has been observed to be proportionate with the growth rate (Schmidt et al., 2009). The differences observed could be attributed to variance in the final weight of the birds. The liver is known as a detoxification organ; the higher value obtained with birds on T5 could be connected to detoxification of cyanide known to be inherent in cassava products. Dayal et al. (2018) have also documented higher liver weight when cassava is incorporated in the diets of broiler; there are however, no signs that the higher inclusion levels pose challenge to the birds. The difference in small intestine length could be attributed to the rate of absorption and particle size of the diet.

The relative organs were similar, an indication that the inclusion levels of HQCP were safe, in addition to adequate hygiene practices coupled with appropriate medication and vaccinations. Furthermore, the results of our trial showed that the cost of feed per kg body weight gain was lowest in T2 (containing 150 kg/t of HQCP), indicating that 150kg/kg replacement of maize with HQCP is a superior and cheaper source of energy and more economical than maize. The decrease in the cost of feed per kg body weight gain was as a result of the lower cost of HQCP compared to maize. The decrease in feed cost per kg body weight gain with the dietary replacement of costly ingredients with cheaper ones has previously

been reported by Igwebuikwe et al. (1998). The highest cost savings of \$0.22 recorded when 150 kg of HQCP was included in a tone of feed showed that more meat could be obtained at less cost. It was then apparent that the inclusion of HQCP in broiler diets could be advantageous in the long run in that it resulted in the reduction of the cost of feed needed to gain a kilogram of weight. The most economic feed is in the order of diets 2, 4, 3, and 1, respectively.

Conclusion

Evidence from the outcome of this study showed that the production of broiler chicken with diets containing HQCP is possible at 42 days with average live weight ranging from 1.55- 2.08 kg. Inclusion of HQCP in the diets positively influenced the percentages of shank and thigh, while savings cost of production and without compromising the animal performance. Therefore, considering the performance of the birds and the production cost, the inclusion of about 150 kg of HQCP in a ton of broiler finisher feed, could be a better energy replacement for maize for increasing productivity in broiler production.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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