EVALUATION OF THE ECONOMICS AND GROWTH PERFORMANCE OF BROILERS FED WITH TWO MILLET VARIETIES DIETS

[1]ONWUMERE, Michael and [2]UCHECHI, Ejirika Chimdi

[1]Department of Vocational and Technical Education, Faculty of Education, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo, Ebonyi State, Nigeria.

[2]Department of Food Science and Technology, Faculty of Agriculture, Abia State University, Uturu, Abia State, Nigeria.

Corresponding Author: Onwumere, M. Department of Vocational and Technical Education, Faculty of Education, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo, Ebonyi State, Nigeria. **Email:** onwumeremichael@gmail.com **Phone:** +234 8060562725

Recieved *August 02, 2023;* ***Revised*** *August 29, 2023;* ***Accepted*** *August 31, 2023*

ABSTRACT

The study focused on the economics and growth performance of broilers fed with two millet varieties diets. Three experimental diets were formulated and designated as M1, M2 and M3. Diet 1 (Maize) served as control, while diets 2 (Pearl Millet) and 3 (Finger Millet) served as replacement for maize in chicken diets respectively. 135 day-old broiler chicks were randomly allotted to three dietary treatments in a completely randomized design (CRD) with 45 chicks per treatment, each replicated three times with 15 chicks. The diets were subjected to proximate composition assay. The data collected were analyzed using Analysis of Variance (ANOVA). The difference between treatments means were separated for significance at 0.05 level of significance using Duncan's multiple range tests. The results of the proximate composition ranges of 7.72 – 9.53% crude protein (CP), 2.61 – 3.61% crude fiber (CF), I.20 – 3.01% ether extract (EE), 1.82 – 2.72% ash and 76.91 – 78.20% nitrogen free extract (NFE) with mixed variations in the diets. At the starter phase, daily weight gain (23.12 – 29.05 g) was significantly affected (p<0.05) across the dietary-treatments. At the finisher and overall phases, all the parameters measured were not significant affected (p>0.05), while the total feed cost was lower in M1 (₦319.79K), M1 had the highest cost per kilogram of feed (₦128.43k), while the best feed cost in Naira per kilogram weight gain was obtained in M3 (₦232.51K). It was concluded that millet varieties can replace maize in broiler diet without adverse effects on growth performance of broilers.

Keywords: Broiler, Millet species, Diets, Growth, Economics, Performance, Feeding

INTRODUCTION

In developing nations, like Nigeria greater part of the general population experience the ill effects of lack of protein because of insufficient supply of animal protein in their diets. Ojo (2003) reported that a normal Nigerian consumes about 8.6% of animal protein each day as opposed to 53.3% by inhabitants of developed nations. Nonetheless, the poultry business is expected to provide majority of the required protein as it has been universally acknowledged (Atteh, 2003; Anosike *et al.*, 2018). Among the different types of poultry, broiler chickens are of more noteworthy benefit in meat production as they can give quick returns in revenue within a shot time of 6 to 8 weeks (Adeyonu *et al.*, 2021). Broiler is a domesticated feathered bird raised basically for meat. Finished broiler chicken arrives the market at weight of 1.5 – 3.0 kg attained at between 6 – 10 weeks of age depending on

feed quality, wellbeing and other management practices (Odukoya *et al.,* 2019). In the poultry industry, feed represents 65 – 80% of the energy input and the poultry business has experienced comparatively higher cost of feed than other domesticated animal industries because of the high cost of grains and other dietary inputs (FAO, 2013). Broiler strain are picked based on their adaptability to prevailing climatic conditions, quick growth rate, resistance to infections, and better feed to flesh conversion ratio.

Over several decades, maize has been a major feed ingredient in poultry diets. With the ongoing fierce competition for maize between man, industry and domesticated animals, the decline in maize production particularly in the arid and semi-arid districts of Nigeria and the globally high cost of maize have made poultry feed to be very expensive (Abdulrahman *et al*., 2022). The high cost and limited availability of dietary ingredients for the production of chicken feed, which is an important source of energy and protein for poultry, can lead to low profits for chicken farmers and reduced protein intake for the general public if not addressed.

Aside from cost, the utilization of maize as the single energy source in poultry diet is becoming unrealistic because of decrease in the decline in maize production arising from in the influence of climatic change among many other factors (Kwari *et al*., 2014). The significant interest of the farmers is to reduce the cost of production through the reduction in feed cost and augment financial benefit which cannot be achieved except if the chickens are taken care of with nutritionally balance least-cost formulated diets (Ibe *et al*., 2014). Ibe *et al.* (2014) further reported that apart from maize, sorghum, millet, rice, soya bean, cowpea, cassava, yam, cotton seed, sesame and groundnut among many others feedstuffs are utilized in formulation of poultry feeds.

However, to help address the high cost of poultry production and sustain achievable economy of broiler production in Nigeria, there is need for the evaluation of other accessible cereals as possible alternative feed ingredient for poultry diets. Millet is one of the cereal grains that have potential for utilization in poultry diets. The protein in millets (10.75%) is adequate for poultry diets and the lysine, methionine and cysteine contents in millet is around 2.86, 1.75 and 1.51% separately (Rachie and Peters, 1977). The full replacement of maize with millet can lessen the high reliance on maize and further reduce the cost of producing broiler chicken. Maidala and Abdullahi (2016) reported the metabolizable energy (ME) and crude protein (CP) of millet is 2555 kcal/kg and 12.0% respectively. Nyannor *et al.* (2007) reported that millet and sorghum are widely grown crops that have been successfully cultivated in arid and semi-arid regions of Africa and Asia for centuries. In Nigeria, the cost of these crops is relatively low, especially in regions where they are predominately grown, due to their limited industrial uses.

Thus, since maize is the principal source of energy, the utilization of alternative energy source, for example, millet is a welcome development (Saleh *et al*., 2013). Millet has higher protein levels than maize and approximately 85% energy with relatively similar mineral profile of 0.29% calcium, 0.48% total phosphorus, 651.45 ppm magnesium and 4.42 ppm copper (Filardi *et al.*, 2005). Considering that millet has nutritional value similar to maize, results from previous researches justifies that millet can replace maize in terms of protein and energy requirement of birds. Medugu *et al.* (2010) reported that maize can be totally replaced with millet in broiler diets without adverse effects on their carcass and blood biochemical parameters. Millet is well adapted to production system characterized by low rainfall, low soil fertility and high ambient temperature and thus can be grown where different cereals cannot thrive or survive. Maidala and Abdullahi (2016) reported that millet can be grown on poor sandy soils and it is known to contain nutrients similar to maize. This study focused on assessment of locally formulated broiler diets containing two varieties of millet (pearl millet and finger millet) on growth performance of broiler chicken.

The specific objectives of the study were to: (i) determine the proximate composition of maize and the two variety of millet, (ii) examine the growth performance of

broiler chickens fed with two millet varieties diets as replacement for dietary maize, and (iii) find out the production cost of broiler fed diets with either maize or two millet varieties.

MATERIALS AND METHODS

Experimental Site: The study was conducted at the Poultry Section of the Department of Agricultural Education, Michael Okpara University of Agriculture, Umudike (MOUAU), Abia State and the Biochemistry Section, National Root Crop Research Institute, Umudike, Abia State, Nigeria. Umudike is located at 5°28'0"N 7°33'0"E (Wikipedia, 2023), with a population of around 8000 people. The climate of Umudike is tropical with an average temperature of 27 ± 4^0C and an annual rainfall of around 1,500 millimeters. The people of Umudike are mostly farmers and are majorly known for the cultivation of maize, yam and cassava.

Source of Grains, Proximate Composition and Diet Formulation: Millet and maize grains were bought from Ndoro town market in Ikwuano Local Government Area of Abia State, Nigeria. The grains were bought around November – December when it was less expensive and highly available in the market. Three different diets containing two different varieties of millets with maize as control were formulated and designated as M1 control, M2 pearl millet based diets and M3 Finger millet diets respectively. Maize and millets were the major sources of protein in the diets. The grains were subjected to proximate analysis (Table 1). The proximate composition of the formulated diets (Table 2) indicated that the diets provided approximately 3000 kcal/kg ME with 23 and 20% CP for started and finisher diets, respectively. Other ingredients include were methionine, lysine, premix, bone meal, wheat offal and salt.

Experimental Design and Its Management: A Completely Randomized Design (CRD) was adopted for this study to establish the potential of using millet grains as a replacement for maize in poultry feed. The experiment lasted for 7 weeks (49 days) and the two millet varieties were Pearl millet and Finger millet varieties and maize as the control.

135 day-old broiler chicks which were purchased from the Main Farm of Michael Okpara University of Agriculture, Umudike, Abia State, the chicks were brooded for the period of one week on deep litter. Two weeks before the arrival of the chicks, the experimental pens were washed, cleaned, disinfected and dried. A week before the arrival of the chicks, wood shavings were spread on the floor, feeding and drinking troughs were all put in proper condition. Two hundred (200) watts electric bulbs were used to supply heat required for brooding and kerosene stove and charcoal were also made available in case of power failure. Feed and water were provided ad libitum for the whole period of feeding trial. Routine management, vaccines and medications were administered as recommended by FAO (2014).

One hundred and thirty-five (135) broiler chicks were randomly assigned to three dietary treatments with 45 birds per treatment; each treatment was replicated three times with 15 birds per replicate in a completely randomized design (CRD).

The collected Birds were placed on experimental diets for seven weeks (49 days) and the data were collected and processed for growth performance and the economics of production of the broiler chickens. The feed was measured and data for feed offered and left over recorded on daily basis while the data for weight gain were taken and recorded on weekly basis. The growth performance of the experimental birds were determined through taking the measurements of the following parameters - feed intake, weight gain, cost of production etc. as shown below:

The Feed Intake: Feeds were weighed on daily basis before giving to the birds and leftover in each replicate collected and weighed on daily basis. The feed intake was obtained from the difference between the feed offered and the leftover, while the feed consumed by each bird was obtained by dividing the amount of feed consumed by the number of birds for each replicate.

Table 1: Proximate compositions of maize and two varieties of millet

Parameters	Maize	Pearl millet	Finger millet
Dry matter (DM) (%)	93.69	92.42	92.42
Crude protein (CP) (%)	8.84	7.72	8.84
Crude fibre (CF) (%)	2.61	3.61	3.22
Ether extracts (EE) (%)	3.01	1.50	1.20
Ash (%)	2.01	3.93	2.72
Nitrogen Free Extracts (NFE) (%)	77.22	78.20	76.93
Calcium (%)	0.30	0.32	0.30
Phosphorus (%)	0.06	0.01	0.01
Metabolizable Energy (ME) (kcal/kg)	3233.95	3308.05	3275.65

Table 2: Proximate composition of the three formulated diets

Dietary ingredients (g/100 g)	M_1		M_2		M_3	
	Starter	Finisher	Starter	Finisher	Starter	Finisher
Ground nut cake	15.00	15.00	15.00	15.00	15.00	15.00
Wheat offal	10.00	15.00	10.00	15.00	10.00	15.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Maize	71.20	66.10	0.00	0.00	0.00	0.00
Pearl millet	0.00	0.00	71.20	66.10	0.00	0.00
Finger millet	0.00	0.00	0.00	0.00	71.20	66.10
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin-mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.35	0.25	0.35	0.25	0.35
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition						
Dry matter (DM) (%)	94.96	94.42	90.70	94.96	93.00	92.49
Crude protein (CP) (%)	23.00	23.50	23.58	23.62	23.78	23.83
Crude fibre (CF) (%)	3.81	4.54	5.27	6.01	6.74	7.13
Ether extracts (EE) (%)	4.65	6.08	6.83	6.91	6.99	7.06
Ash (%)	1.20	1.22	6.94	2.59	1.20	1.70
Phosphorus (%)	0.63	0.63	0.63	0.63	0.63	0.63
Calcium (%)	1.29	1.29	1.29	1.29	1.29	1.29
Nitrogen Free Extracts (NFE) (%)	65.42	62.74	55.46	58.95	59.37	58.36
Metabolizable Energy (ME) (kcal/kg)	2900	2920	2920	2925	2925	2930

**Vitamin-mineral premix provided per kg the following: Vitamin A 1500 IU; Vitamin D3 3000 IU; Vitamin E 30 IU; Vitamin K 2.5 mg; Thiamine B1 3 mg; Riboflavin B2 6 mg; Pyrodoxine B6 4 mg; Niacin 40 mg; Vitamin B12 0.0 mg; Pantothenic acid 10 mg*

Weight Gain: The weights of birds were determined weekly by taking the weight of the birds, early in the morning, before feeding. The birds in each replicate were weighed separately and the average per birds was determined by dividing the weights of the birds by the number of birds per diet. Weight gain was calculated as the final weight minus the initial weight on a weekly basis.

Cost of Production: The Cost of production of the experimental birds were determined by calculating the cost of the feed ingredients per kg, the total cost of the feed consumed by the chickens (₦/kg) and the cost of kg weight gain in ₦/kg.

Feed Conversion Ratio: The feed conversion ratio was determined as the difference between the feed intake and the body weight gain using the formula – FCR = feed intake/weight gain.

Data Analysis: The data collected were subjected to analysis of variance (ANOVA) using

Steel and Torrie (1980), while difference between treatment means were separated for significance at 0.05 level of significance using Duncan's multiple range test (Duncan, 1955).

RESULTS

The proximate compositions of maize and two varieties of millet are presented (Table 1). The values of the proximate composition revealed that millet has nutritional value similar to maize. Diet M2 had higher level of crude fiber (3.61%), ash (3.93%) and nitrogen free extract (78.20%), while diet M3 had the highest level of CP (8.84%). The control diet (M1) recorded the highest level of ether extract (3.01) (Table 2). There were no significant differences among the diets with regards to these parameters.

The effects of two millet varieties based diets as replacement for dietary maize on growth performance of broiler chickens at starter phase showed no significant difference ($p>0.05$) among the dietary treatments except for final weight, total body weight gain and daily weight gain that were significantly ($p<0.05$) affected (Table 3).

Table 4 presents the performance characteristics of broiler chickens fed the experimental and control diets at finisher phase. There was no significant difference ($p>0.05$) among all the parameters studied across the dietary treatments.

Table 5 presents the overall performance characteristics of broiler chickens fed the experimental and control diets. There were significant difference ($p<0.05$) in all the parameters studied across the treatment groups. The initial body weight, final body weight gain, total body weight gain, total body weight gain, average daily feed intake and feed conversion ratio were not significantly ($p>0.05$) impacted by the dietary treatments both in starter, finisher and overall phase, though final body weight (671.11 – 733.33 g). Daily weight gain (23.12 – 28.09 g) and total body weight gain (485.58 – 590.00 g) were significantly affected ($p<0.05$) at starter stage.

Table 6 presents the economics of production of broiler chickens fed the millet based diets and control diet. The values for economics of production showed that millet based diets especially the finger millet based diet had significant reduction in price compared to maize based diet. The study showed that higher feed cost per kilogram was observed in control diet M1 (₦128.43), while the lowest value (₦110.34) was found in diet M2. Feed cost N per kg gain was between ₦225.54 to ₦233.46/kg; with diet M2 recording the highest cost savings (₦7.92) despite the fact that cost per kg weight gain in control diet M1 (₦233.46) was somewhat higher than the M2 (₦225.54) and M3 diet (₦232.51). There was tremendous contrast in cost of broiler production with millet being less expensive than maize irrespective of variety. Total feed intake showed that the millet based diets were palatable and acceptable to the birds than the control diets.

DISCUSSION

The finding on proximate composition ranges from 92.42 – 93.64% DM, 1.82 – 2.72% ash, 76.91 – 78.20% NFE was in agreement with the values 89.13 – 94.10% DM, 1.62 – 2.24% ash and 72.20 – 78.92% NFE reported by Ibe *et al.* (2014). Furthermore, Bulus *et al.* (2014) reported 90.31 – 96.35% DM, 1.62 – 1.89% ash and 68.06 – 80.60% NFE for broiler chickens fed two varieties of guinea corn and millets as replacement for maize. The CP and crude fibre (CF) levels obtained in the current study (7.72 – 9.53) CP and (2.61 – 3.61%) CF were lower than the 8.60 – 12.14% CP and 3.20 – 6.30% CF reported in separate studies by Bulus *et al.* (2014) and Ibe *et al.* (2014) for maize, guinea corn and millet respectively. The differences on the proximate composition of the test ingredients may be as a result of different climate conditions, time and stage at which the grains were harvested as well as the method of processing adopted. The CP levels of the experimental diets were 8.84, 7.72 and 8.84 respectively for maize, pearl millet and finger millet based diets.

The finding of the current study indicated that there was no significant difference in proximate composition of the various diets.

Table 3: Growth performance of broiler chickens fed two varieties of millet based diets as replacement for dietary maize for 2 – 4 weeks

Parameters	Dietary Treatment		
	M_1	M_2	M_3
Initial body weight (g)	185.53 ± 3.99[b]	182.22 ± 3.99[a]	183.33 ± 3.99[a]
Final body weight (g)	671.11 ± 13.71[a]	766.66 ± 13.71[b]	773.33 ± 13.71[b]
Total body weight gain (g)	485.58 ± 11.41[a]	584.44 ± 11.41[b]	590.00 ± 11.41[b]
Average daily weight gain (g)	23.12 ± 0.54[a]	27.83 ± 0.54[b]	28.09 ± 0.54[b]
Total feed intake (g)	889.55 ± 26.98[a]	1024.22 ± 26.98[b]	985.11 ± 26.98[a]
Average daily feed intake (g)	42.36 ± 1.28[a]	48.77 ± 1.28[b]	46.91 ± 1.28[b]
Feed conversion ratio (g)	1.83 ± 0.05[b]	1.75 ± 0.05[b]	1.67 ± 0.05[a]
Mortality (%)	4.40[b]	4.40[b]	2.20[a]

Means with different superscripts on the same row differ significantly (p<0.05)

Table 4: The growth performance of broiler chickens fed two varieties of millet based diets as replacement for dietary maize for 5 – 7 weeks

Parameters	Dietary treatment		
	M_1	M_2	M_3
Initial body weight (g)	671.11 ± 13.71[a]	766.66 ± 13.71[b]	733.33 ± 13.71[b]
Final body weight (g)	1561.11 ± 58.93[b]	1547.77 ± 58.93[a]	1576.60 ± 58.93[b]
Total body weight gain (g)	890.00 ± 49.42[b]	781.11 ± 49.42[a]	843.33 ± 49.42[b]
Average daily weight gain (g)	31.78 ± 1.76[b]	27.89 ± 1.76[a]	28.69 ± 1.76[a]
Total feed intake (g)	1296.19 ± 62.41[a]	1431.30 ± 62.41[b]	1331.66 ± 62.41[a]
Average daily feed intake (g)	46.29 ± 2.23[a]	51.11 ± 2.23[b]	47.55 ± 2.23[a]
Feed conversion ratio (g)	1.46 ± 0.09[a]	1.83 ± 0.09[b]	1.66 ± 0.09[b]

Means with different superscripts on the same row differ significantly (P<0.05)

Table 5: The combined growth performance of broiler chickens fed two varieties of millet based diets as replacement for dietary maize for 2 – 7 weeks

Parameters	Dietary treatment		
	M_1	M_2	M_3
Initial body weight (g)	185.55 ± 3.99	182.22 ± 3.99	183.33 ± 3.99
Final body weight (g)	1561.22 ± 58.93[a]	1547.77 ± 58.93[a]	1576.67 ± 58.93[b]
Total body weight gain (g)	1375.50 ± 55.64[a]	1365.55 ± 55.64[a]	1393.34 ± 55.64[b]
Average daily weight gain (g)	28.07 ± 1.13[b]	27.86 ± 1.13[a]	28.43 ± 1.13[b]
Total feed intake (g)	2185.74 ± 77.73[a]	2455.53 ± 77.73[b]	2316.77 ± 77.73[b]
Average daily feed intake (g)	44.60 ± 1.58[a]	50.11 ± 1.58[b]	47.28 ± 1.58[a]
Feed conversion ratio (g)	1.59 ± 0.05[a]	1.80 ± 0.05[b]	1.66 ± 0.05[a]

Means with different superscripts on the same row differ significantly (p<0.05)

Saleh *et al.* (2013) reported that millets contain high CP content and well balanced amino acid than most other cereal grains which enhance growth, feed intake and feed conversion ratio. The daily feed intake (42.36 – 48.77 g) obtained in the current study was in agreement with the reported of Kwari *et al.* (2014) who reported no significant difference (p>0.05) for daily feed intake (119.02 – 130.87 g) of broiler chickens fed maize, sorghum, millet and their combinations in the semi arid zone of Nigeria. However, Bulus *et al.* (2014) reported significant difference (p<0.05) for total body weight gain (435.6.7 – 537.83 g) and daily feed intake (36.42 – 44.43) of broiler chickens fed two varieties of guinea corn and millets as replacement for maize at the starter phase. Mortality of the birds, though not statistically analyzed was low across the treatments. Some broiler chicks, approximately 4.5% of the total experimental birds died during the starter phase.

Table 6: Cost analysis of broiler chickens fed two millet varieties based diets as replacement for dietary maize

Parameters	*Dietary treatment cost		
	M_1	M_2	M_3
Total feed intake (kg)	2.49	2.78	2.58
Cost per kg feed (₦/kg)	128.43	110.34	125.27
Total Feed Cost (₦)	319.79	306.74	323.19
Total Weight Gain (Kg)	1.37	1.36	1.39
Cost per Kg gain (₦/kg)	233.46	225.54	232.51
Cost Saving	-	7.92	0.95

** = Prevailing market price at the time of the experiment*

There were no significant (p>0.05) difference across the treatment means for final body weight (1547.77 – 1642.22 g), daily weight gain (27.89 – 31.78 g), daily feed intake (46.29 – 51.11 g) and feed conversion ratio (1.4761.83), except initial weights (671.11 – 804.44) which were significantly (p<0.5) similar and birds fed diets M2 and M3 recorded numerically higher values (766.66 and 773.33) compared to the birds fed the control diet M1 (671.11), while lowest value was recorded in diet M2 (1547.77 g). Bulus *et al*. (2014) reported lower FCR in birds fed diets containing finger and pearl millet compared with maize based diets. Higher daily feed intake and feed conversion ratio were observed in diet M2 (51.11 and 1.85 g respectively), while birds fed diet M1 recorded the lowest values (46.29 and 1.47 g respectively). The high value of feed intake in diet M2 may probably be due to high CP, high oil content and low portion of less digestible proteins (Jambunathan and Subramanian, 1988). Millet is also free tannin that can interfere or slowdown digestibility. The lower feed intake of maize may be attributed to the level of oil in maize which affect voluntary intake by birds (Zand and Foroudi, 2011).

During the finisher phase, the daily feed intake (44.60 – 50.11 g) was not significantly different (p>0.05) across the dietary treatments which was in agreement with the report of Yunusa *et al.* (2014) who replaced millet for maize and obtained no significant difference (p>0.05) in daily feed intake when substituting yellow maize for sorghum on broiler performance. The result was equally in conformity with the report of Maidala and Abdullahi (2016) who stated that all dietary maize portions in broiler diets can be replaced with low tannin sorghum without adverse effect on feed intake. The daily weight gain values (27.89 – 31.78 g/bird/day) obtained in this study was lower than the values (31.57 – 43.01 g/bird/day) reported by Ibe *et al.* (2014) who fed diets containing two varieties each of guinea corn and millet. There was no significant difference (p>0.05) in daily weight gain (27.89 – 31.78 g) and feed conversion ratio (1.46 – 1.85). This finding was in line with the study of Medugu *et al.* (2010) who reported no significant difference (p>0.5) for daily weight gain (34.66 – 43.17), and feed conversion ratio (2.24 – 2.94) when broiler chickens were sorghum or millet as replacement for maize. The feed conversion values (1.47 – 1.85 g) obtained in the present study were in line with the values (1.91 – 1.97 g) reported by Wakibia (2015), but slightly close to the values (1.74 – 2.14 g) reported by Akinola *et al.* (2015). However, the findings of this study were not in agreement with the report of Ibe *et al.* (2014), Bolus *et al.* (2014) and Abakisi *et al.* (2015) who reported significant difference (p<0.05) in their separate studies when maize was replaced with guinea corn, millet and millet residue based diets in broiler diets.

The result of the combined performance (body weight, daily weight gain, daily feed intake and feed conversion ratio) of broiler chickens in this study was in agreement with the findings of Yunusa *et al.* (2014). Yunusa *et al.* (2014) fed broiler chickens with different energy sources and measured their performance. The results of both studies suggested that the energy source (millet variety) had significant effect on the performance of broiler chickens. The highest feed intake recorded for diet M2 suggests that millet is free from anti-nutritional properties (phytate and tannins) and contain more mineral and high protein than maize (NRC, 1996). The millet groups have the highest daily feed intake and feed conversion ratio, pearl millet (50.11 and 1.80 g), finger millet (47.74 and 1.62 g) respectively when compared to maize (44.60 and 1.59 g) at the combined phase. This could be attributed to the high oil content in millet

than other common cereal grains in the diet which has been reported to enhance growth, feed conversion ratio, improve appetite and ameliorate the growth depressive effects of heat stress (Medugu *et al.*, 2010). The non-significant ($p>0.05$) difference in daily weight gain (43.80 – 53.98 g) of broiler chickens. The results for feed conversion ratio in both the starter (1.64 – 1.83), finisher (1.47 – 1.85) and overall (1.59 – 1.80) phases showed no significant difference ($p>0.05$) across the treatment groups, however, the highest feed conversion ratio was recorded in diet M2 (1.80 g).

The cost per kg feed was higher in maize based diet M1 (₦128.43) than the cost of different millet based diets (₦124.34 – ₦125.95). The higher values of maize are due to the high cost of maize in the international market is 5% higher when compared to sorghum and millet. The total feed cost per kg gain was higher in pearl millet based diet. The findings of this study were in agreement with the findings of Kekeocha (1984) and Esonu *et al.* (2003) who reported economic benefits in feeding alternative low cost feed materials to poultry birds as such feed resources reduced cost of feed and maximize the returns from poultry farming. Considering the weight gain of birds and the feed cost per weight gain, it can be concluded that millet can completely replace maize in broiler chicken diets without adverse effects on growth performance and the added advantage is the concomitant reduction of cost of feeding the broiler chickens.

Conclusion: The findings concluded that: (i) Broilers fed finger millet-based diets performed favorably than broiler chicks fed the control (maize based) diets. (ii) The two millet varieties (pearl millet and finger millet) can be used as an alternative feed option for dietary maize in broiler diets without adverse effects on growth performance and the economy of production of broiler chickens, and (iii) Using the millet varieties (pearl millet and finger millet) to replace maize can help cut down the cost of feed and broiler production, particularly in the areas where the climatic conditions favor the production of millet in large quantities. Based on the findings of this study, the following recommendations are made: (i) Millets should be used by farmers as an alternative energy sources in broiler diets without any adverse effects on the growth performance, (ii) Millet should replace maize in poultry feeds because doing so will cut down the cost of broiler productions, increasing the farmers' profit, and (iii) Entrepreneurial skills acquisition centers should be supported through the provision of required incentives to make the teaching and learning of agriculture more practical oriented.

ACKNOWLEDGEMENTS

The authors acknowledge the assistance and cooperation of the academic and non academic staff of Michael Okpara University of Agriculture, Umudike and Department of Biochemistry, National Root Crop Research Institute, Umudike; Abia State, Nigeria. Special thanks also go to Professor C. I. Obi and Dr. V. C. Asogwo for their professional guidance and directions.

REFERENCES

ABAKISI, F., ATUAHENE C. C., ARROH-KOTOKU, V. and ADJEI, B. M. (2015). Response of broilers to "Dusa", a millet residue meal: proximate composition and effect on growth performance. *Journal of Animal Science Advances*, 5(5): 1273 – 1278.

ABDULRAHMAN, O. L., OLATUNDE, P. F., BELLO, O. G., AYANDA, I. F. and OYEGBAMI, G. (2022). Poultry feed crisis in Nigeria: implication for poultry production in Kwara State. *Journal of Agriculture and Environment*, 18(2): 15 – 24.

ADEYONU, A. G., OKUNOLA, A., ALAO, M. E., OYAWOYE, E. O. and OKONKWO, C. E. (2021). An assessment of broiler value chain in Nigeria. *Open Agriculture*, 6(1): 296 – 307.

AKINOLA, L. A. F., EKINE, O. A. and EMEDO, C. C. (2015). Performance and carcass evaluation of broilers fed whole millet meal in a humid tropical environment.

American Journal of Experimental Agriculture, 7(2): 135 – 140.

ANOSIKE, F. U., REKWOT, G. Z., OWOSHAGBA, O. B., AHMED, S. and ATIKU, J. A. (2018). Challenges of poultry production in Nigeria: a review. *Nigerian Journal of Animal Production*, 45(1): 252 – 258.

ATTEH, J. O. (2003). *Romancing the Chicken*. The Sixty-Eighth Inaugural Lecture, Thursday 26th June 2003, Library and Publications Committee, University of Ilorin, Ilorin, Nigeria.

BULUS, E. D., IBE, E. A., YAKUBU, 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.

DUNCAN, D. B. (1955). Multiple range and multiple F tests. *Biometrics*, 11(1): 1 – 42.

ESONU, B. O., IHEUKWUMERE, F. C., IWUJI, T. C., AKANU, N. and NWUGO, O. H. (2003). Evaluation of *Microdesmis puberula* leaf meal as feed ingredient in broiler starter diets. *Nigerian Journal of Animal Production*, 30(1): 3 – 8.

FAO (2013). *Poultry Development Review.* Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. https://www.fao.org/3/i3531e/i3531e.pdf

FAO (2014). *Livestock Country Reviews - Poultry Sector Ghana*. FAO Animal Production and Health, Food and Agriculture Organization of the United Nations, Rome, Italy. https://www.fao.org/3/i3663e/i3663e.pdf

FILARDI, R. S., JUNQUEIRA, O. M., CASARTELLI, E. M., LAURENTIZ, A. C., DUARTE, K. F. and ASSUENA, V. (2005). Pearl millet utilization in commercial laying hen diets formulated on a total or digestible amino acid basis. *Brazilian Journal of Poultry Science*, 7(2): 99 – 105.

IBE, E. A., MAKINDE, J. O., OGUNDIPE, S. O., DURU, S., BABAJIDE, S. E. and SAMUEL, I. (2014). Growth performance and carcass characteristics of broiler chickens fed two varieties each of guinea corn and millet as replacements for dietary maize. *World Journal of Life Science and Medical Research*, 3(2): 46 – 52.

JAMBUNATHAN, R. and SUBRAMANIAN, V. (1988). Grain quality and utilization of sorghum and pearl millet. Pages 1330 – 1339. *In: Proceedings Workshop on Biotechnology for Tropical Crop Improvement*, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India.

KEKEOCHA, C. C. (1984). *Pfizer Poultry Production Handbook*. Macmillan, London.

KWARI, I. D., IGWEBUIKE, J. U., SHUAIBU, H., TITIMA, S. I. and RAJI, A. O. (2014). Growth and carcass characteristics of broiler chickens fed maize, sorghum, millet and their combinations in the semi arid zone of Nigeria. *Global Journal of Bioscience and Biotechnology*, 5(2): 240 – 245.

MAIDALA, A. and ABDULLAHI, I. B. (2016). Utilization of millet (*Pennisetum* spp.) as an energy source by broiler chickens: a review. *International Journal of Agriculture and Earth Science*, 2(7): 18 – 24.

MEDUGU, C. I., KWARI, I. D., IGWEBUIKE, J., NKAMA, I., MOHAMMED, I. D. and HAMAKER, B. (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*, 1(3): 321 – 325.

NRC (1996). *Nutrient Requirements of Poultry*. 9th Revised Edition, National Academy of Sciences, National Research Council, Washington D. C., USA.

NYANNOR, E. K. D., ADEDOKUN, S. A., HAMAKER, B. R., EJETA, G. and ADEOLA, O. (2007). Nutritional evaluation of high-digestible sorghum for pigs and broiler chicks. *Journal of Animal Science*, 85(1): 196 – 203.

ODUKOYA, S. O., ORIMOGUNJE, A. A., YAHAYA, M. O. and SAKA, A. A. (2019). Growth response and carcass characteristics of broiler chickens on different daily feeding frequency. *Nigerian Journal of Animal Science*, 21(2): 106 – 111.

OJO, S. O. (2003). Productivity and technical efficiency of poultry egg production in Nigeria. *International Journal of Poultry Science*, 2(6): 459 – 464.

RACHIE, K. O. and PETERS, L. V. (1977). *The Eleusine – A Review of the World Literature.* International Crops Research Institute for Semi-Arid Tropics, Hyderabad, India. https://pdf.usaid.gov/pdf_docs/pnaah492.pdf

SALEH, A. S. M., ZHANG, Q., CHEN, J. and SHEN, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Comprehensive Reviews in Food Science and Food Safety*, 12(3): 281 – 295.

STEEL, R. G. D. and TORRIE, J. H. (1980). *Principles and Procedures of Statistics: A Biometrical Approach*. 2nd Edition, McGraw-Hill Book Company, New York.

WAKIBIA, F. W. (2015). *Effect of Pearl Millet and Selected Grain Legumes on Growth Performance and Carcass Quality of Broiler Chicken.* Doctoral Dissertation, University of Nairobi, Nairobi, Kenya.

WIKIPEDIA (2023). *Umudike*. https://en.wikipedia.org/wiki/Umudike Accessed August 29, 2023.

YUNUSA, Y., DOMA, U. D., ZAHRADDEEN, D., UMAR, A. and ABUBAKAR, S. B. (2014). Carcass and gut characteristics of broiler chicken fed different energy sources. *International Journal of Poultry Science*, 13(9): 525 – 529.

ZAND, N. and FOROUDI, F. (2011). Effect of feeding different levels of corn snack waste on broiler performance. *African Journal of Biotechnology*, 10(7): 1260 – 1264.