



Growth Performance, Nutrient Digestibility and Cost Benefits of Broiler Chickens Fed Diets with Milled Maize, Sorghum, Millet and Their Combinations with Whole Millet in a Semi – Arid Zone of Nigeria.

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Abstract

The experiment was carried out to evaluate the effect of feeding diets containing milled maize, milled sorghum, milled millet and their combinations on the growth performance, digestibility and cost benefit of production of broiler chickens. The experiment lasted for 42 days. Three hundred and six (306) unsexed day-old broiler chicks weighing averagely 368.77 g were randomly distributed to six experimental groups consisting of 51 birds per group with three (3) replicates of 17 birds each. The control group designated T₁, was fed a diet containing 100% milled maize. Other groups were, T₂ (milled sorghum 100%), T₃ (milled millet 100%), T₄ (50% milled maize + 50% whole millet), T₅ (50% milled sorghum + 50% whole millet) and T₆ (50% milled millet + 50% whole millet). The results showed that there were no significant ($P < 0.05$) difference in final body weights among the treatment groups. The final weight gains were 2070.30, 2113.90, 2232.00, 2193.10, 2159.10 and 2108.60g for T₁, T₂, T₃, T₄, T₅ and T₆, respectively. However, the results showed significant ($P < 0.05$) difference in feed intake and daily weight gain, with T₁ (milled maize 100%) and T₃ (milled millet 100 %) recording higher values for these parameters, respectively. The feed conversion ratio was better in T₃ (milled millet 100 %). The digestibility results showed that T₆ (50% millet + 50 % whole millet) had higher dry matter digestibility compared to the other treatments. The cost of feed per unit weight gain was low in millet-based diets. These results suggest that milled maize, sorghum, and millet and their 50: 50 combinations with whole millet had no adverse effect on the growth and economic performance of broiler chickens.

Keywords: Maize, Sorghum, Millet, Growth, Nutrient Digestibility and Cost Benefit

Introduction

Cereals grains, especially maize which form the bulk of energy in poultry feed, is in short supply as a result of industrial and human needs. This has resulted in competition between humans and animals for available feed resources, hence brought about high cost of poultry production. However, the important measure that can be taken to alleviate such problem is the use of alternatives sources of energy like sorghum and millet. The semi- arid condition of northern Nigeria having high ambient temperature ($>38^{\circ}\text{C}$) for most part of the year, with low and poorly distributed rainfall makes it more conducive for sorghum and millet production. Sorghum (*Sorghum bicolor*) is a crop which can be successfully

cultivated in the semi-arid region of Asia and Africa and it is cheaper and more readily available than maize (Ravindra and Blair, 1992; Douglas *et al.*, 1993). In terms of nutritive value, cost and availability, sorghum is the next alternative to maize in poultry (Subramanian and Metta, 2000).

Studies have also shown that pearl millet is a promising crop for areas in which drought, soil type and short rainy season diminish the yield potential of sorghum. For non- ruminants, pearl millet has metabolizable energy that is equivalent to that of maize (Abate and Gomez 1984; Francer *et al.*, 1987; Amato and Forrester 1995). NRC (1996) reported that millet has no tannin. Millet has higher protein

and mineral content than maize, and studies conducted by some researchers (Singh and Barsoul, 1976; Sharma *et al.*, 1979, Medugu *et al.*, 2010) have shown that millet could be compared with maize in poultry diets. Reddy *et al.* (1989) obtained better body weight while feeding broiler with whole millet. Therefore, the objective of the study was to evaluate the growth performance, nutrient digestibility and cost benefits of production of broiler chickens fed diets with milled maize, sorghum, millet and their combinations with whole millet in semi – arid Nigeria.

Materials and Methods

Study Site

The study was carried out at the Livestock Teaching and Research Farm, Department of Animal Science, University of Maiduguri, Maiduguri, Borno State. Maiduguri is situated between latitudes $11^{\circ} 5'$ and 12° N, longitudes $13^{\circ} 09'$ and 15° E and at an altitude of 354 m above sea level. The area falls within the sahelian (semi-arid) region of West Africa which is noted for its great climatic and seasonal variation. It has short period of rainfall of 3-4 months giving 645.9 mm per annum with a long dry season of about 8-9 months (Afolayan *et al.*, 2013). The ambient temperature could be as low as 20° C during the dry cold (October-January) season and as high 44° C during dry hot (March -May). Relative humidity may be as low as 5% in April and May. Day length varies from 11-12 hours (Raji *et al.*, 2009).

Experimental Stock and Management

A total of three hundred and six (306) mixed sex broiler chicks were purchased from Zams Nigeria Ltd. Before the arrival of the chicks, the brooding house was cleared, washed and disinfected with izal[®]. The feeders and drinkers were also washed and disinfected. The chicks were raised on deep litter floor using wood shavings as litter material. Brooding was by means of charcoal stove as a

source of heat. Temperature of the brooding room was controlled by either reducing or increasing the charcoal or removal of the charcoal stove.

On the arrival at the farm, glucose was added to the birds' drinking water as an anti-stress. The chicks were weighed individually at 2 weeks of age and randomly allocated to six (6) dietary treatments in groups of 51 chicks with 3 replicates of 17 chicks each in a completely randomized design (CRD). Each group received one of the experimental diets and clean drinking water *ad libitum* for a period of 42 days. The chicks were fed commercial starter feed for the brooding period of two weeks and the experimental starter diets for the remaining two weeks of the starter period. The experimental finisher diets were fed from week's five to nine. The birds were vaccinated against infectious bursa disease (Gumboro) at week 2 of age via drinking water, while at the age of 5 weeks, Newcastle disease vaccine was administered. Proper sanitation was maintained throughout the experimental period of 42 days.

Experimental Diets

The experiment diets were formulated using three different cereal grains (maize, sorghum and millet). The diets were:

- T₁ (control) = 100% Maize,
- T₂ = 100% Sorghum,
- T₃ = 100% Millet,
- T₄ = 50% Maize (milled) + 50% Millet (whole)
- T₅ = 50% Sorghum (milled) + 50% Millet (whole)
- T₆ = 50% Millet (milled) + 50% Millet (whole)

The experimental starter and finisher diets were fed for the period of the experiment. The composition of the experimental starter and finisher diets is shown in Tables 1 and 2, respectively.

Data Collection

During the experiment, the following data were collected:

Feed intake: Known quantities of feed were offered in the morning and left over were measured the next morning. The difference was considered as feed intake. This was measured daily

Body weight gain: This was measured weekly per bird. The current body weight was subtracted from the weight of the previous week to obtain the weight gain.

Feed conversion ratio (FCR): This was calculated as the ratio of intake to weight gain.

$$\text{FCR} = \frac{\text{Feed intake of the birds(g)}}{\text{Weight gain of bird (g)}}$$

Mortality

All dead birds were recorded during the period of the experiment and post-mortem examination was conducted to ascertain the possible cause of death.

Digestibility Trial

During the last week of the experimental period, three birds from each treatment were randomly selected for digestibility study. The selected birds were kept in a metabolism cage, and were fed known quantities of the respective experimental diet and the left over recorded the next day to determine feed intake. The daily faeces excreted by the individual birds were collected and sundried in order to determine the faecal output.

Table 1: Composition and Calculated Analysis of the Experimental Starter Diet

Ingredient (%)	Diets/ Treatments					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Maize (milled)	44.39	-	-	22.20	-	-
Sorghum (milled)	-	44.39	-	-	22.20	-
Millet (milled)	-	-	44.39	-	-	22.20
Millet (whole)	-	-	-	22.20	22.20	22.20
Wheat bran	10.20	10.20	10.20	10.20	10.20	10.20
Soya bean meal	34.63	34.63	34.63	34.62	34.62	34.62
Fish meal	6.93	6.93	6.93	6.93	6.93	6.93
Bone ash	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%)						
Crude protein (CP)	22.45	22.89	22.45	22.45	22.67	22.45
Calcium (Ca)	1.37	1.21	1.21	1.21	1.21	1.21
Phosphorus (P)	0.90	0.86	0.86	0.86	0.86	0.86
Ether extract (EE)	3.66	3.21	3.66	3.66	3.43	3.66
Crude fibre (CF)	4.08	4.08	4.74	5.41	3.63	3.74
ME (kcal/kg)	2847.0	2789.0	2460.0	2654.0	2625.0	2460.0

ME = Metabolizable Energy

*Premix supplying the following per kg of feed; Vitamin A= 12000IU, Vitamin E= 15000mg, Folic acid= 1000mg, Pantothenic acid= 15000mg, B₁₂= 15000mg, Mn= 100mg, Vitamin D₃= 2,500,000IU, Nicotinic acid= 40,000mg, Vitamin B₁= 6000mg, Vitamin B₂= 2000, Biotin= 6000mg, Vitamin C=3000mg, Copper= 15000, Cobalt= 250mg and Selenium= 1000mg, T₁ (control) = 100% Maize, T₂ = 100% Sorghum, T₃ = 100% Millet, T₄ = 50% Maize (milled) + 50% Millet (whole), T₅ = 50% Sorghum (milled) + 50% Millet (whole) and T₆ = 50% Millet (milled) + 50% Millet (whole)

Table 2: Composition and Calculated Analysis of the Experimental finisher Diet

Diets/ Treatments

Ingredient (%)	T₁	T₂	T₃	T₄	T₅	T₆
Maize (milled)	48.92	-	-	24.46	-	-
Sorghum (milled)	-	48.92	-	-	24.46	-
Millet (milled)	-	-	48.92	-	-	24.46
Millet (whole)	-	-	-	24.46	24.46	24.46
Wheat bran	15.46	15.46	15.46	15.46	15.46	15.46
Soya bean meal	26.48	26.48	26.48	26.48	26.48	26.48
Fish meal	5.29	5.29	5.29	5.29	5.29	5.29
Bone ash	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Lysine	0.15	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15	0.15
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis (%)						
Crude protein (CP)	19.96	20.45	19.96	19.96	20.21	19.96
Calcium (Ca)	1.34	1.16	1.16	1.16	1.16	1.16
Phosphorus (P)	0.92	0.88	0.88	0.88	0.88	0.88
Ether extract (EE)	3.67	3.18	3.67	3.67	3.42	3.67
Crude fibre (CF)	4.06	4.06	5.99	5.55	5.53	4.99
ME (kcal/kg)	2834.0	2770.0	2408.0	2621.0	2589.0	2408.0

ME = Metabolizable Energy *Premix supplying the following per kg of food; Vitamin A= 12000IU, Vitamin E= 15000mg, Folic acid= 1000mg, Pantothenic acid= 15000mg, B₁₂= 15000mg, Mn= 100mg, Vitamin D₃= 2,500,000IU, Nicotinic acid= 40,000mg, Vitamin B₁= 6000mg, Vitamin B₂= 2000, Biotin= 6000mg, Vitamin C=3000mg, Copper= 15000, Cobalt= 250mg and Selenium= 1000mg. T₁ (control) = 100% Maize, T₂ = 100% Sorghum, T₃ = 100% Millet, T₄ = 50% Maize (milled) + 50% Millet (whole), T₅ = 50% Sorghum (milled) + 50% Millet (whole) and T₆ = 50% Millet (milled) + 50% Millet (whole)

The faeces were bulked according to treatment and thoroughly mixed. The dried faeces samples were well-labelled and taken to the laboratory for oven-dry and analysis. The apparent digestibility coefficient was calculated as follows:

$$\text{Apparent digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \times 100$$

Where;

Nutrient intake = feed intake x % Nutrient in feed

Nutrient in faeces = faecal output % Nutrient in faeces.

Cost benefit analysis

The economic implication of all the diets for growing broilers was assessed by calculating the;

- Cost per kilogram of each diet based on the cost of the ingredients during the experimental period (May – August, 2015).
- Cost of feeding the broilers
- Cost per kilogram of weight gain by the broiler chicken.

Chemical Analysis

The proximate composition of test ingredients (maize, sorghum and millet grains), the experimental diets and faeces were analysed using AOAC (2006) methods.

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) in a completely randomized design (Steel and Torrie, 1980) using Statistix 9.0 (Statistix, 2008). Where applicable, means were separated using Least Significant Difference.

Results and Discussion

Chemical composition of the Experimental diets

The chemical composition of the experimental diets is presented in Table 3 for both broiler starter and finisher diets, respectively. The crude protein values for starter and finisher diets ranged from 22.45 to 22.89 % and 19.96 to 20.45 %, respectively. These values were similar to the those recorded by Medugu *et al.* (2010) who obtained 21.60 to 33.95 for starter and 20.75 to 21.85% for finisher, while feeding broilers with sorghum or millet as a replacement for maize in semi- arid zone of Nigeria. The crude fibre obtained in the experiment was 3.63 to 5.41% for starter diets and 4.06 to 5.99% for finisher diets. These values are in line with NIS (1989) recommendations. The metabolizable energy obtained in this experiment ranged from 2460 to 2847 Kcal/kg for starter diets and 2408 to 2834 Kcal/ kg for finisher diets. These values fall within the range of recommended energy levels for broilers as reported by Olomu (2011). This shows that all the experimental diets are capable of supporting the growth and development of broiler chickens at both starting and finishing stages.

Productive Performance

The results of the productive performance indices of broilers chickens fed with milled maize, sorghum or millet and their 50:50

combinations with whole millet are presented in Table 4.

Feed Intake

The feed intake was significantly ($P < 0.05$) different among the treatment groups. The values ranged from 111.63 to 122.76 g per bird. From this experiment, the highest value was obtained for T₁ (Milled maize, 100%) and the lowest T₃ (Milled millet, 100%). These values were close to those reported by Medugu *et al.* (2010) who fed broiler chickens with sorghum or millet as an alternative to maize as well as values obtained by Shuaibu (2014) who fed broiler chicken with maize, millet sorghum and their combination. Therefore, using milled cereals (maize, sorghum, and millet) and whole with 50: 50 combination had no adverse effect on feed intake.

Daily weight gain

The daily weight gain indicates the growth rate of the birds per day and there were significant ($P < 0.05$) differences among the treatments as shown in Table 4. The values obtained ranged from 40.36 to 44.19 g/day/bird. The highest value was obtained for T₃ (milled millet 100%) and control (T₁. 100% maize), the lowest. These values (40.36 to 44.19 g) were lower than the ones reported by Kwari *et al.* (2014) who fed diets containing graded levels of low- tannin sorghum at inclusion levels of 25, 50, 75 and 100 % as a replacement for maize. However, the values (40.36 to 44.19g) were similar to the values reported by Medugu *et al* (2010) who fed broiler chickens with sorghum or millet as a replacement for maize. This variation may be attributed to the strain or weather condition when the experiments were carried out.

Table 3: Proximate composition of the Experimental broiler starter and finisher diets

Components (%)	Treatments/Diets					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
	Maize (100%)	Sorghum (100%)	Millet (100%)	Maize 50% +	Sorghum 50% +	Millet 50 % +

				Whole Millet 50%	Whole Millet 50%	Whole Millet 50%
Starter Diets						
DM	97.60	97.90	97.90	98.00	97.30	97.90
Moisture	2.45	2.10	2.10	2.00	2.70	2.10
CP	22.40	22.89	22.45	22.45	22.67	22.45
EE	3.66	3.21	3.66	3.66	3.43	3.66
CF	4.08	4.08	4.74	5.41	3.63	3.74
Ash	2.00	3.00	2.00	1.00	3.00	2.00
NFE	65.41	64.72	65.05	65.48	64.56	65.05
ME(Kcal/kg)	2847.00	2789.00	2460.00	2654.00	2625.00	2460.00
Finisher diets						
DM	98.10	98.00	97.80	97.10	97.40	97.10
Moisture	2.90	2.00	2.20	2.90	2.60	2.90
CP	19.96	20.45	19.96	19.96	20.21	19.96
EE	3.67	3.18	3.67	3.67	3.42	3.67
CF	4.06	4.06	5.99	5.55	5.53	4.99
Ash	2.00	3.00	2.00	3.00	3.00	3.00
NFE	67.41	67.31	65.18	64.94	65.24	65.24
ME(Kcal/kg)	2834.00	2770.00	2408.00	2621.00	2589.00	2408.00

DM= Dry Matter, CP= Crude Protein, EE= Ether Extract, CF= Crude Fibre, NFE= Nitrogen Free Extract and ME= Metabolizable Energy (Kcal/ Kg).

Table 4: Performance of Broiler chickens fed maize, sorghum, millet and their combinations with 50% whole millet as energy source.

	Treatments/ Diets						
	T₁	T₂	T₃	T₄	T₅	T₆	SEM
Parameters							
Initial body weight(g)	375.25	365.33	375.17	368.17	356.31	371.83	4.55 ^{NS}
Final Body weight(g)	2070.30	2113.90	2232.00	2193.10	2159.10	2108.60	85.3 ^{NS}
Daily feed intake(g)	122.76 ^a	113.92 ^{ab}	111.63 ^b	114.84 ^{ab}	112.04 ^b	116.08 ^{ab}	3.14 [*]
Daily weight gain(g)	40.36 ^c	41.16 ^c	44.19 ^a	43.45 ^{ab}	42.92 ^{bc}	41.14 ^c	1.64 [*]
Feed Conversion ratio	3.04 ^d	2.77 ^c	2.53 ^a	2.64 ^b	2.61 ^b	2.82 ^c	0.11 [*]
Mortality (Number)	5	6	7	8	7	9	NA

a, b, c means within the same rows bearing different superscript differ significantly ($P \leq 0.05$) * = Significant NS = Non significant SEM = Standard Error of Means NA = Not applicable T₁ = Milled maize 100 % T₂ = Milled sorghum 100 % T₃ = Milled millet 100 % T₄ = Milled maize 50 % + whole millet 50 % T₅ = Milled sorghum 50 % + whole millet 50 % T₆ = Milled millet 50 % + whole millet 50 %

Final live weight

The results on body final weights are presented in Table 4. There was no significant ($P > 0.05$) difference among all the treatment. The value recorded were between 2070.30 and 2232 g, and these values compared favourably with the work of Medugu *et al.* (2010) who recorded 1931.37 2218.67 g, for final body weight for broilers fed diets containing maize, millet, low-tannin sorghum and high-tannin sorghum. Kwari *et al* (2014) reported final

body weight of 2298.00 to 2352.70 g for broilers fed diets containing low-tannin sorghum at inclusion levels of 25, 50, 75 and 100% as replacement for maize in broiler chickens diets. The final weights (2070.30-2232.00 g) were higher than the values (1788.33-1888.44 g) reported by Adamu *et al.* (2001) who fed diets containing pearl millet at inclusion levels of 10, 33, 67 and 100% in broilers diet. These differences may be

attributed to genetic factors associated with strain difference.

Feed conversion ratio

The results of feed conversion ratio (FCR) are presented in Table 4. There were significant ($P < 0.05$) differences across the treatments. The values obtained ranged from 2.53 to 3.04. The worst value was obtained from T₁ (maize 100%) and the best value was T₆ (Milled millet 50% + whole millet 50%). These values were supported by the results obtained by Medugu *et al.* (2010) who reported FCR of 2.24-2.94, while Shuaibu (2014) recorded 2.46 – 2.8 for broilers fed broiler sorghum or millet as a replacement for maize. Kwari *et al.* (2014) who fed diets containing graded level of low-tannin sorghum at inclusion levels of 25, 50, 75 and 100% as a replacement of maize, reported 2.46 to 2.80. These values are close to the ones obtained in this study.

Mortality

The experiment recorded a mortality of forty-two (42) birds. The highest of nine (9) birds was recorded in T₆ (Milled millet 50% + whole millet 50%), followed by 8 birds recorded in T₄ (milled sorghum 50% + whole millet 50%). The lowest (3) was recorded in T₃ (100% milled millet) as presented in Table 4. The mortality in each treatment was ascertained after post-mortem examination. The implicated cause of death was the heat stress during the period of the experiment. During this period, the ambient temperature was as high as 40° C.

Nutrient Digestibility

The result of the digestibility coefficient of various nutrients is presented in Table 5. Dry matter, crude protein, ether extract, crude fibre, ash and nitrogen-free extract are significant ($P < 0.05$) different among the treatment. Dry matter digestibility results showed that T₆ (50% milled millet + 50% whole millet) produced significantly ($P < 0.05$)

higher dry matter digestibility (77.29%) which is comparable with T₂ (100% sorghum), T₃ (100% millet), T₄ (50% maize + 50% whole millet) and T₅ (50% sorghum + 50% whole millet) while T₁ (100% maize) produced the lowest dry matter digestibility (66.31%). With respect to crude protein digestibility, T₄ (50% maize + 50% whole millet) and T₆ (50% milled millet + 50% whole millet) recorded the highest significant value of 86.25 and 85.87% which are comparable with T₁ (100% maize), T₂ 100% sorghum) and T₅ (50% sorghum + 50% whole millet), but T₃ (100% millet) and T₅ (100% millet) produced the lowest value of 78.67%. However, T₃ (100% millet) was similar to control (100% maize).

The result of ether extract digestibility showed that T₁ (100% Maize) and T₆ (50% milled millet + 50% whole millet) produced significantly higher values of 91.39 and 91.90%, respectively which were comparable with T₂ (100% sorghum). T₄ (50% maize + 50% whole millet) and T₅ (50% sorghum + 50% whole millet) and the lowest value (83.64%) was recorded in T₃ (100% millet). The highest (45.71%) crude fibre digestibility was observed T₃ (100% millet), while the lowest (25.71%) was obtained in T₆ (50% milled millet + 50% whole millet). The highest value of ash digestibility was observed in T₂ (100% sorghum) and T₆ (50% milled millet + 50% whole millet). The highest value of ash digestibility was observed in T₂ (100% sorghum and T₆ (50 % milled millet + 50% whole millet, but the values are comparable with T₁ (100% maize), T₄ (50% maize + 50% whole millet and T₅ (50% milled sorghum + whole millet) while the lowest value (75.23%) was observed in T₃ (100% millet). The results of nitrogen-free extract digestibility showed that T₃ (100% millet), T₄ (50% maize + 50 whole millet) and T₆ (50% milled millet + 50% whole millet) recorded the highest values which were better than the other treatments. However, the other treatments, T₁ (100%

maize), T₂ (100% sorghum) and T₅ (50% sorghum + 50% whole millet) were comparable with each other. Medugu *et al.* (2018) who replaced maize with sorghum stated that the variation in dry matter digestibility may be attributed to the environmental condition and the variety of sorghum.

used. The crude protein digestibility of this study (80.66-86.25%) are comparable to the values (95.3-98.5%) of Hidalgo *et al.*, (2004)

who fed broilers containing 5, 10, 15 and 20% whole pearl millet, respectively. These results indicate that whole pearl millet can be readily broken down by young broilers and thus can be incorporated into their diets. The low crude protein digestibility observed in treatment T₂ (100% sorghum) and T₅(50% sorghum + 50% whole millet) could be attributed to tannin content of the sorghum as observed by other workers (Medugu *et al.*, 2010, Kwari *et al.*, 2014).

Table 5: Nutrient digestibility (%) of broiler chickens fed, maize, sorghum, millet and their 50% combination with whole millet.

Treatments/Diets	T ₁ Maize (100%)	T ₂ Sorghum (100%)	T ₃ Millet (100%)	T ₄ Maize 50% + Whole Millet 50%	T ₅ Sorghum 50% + Whole Millet 50%	T ₆ Millet 50% + Whole Millet 50%	SEM
Components (%)							
DM	66.31 ^b	69.49 ^{ab}	72.05 ^{ab}	69.98 ^{ab}	69.47 ^{ab}	77.29 ^a	3.45 [*]
CP	85.34 ^{ab}	85.13 ^{ab}	78.67 ^b	86.25 ^{ab}	80.66 ^{ab}	85.87 ^a	2.19 [*]
EE	91.39 ^a	85.99 ^{ab}	83.64 ^b	90.27 ^{ab}	88.80 ^{ab}	91.90 ^a	2.29 [*]
CF	32.44 ^c	35.71 ^{bc}	45.71 ^a	40.50 ^{ab}	29.03 ^{cd}	24.02 ^d	2.46 [*]
Ash	77.48 ^{ab}	86.47 ^a	75.23 ^b	83.02 ^{ab}	84.44 ^{ab}	87.10 ^a	3.23 [*]
NFE	63.31 ^b	62.08 ^b	70.40 ^a	74.37 ^a	64.73 ^b	72.14 ^a	1.52 [*]

DM= Dry Matter, CP= Crude Protein, EE= Ether Extract, CF= Crude Fibre, NFE= Nitrogen-Free Extract.

a, b, c means within the same rows bearing different superscript differ significantly (P ≤ 0.05) * = Significant NS = Non significant SEM = Standard Error of

Means NA = Not applicable T₁ = Milled maize 100 % T₂ = Milled sorghum 100 % T₃ = Milled millet 100 % T₄ = Milled maize 50 % + whole millet 50 % T₅ = Milled sorghum 50 % + whole millet 50 % T₆ = Milled millet 50 % + whole millet 50 %

The results of the ether extract digestibility (83.64-91.91 %) obtained in this study is in consonance with the those of Kwari *et al.* (2014) who obtained similar values in broiler chickens fed diets containing maize, sorghum and millet. This could be attributed to the fact that these diets have high fat content. Ojewola and Longe (1999) obtained higher ether extract digestibility in diets containing higher fat levels.

The highest value for crude fibre digestibility was observed in T₃ (100% millet) and T₄ (50% maize + 50% whole millet) which was significantly (P<0.05) different across the treatment groups and higher than the control.

However, fibre is not readily digestible in monogastrics. Cheeke and Meyer (1975) stated that high fibre increases the rate of passage of feed through the gut, hence reduces digestibility. The fibre tends to encrust other nutrients particularly when the lignin is high. Nwokolo *et al.* (1985) reported that as intake of dietary fibre increases, the apparent digestibility of the other components of the diet decreases. It was observed from this study that the fibre content is within the range (4-6%) of fibre requirement for broiler chickens as recommended by Olomu (2011) and hence the adverse effect of fibre on digestibility was not very pronounced in this study. Similarly, the ash utilization in all the treatment is

relatively high (75.23-87.10%). This goes to support the assertion by Underwood (1980) that animals fed balance diets seldom vary in their ash utilization.

The values for nitrogen-free extract (NFE) showed that all the treatments were statistically different ($P < 0.05$) with T₃ (100% millet), T₄ (50% maize + 50% whole millet) and T₆ (50% millet + 50% whole millet) better than the control, while T₂ (100% sorghum)

and T₅ (50% sorghum + 50% whole millet), are similar with the control. The values obtained here are in agreement with the result of other workers (Kwari *et al.*, 2011) who fed similar diets to broiler chickens

Cost benefit Analysis

The cost benefit analysis is presented in Table 6. The market prices per kilogram of milled millet (100%), whole millet, milled maize and milled sorghum at the time of the

Table 6: Cost benefit analysis of broilers fed with milled maize, sorghum, millet and their 50: 50 combinations with whole millet.

Parameters	Treatment/Diet					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Initial body weight(g)	375.25	365.33	375.17	368.17	356.31	371.83
Final body weight (g)	2070.30	2113.90	2232.00	2193.10	2159.10	2108.60
Total feed intake (g)	5155.92	4784.64	4688.46	4823.28	4705.68	4875.36
Total feed intake (kg)	5.16	4.78	4.69	4.82	4.71	4.88
Total weight gain (g)	1695.05	1748.57	1856.26	1804.94	1802.79	1736.77
Total weight gain (kg)	1.70	1.75	1.86	1.80	1.80	1.74
Cost/ kg feed(N)	105.41	102.97	107.86	105.66	104.44	106.88
Total feed cost(N)	543.92	492.20	505.86	509.28	491.91	521.57
Cost/kg gain(N/kg)	318.85	281.26	271.97	282.93	273.28	299.75

Cost per kilogram of various feed ingredient used in compounding the experimental diets, Maize ₦59, Sorghum ₦54, Millet ₦64, Whole millet ₦60, Fishmeal ₦130, Bone ash ₦40, Limestone ₦40, Lysine ₦1000, Methionine ₦1500, Salt ₦100, Premix. 1400;

T₁ = Milled maize 100 % T₂ = Milled sorghum 100 % T₃ = Milled millet 100 % T₄ = Milled maize 50 % + whole millet 50 % T₅ = Milled sorghum 50 % + whole millet 50 % T₆ = Milled millet 50 % + whole millet 50 %

experiment were N64, N60, N59 and N54, respectively. Feeds cost per weight gain was lowest in T₃ (Milled millet, 100%) followed by T₂ (milled sorghum 100%), and the highest was in T₁ (Milled maize 100%). Medugu *et al.* (2010) who fed broiler chicken with sorghum or millet as an alternative to maize obtained similar results. Therefore, considering the weight gain of birds and feed cost per weight gain, milled sorghum, millet and their 50:50 combinations with whole millet can completely replace maize in broiler

chicken diets without adverse effect on growth and digestibility of nutrients, and also have advantage of reducing the cost of feeding the broilers chickens to market weight.

Conclusion and Recommendations

It can be concluded from the results obtained that milled maize, milled sorghum, milled millet and whole millet and their 50:50 combination can be used as a major source of energy in broiler diets. This study revealed that there is no adverse effect on feed intake,

feed conversion ratio, daily weight gain, final body weight and overall weight gain in broiler chicken feed with whole millet up to 50% inclusion level in semi-arid zone of Nigeria. In addition, the lowest cost/kg gain was recorded in millet-based diet. It is therefore recommended that farmers should use milled or whole millet as alternative energy sources in broiler diets so as to enhance performance of their birds and lower production cost. In addition, the use of whole millet will eliminate the cost associated with grinding millet and the need for bin space to store milled millet.

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