ECONOMIC ANALYSIS OF MAIZE GRAIN RESIDUE IN BROILER DIETS AND HAEMATOLOGICAL IMPLICATIONS IN NIGERIA

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Abstract. A six-week experiment was carried out to determine the haematological and serum biochemical indices and cost effectiveness of broiler chicken fed maize grain residue (pap sievette). A total of 150 broiler chickens were used for the experiment. The birds were randomly assigned to five (5) dietary treatments in groups of 30, with each treatment consisting of three replicates of 10 chickens each. Maize grain residue (MGR) replaced maize at 0, 25, 50, 75 and 100% levels in Diets 1 (Control), 2, 3, 4 and 5. The experimental diets were fed *ad-libitum* throughout the experimental period. For haematological values, there were no significant (P>0.05) differences among treatments for haemoglobin, white blood cells, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, neutrophils, monocytes and basophils, except the packed cell volume, red blood cells, mean corpuscular volume, eosinophils and lymphocytes. Serum biochemical values of total protein, albumin, glucose, total cholesterol, creatinine and phosphorus were not significantly (P>0.05) different while globulin, urea and calcium values recorded significant (P<0.05) difference among treatments. Urea and calcium values in the 75% MGR and 100% MGR were significantly (P<0.05) different from T1 (0% MGR) and T3 (75% MGR). The economic analysis showed that T5 (100% MGR) has the lowest values of feed cost/kg weight gain of N129.71/kg and highest percentage reduction in cost/kg weight gain of 17.11% with an incremental reduction in cost as the amount of residue increases. Based on these, maize grain residue (MGR) could replace maize in broiler chicken diets without adverse effect on performance. However, further studies should cover laying hens and the need for proper drying of maize grain residue to prevent fungal infection and the development of offensive fermentative odour.
Keywords: *maize, grain, residue, haematological, economic, broiler*

Introduction

As the population of Nigeria continues to increase in a geometric pattern, food supply particularly, protein supply lags behind in arithmetic pattern. Ladokun and Longe (2004) have stated that one of the ways of increasing protein supply for the Nigerian population is through broiler production. Broilers are poultry birds used mainly for meat, and in recent years occupied a leading role in meeting the animal protein need of people worldwide (Meremikwu and Udedibie, 2007). The high price of conventional poultry feed ingredients in Nigeria has increased the feeding cost to about 80% of the total cost of production (Olomu, 2003; Durunna et al., 1999). This is due to the stiff competition between human and monogastric animals for the already scarce conventional feed resources (Ladokun and Longe, 2004; Abeke et al., 2003). The resultant effects have been low production level, narrow profit margin and collapse of the once prosperous poultry farms. In the present time, the choice of feed is determined to a large extent by price rather than by quality of feed (Alikwe, 2012). This development has also contributed to the indiscriminate appearance of new commercial feeds in the market, the quality of such commercial feeds being doubtful because no quality grading system is in place.

Chickens have short generation interval and therefore are the choice animal species for achieving sustainable and rapid production of animal protein for human consumption (Alikwe et al., 2005). Unlike other forms of animals (livestock) that have either or both cultural taboos and religious prohibitions attached to them, the chickens have neither restrictions in all parts of Nigeria (Atteh, 2004). Ikeme (1990) also reported that poultry, particularly broilers are fast growing birds, with high feed efficiency, reaching the required market weight of 2 kg within eight to twelve weeks (8-12 weeks) of age. In a world where malnutrition and starvation stare the entire human race at the face, it is amazing that there exist some agro-industrial by-products lying waste, which could be utilized for increased food production, especially livestock and poultry, to supply protein (Abeke et al., 2003). In cases where agricultural by-products are utilized, they are inappropriately or grossly under-utilized; not withstanding their favourable yield characteristics and relatively lower cost (Fanimo et al., 2007). This study investigated the economic analysis of the use of maize rain residue in broiler chicken diets and its haematological implications in tropical Nigeria.

Materials and Methods

Location of study

The study was carried out at the Livestock Teaching and Research Farm of the University of Maiduguri. Maiduguri is situated at latitude 11^{o}51' North, longitude 30^{o}09' East and on an altitude of 364m above sea level in the north-eastern part of Nigeria (Alaku and Moruppa, 1983). Maiduguri falls in the semi-arid zone characterized by a shorter rainy season (3 to 4 months), longer period of dry season (8 to 9 months), hot and dry climate, and has ambient temperatures that can be as high as 40^{o}C and above by the months of April, May and June; and as low as 20^{o}C during the months of November, December and January (Dana et al., 2010; Ubosi, 1988). The area is therefore, prone to extreme weather conditions and variations (Ugherughe and Ekedolum, 1986).

Experimental stock and management

One hundred and fifty straight run day-old Anak-2,000 broilers were used for this study. They were obtained from Obasanjo Farms Ltd, Otta, Ogun State, Nigeria. The birds were brooded together on a deep litter floor which was previously cleaned and disinfected. During the study, the birds received the conventional husbandry practices and necessary medications which included vaccinations and anti-stress drugs

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administration. They were vaccinated against Newcastle disease at first and third week, while Gumboro disease vaccine was administered at fourth week of age. Vita stress® and vitalyte extra® served as anti-stress drugs. Commercial broiler starter diet was given during brooding till the third week.

Preparation of maize grain residue (Pap sieviette)

Maize grain residue (MGR) is the left-over after processing maize grains into ‘‘akamu’’ or pap. During the preparation of pap, maize grains are soaked in plastic container with water for two days and allowed to ferment. On the third day, the grains are washed and ground after draining the water. The ground mass of maize is sieved using a nylon cloth. The chaff or by-product in the basket is the “Pap Sieviette” while the watery product below is the ‘akamu’ or pap. The watery product is further compressed in a bag, with water seeping out. The ‘akamu’ or pap may then be stored in a container or bag and kept in the fridge. In some communities, it may be sun-dried for some days and reconstituted when necessary, for pap production. The chaff or by-product from the sieve (MGR) was sun-dried for some days and used in the formulation of the diets.

Experimental design and diets

At the commencement of the study, the 3-week-old birds, numbering 150 were weighed individually and randomly assigned to five (5) treatments in a randomized complete block design (RCBD) and the test diets administered *ad libitum* to the experimental birds. Each treatment contained thirty birds each replicated three times with ten birds per replicate. Data collection started at the third week, for the six-week trial. Five experimental diets were formulated using locally available feedstuffs viz: maize grain residue (pap sieviette, i.e. the test material), maize, groundnut cake, wheat offal, fish meal, bone meal, salt and premix. The compositions of the experimental diets are shown in *Tables 1* and *Table 2*. Maize was replaced with maize grain residue (MGR) at 0%, 25%, 50%, 75% and 100% levels in diets 1 (control), 2, 3, 4 and 5 respectively during the starter and finisher phases.

***Table 1**. Ingredient composition and calculated analysis of the experimental starter diets..*

Ingredient (%)	Levels of replacement of maize with maize grain residue (%)				
	0	25	50	75	100
Maize	54.00	40.00	27.00	13.50	0.00
Maize grain residue	0.00	13.50	27.00	40.50	54.00
Groundut cake	25.00	25.00	25.00	25.00	25.00
Wheat offal	9.00	9.00	9.00	9.00	9.00
Fish meal	9.00	9.00	9.00	9.00	9.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
Premix*	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Metabolizable energy(kcal/kg)	2913.98	2844.77	2775.57	2706.36	2637.15
Crude fibre (CF%)	3.19	4.64	6.08	7.52	8.97
Ether extract (EE%)	4.39	4.18	3.97	3.76	3.55
Crude protein (CP%)	24.03	24.39	24.75	25.11	25.47
Calcium (Ca%)	1.36	1.42	1.48	1.54	1.61

Phosphorus (P%)	0.70	0.72	0.73	0.75	0.77

*Notes: * means composition of premix per kg of diet: vitamin A=12, 000.000 IU, vitamin E=15,000 mg, folic acid=1000 mg, pantothenic acid=1,500 mg, vitamin B_{12}=15,000 mg, vitamin B_6=2,500 mg, vitamin K=2,000 mg, Choline=50,000 mg, Manganese=10,000 mg, vitamin D_3=25,000 IU, Nicotinic acid=40,000 mg, vitamin B_1=2,000 mg, vitamin B_2=6,000 mg, Biotin=6,000 mg, vitamin C=3,000 mg, Copper=15,000 mg, Cobalt=250 mg and selenium=1000 mg.*

***Table 2**. Ingredients composition and the calculated analysis of the experimental finisher diets.*

Ingredient (%)	Levels of replacement of maize with maize grain residue (%)				
	0	25	50	75	100
Maize	56.00	42.00	28.00	14.00	0.00
Maize grain residue	0.00	14.00	28.00	42.00	56.00
Groundut cake	24.00	24.00	24.00	24.00	24.00
Wheat offal	10.00	10.00	10.00	10.00	10.00
Fish meal	7.00	7.00	7.00	7.00	7.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
Premix*	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Metabolizable energy(kcal/kg)	2918.72	2846.95	2775.18	2703.41	2631.64
Crude fibre (CF%)	3.24	4.74	6.24	7.73	9.23
Ether extract (EE%)	4.35	4.13	3.92	3.70	3.48
Crude protein (CP%)	22.65	23.02	23.40	23.77	24.14
Calcium (Ca%)	1.24	1.30	1.36	1.43	1.50
Phosphorus (P%)	0.64	0.66	0.68	0.70	0.72

*Notes: * means composition of premix per kg of diet: vitamin A=12, 000.000 IU, vitamin E=15,000 mg, folic acid=1000 mg, pantothenic acid=1,500 mg, vitamin B_{12}=15,000 mg. vitamin B_6=2,500 mg, vitamin K=2,000 mg, Choline=50,000 mg, Manganese=10,000 mg, vitamin D_3=25,000 IU, Nicotinic acid=40,000 mg, vitamin B_1=2,000 mg, vitamin B_2=6,000 mg, Biotin=6,000 mg, vitamin C=3,000 mg, Copper=15,000 mg, Cobalt=250 mg and selenium=1000 mg.*

Data collection

Feed intake and live weight gain

A known quantity (1 kg) of feed was given to the birds daily and the left-over weighed every morning. The feed intake was obtained by subtracting the left over from the quantity supplied the previous day. The average feed intake per bird per day was determined by dividing the total feed consumed by the number of birds in each pen. At the end of each week, the mean daily feed consumption was calculated.

The total live weight gain for each treatment group was obtained by calculating the difference between the mean initial live weight and the final live weight.

Blood parameters

At the 6th week of the experiment, three (3) chickens were randomly selected from each treatment, which is one from each replicate. Blood samples were collected from the brachial vein using sterile disposable (21-gauge) needle and syringe. Blood samples collected into sample bottles containing dipotassium salts of ethylene diamine tetraacetic acid (EDTA), an anti-coagulant were used to determine the haematological parameters. Repeated gentle inversion of the sample bottles was done to ensure thorough mixing of the blood and anti-coagulant to prevent clotting.

Samples for biochemical indices were collected into anti-coagulant free tubes and allowed to clot. Serum to be obtained after the blood samples had been allowed to stand for two hours at room temperature and centrifuged for ten minutes at 2000rpm to separate the cells from the serum. Serum is vital for the estimation of biochemical substances because many of these substances are present in different concentrations in the serum and it is the concentration in the serum which changes in diseases or abnormal condition and therefore aids in diagnosis (Bush, 1975). Sigma assay kit was used for the analysis.

The haematological parameters include packed cell volume (PCV), red blood cells (RBC) count, white blood cell (WBC) count and haemoglobin (Hb) concentration (Hb). Their measurements were carried out as outlined by Bush (1975). Mean corpuscular volume (MCV), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular haemoglobin (MCH) were calculated according to the standard formulae of Schalm et al. (1975).

$$\text{MCV (femtolitre)} = (\text{PCV}(\%) \times 10) / (\text{No. of RBC} \times 10^6/\text{mm}^3) \qquad \text{Eq. (1)}$$
$$\text{MCH (Picogram)} = (\text{Hb (g/dl)} \times 10) / (\text{No. of RBC} \times 10^6/\text{mm}^3) \qquad \text{Eq. (2)}$$
$$\text{MCHC (\%)} = (\text{Hb (g/dl)} \times 100) / (\text{PCV (\%)}) \qquad \text{Eq. (3)}$$

The biochemical indices determined were total protein, albumin, globulin, total cholesterol, calcium ion, phosphorus, glucose, creatinine and urea (Bush, 1975).

Economic analysis

The following were calculated to assess the cost benefit or replacement value of maize grain residue for maize in broiler chicken diets: (1) cost per kilogram of each diet (N/kg); (2) cost of feeding each broiler chicken on the various diets during the period of experiment; (3) total cost of feed consumed by each group during the experiment; and (4) cost per kilogram of weight gained on each diet.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using Randomized Complete Block Design (RCBD) and treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Haematological parameters

Data on the haematological parameters are shown in *Table 3*. There are significant ($P<0.05$) differences among treatments for all the haematological parameters except haemoglobin (Hb), white blood cells (WBC) count, mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC),neutrophils, monocytes and basophils which did not differ ($P>0.05$) significantly among the treatments. The ranges for PCV (36.67-44.00%) in all the treatments fall within the normal range (25-

45%) for chickens reported by Anon (1980), Ross et al. (1978) as well as Mitruka and Rawnsley (1977).

***Table 3**. Haematological values of broiler chickens fed graded levels of maize grain residue as replacement for maize.*

Parameters	Level of replacement of maize with MGR (%)					
	0	25	50	75	100	SEM
PVC (%)	43.33^{a}	36.67^{b}	37.00^{b}	40.67^{a}	44.00^{a}	1.12*
Hb (g/dl)	11.50	9.80	10.93	10.67	11.03	0.72^{NS}
RBC (x 10^6/mm^3)	3.87^{a}	3.08^{b}	3.32^{b}	3.00^{b}	3.22^{b}	0.12*
WBC (x 10^3/mm^3)	4.30	4.23	4.17	4.32	4.37	74.82^{NS}
MCV (fl)	11.22^{b}	11.88^{b}	11.17^{b}	13.61^{a}	13.69^{a}	0.46*
MCH (pg)	29.75	31.88	32.87	35.47	34.27	1.83^{NS}
Neutrophils (%)	33.33	34.67	33.33	32.00	34.00	0.96^{NS}
Monocytes (%)	7.33	7.67	7.33	6.33	6.33	0.61^{NS}
Eosinophils (%)	5.67^{b}	6.33^{ab}	6.00^{ab}	6.33^{ab}	7.67^{a}	0.56*
Basophils (%)	0.00	0.33	0.67	0.33	0.00	0.25^{NS}
Lymphocytes (%)	53.67^{ab}	51.00^{c}	52.67^{abc}	55.00^{a}	52.00^{bc}	0.72*

*Notes: PCV=Packed cell volume; Hb=Haemoglobin; RBC=Red blood cells; WBC=White blood cells; MCV=Mean corpuscular volume; MCH=Mean corpuscular haemoglobin; MCHC=mean corpuscular haemaglobin concentration; a,b,c=Means in the same row bearing the same superscripts are not significantly (P> 0.05) different; *=Significant (P<0.05); NS=Not significant (P>0.05); SEM=Standard Error of the Means.*

The ranges (9.80 to 11.50g/dl) of Hb values were lower than the 33 to 47g/dl reported by Ross et al. (1978) as well as Mitruka and Rawnsley (1977). The haemoglobin (Hb) values for T1 (0%MGR), T2 (25%MGR), T3 (50%MGR), T4 (75%MGR) and T5 (100%MGR) of 11.50g/dl, 9.80g/dl, 10.93g/dl, 10.67g/dl and 11.08g/dl, respectively, were however within the 7-13g/dl reported by Anon (1980) for haemoglobin (Hb) concentration for chicken. This also agrees with the report of Kwari and Ubosi (1991). The range (3.00 to 3.87 x 106/mm3) of RBC values observed in this study were within the normal range of 2 to 4 x 106/mm3 for healthy chickens (Anon, 1980; Ross et al., 1978; Mitruka and Rawnsley, 1977).

The white blood cells (WBC) count and differential counts are presented in Table 3. The WBC counts in blood are classified as granulocytes and agranulocytes. The granulocytes are characterized by specific granules in their cytoplasm. According to their staining reactions, they are neutrophils, eosinophils and basophils. The agranulocytes are the lymphocytes and monocytes (Swenson, 1970). The lymphocytes in the WBC produce antibodies that can fight bacterial and viral infection in the body. The WBC values were 4.30, 4.23, 4.17, 4.32 and 4.37g x 10^3/mm^3 for T1 (0%MGR), T2 (25%MGR), T3 (50%MGR), T4 (75%MGR) and T5 (100%MGR) respectively. For the differential counts, neutrophils values were 33.33, 34.67, 33.33, 32.00 and 34.00%; monocytes counts were 7.33, 7.67, 7.33, 6.33, and 6.33%; eosinophils values were 5.67, 6.33, 6.00, 6.33 and 7.67%; basophils values were 0.00, 0.33, 0.67, 0.33 and 0.00% and the lymphocytes counts were 53.67, 51.00, 52.67, 55.00 and 52.00% for treatments 1 (0%MGR), 2 (25% MGR), 3(50% MGR) 4(75% MGR) and 5 (100% MGR) respectively.

The WBC and differential counts were not significantly (P>0.05) different from one another among treatments except eosinophils and lymphocytes which differed significantly (P<0.05) among treatment groups. The monocyte value of 7.67% in treatment 2 (25%MGR) was higher (P<0.05) than other treatments while treatment 2

(25%MGR) had the lowest ($P<0.05$) lymphocyte value of 51.00% compared to other treatments. The neutrophils (32.00 to 34.67%) and basophils (0.00 to 0.67%) in all the treatments were not significantly ($P>0.05$) different. However, for eosinophils, treatment 5 (100%MGR) had the highest value of 7.67%. Treatment 1 (0%MGR) had the lowest value. The WBC values did not fall within the normal physiological limits (9-13 x 10^3/mm) for chickens as reported by Anon (1980). The lower values noticed in the WBC were probably due to the environmental temperature (38.6-41.7^{0}C) during the study period. Kwari and Ubosi (1991) have reported that in broiler chickens, haematological parameters decreased with increase in environmental temperatures. The monocytes values (6.33 to 7.67%) were much lower than the value (10%) reported by Swenson (1970). Increase in the number of monocytes (monocytosis) occurs in chronic diseases while decrease in the number of monocytes (monopenia) is rarely recorded (Swenson, 1970). The range of lymphocytes (51.00 to 55.00%) obtained in this study were close to the range (55 to 60%) recorded by Swenson (1970). Decrease in the number of lymphocytes (lymphopenia) occurs in increased activity of the adrenal cortex (hyperadrenocorticalism) and the condition may be stimulated by the addition of large doses of corticosteroids and increase in the number of lymphocytes (lymphocytosis) is associated with recovery from viral infections (Bush, 1975).

The basophils range (0.00 to 0.67%) for all the treatments were lower than the value (1 to 4%) reported by Swenson (1970). The basophils ranges were higher in treatment 3 (50% MGR). Bush (1975) reported that increase in the number of basophils (basophilia) is very rare and it may occur in association with certain types of leukaemia and decrease in the number of basophils (basophenia) is undetectable by normal means. Neutrophils values (32.00 to 34.67%) recorded in the study were not significantly different ($P>0.05$) among treatments. Neutrophils, eosinophils and basophils, make up 61% of leukocytes (White blood cells). Generally these values are higher than the values (25 to 30%) recorded by Swenson (1970). Bush (1975) reported that increase in the number of neutrophils (neutrophilia) generally indicates the existence of recent (acute) infection, usually with bacteria such as streptococci and staptylococci especially in septicaemia and it may also be due to an acute loss of RBC particularly in acute haemolyticanaemia.

Serum biochemical indices

The data for serum biochemical indices are presented in *Table 4*. There were significant ($P<0.05$) differences among all the treatments with respect to globulin, urea and calcium. On the other hand, total protein, albumin, glucose, total cholesterol, creatinine and phosphorus, showed no significant ($P>0.05$) differences among all the treatment groups. The ranges of total blood protein (4.27 to 4.90 g/dl) and albumin (1.90 to 2.13 g/dl) were higher than the reference range values (3.31 to 5.39 g/dl) and (1.17 to 2.74 g/dl) for total protein and albumin respectively as recorded by Meluzzi et al. (1991) when determining blood constituent reference values in broiler chickens. The high values of total protein and albumin observed in this study may suggest high quality protein of the experimental diet. Eggum (1970) stated that the higher the value of total protein of blood serum, the better the quality of the protein of the feed. The total protein, albumin and globulin are generally influenced by total protein intake (Onifade and Tewe, 1993; Birth and Schuldt, 1982). The protein values obtained in this study connotes the nutritional adequacy of the dietary protein in the treatment diets.

***Table 4**. Serum biochemical indices of broiler chickens fed graded levels of maize grain residue as replacement for maize.*

Parameters	Level of replacement of maize with MGR (%)					
	0	25	50	75	100	SEM
Total protein (g/dl)	4.43	4.90	4.77	4.27	4.33	2.25^{NS}
Albumin (g/dl)	2.00	1.90	1.97	2.13	1.97	1.52^{NS}
Globulin (g/dl)	2.43^{abc}	3.00^{a}	2.80^{ab}	2.13^{c}	2.37^{bc}	1.84*
Glucose (g/l)	10.47	9.77	9.27	9.47	12.43	1.03^{NS}
Total cholesterol (mg/dl)	4.23	2.83	2.87	4.00	3.23	0.48^{NS}
Urea (Mmol/l)	3.27^{b}	3.67^{ab}	3.03^{b}	4.37^{a}	4.23^{a}	0.25*
Creatinine	85.33	83.67	79.67	84.67	85.67	3.06^{NS}
Calcium (Mmol/l)	1.97^{b}	1.97^{b}	2.40^{a}	2.40^{a}	2.47^{a}	0.07*
Phosphorus (Mmol.l)	1.53	1.50	1.33	1.57	1.37	0.09^{NS}

*Notes: MGR=Maize grain residue; SEM=Standard Error of the Means; a,b,c=Means in the same row bearing the same superscripts are not significantly (P>0.05) different; *=Significant (P<0.05); NS=Not significant (P>0.05).*

Serum creatinine showed no significant difference (P>0.05). Eggum (1970) stated that the level of serum creatinine signals the extent of muscle wastage. The non-significant difference (P>0.05) in serum creatinine of birds in all the treatments gives credence to the fact that the birds were not surviving at the expense of body reserves; hence there were no general weight losses observed in this study. The values of total blood cholesterol were 4.23, 2.83, 2.87, 4.00 and 3.23 mg/dl for treatments 1, 2, 3, 4 and 5 respectively, and showed no significant differences (P>0.05) among the treatment groups. The blood cholesterol level is a reflection of the comparably dry matter intake and crude fat levels of the diets (Yeh and Leville, 1972). All values obtained were below the normal glucose level (22.57 g/dl) reported by Balasch et al. (1973) and 19.20-21.70 g/dl range observed by Vo et al. (1978) for laying hen. Swenson (1970) indicated that low blood glucose confirms inadequate energy intake, which was informed by the increased feed intake.

Other serological index such as phosphorus did not significantly differ (P>0.05) among all the treatments. This trend is indicative of good quality diets in all treatments. Serum index such as blood calcium is essential for blood coagulation, membrane permeability, neuromuscular excitability, transmission of nerve impulses and activation of certain enzyme systems (Mitruka and Rawnsley, 1977). The serum calcium levels generally increased through treatments 1 (control), 2, 3, 4 and 5 with increase in blood protein levels. This agrees with the report of Swenson (1970) that in laying hens, the calcium level in the serum increases simultaneously with increase in plasma protein. However, the low levels of calcium in all treatments could be probably due to hot weather. Walugembe (2013) reported that blood calcium levels of chickens tend to reduce with increased environmental temperature, but rises as weather cools with increased calcium intake. The reducing ambient temperature in chicken pens increases the level of serum calcium which is the capacity of blood to carry calcium ions (Walugembe, 2013).

Economic analysis

The cost benefit analysis of the broilers on the experimental diets is presented in *Table 5*. The kilogram (Kg) of diets 2 (25%MGR), 3 (50%MGR), 4 (75%MGR) and 5 (100%MGR) were cheaper than diet 1 (0%MGR). Looking at total feed cost (N), however, treatment 1 (0%MGR) appears to be cheaper in raising the broilers to market weight. With respect to feed cost per kg gain (N/kg), all the groups containing MGR were better than the control. Treatment 5 (100%MGR) was the lowest and hence treatment 5 proved more cost effective than the other treatments. The highest feed cost per kg feed (N60.58) was recorded in treatment 1 (0%MGR) and the lowest feed cost (N56.73) in treatment 5 (100%MGR). This could be attributed to the high level of maize whose level of inclusion decreased across the treatments.

***Table 5**. Economic analysis of broiler chicken fed graded levels of maize grain residue (MGR) as replacement for maize.*

Parameters	Level of replacement of maize with MGR (%)				
	0	25	50	75	100
Mean initial weight (g)	303.33	293.33	353.00	315.67	311.67
Mean final weight (g)	2153.33	2370.00	2483.33	2510.00	2583.33
Total weight gain (g)	1850.00	2076.67	2130.33	2194.33	2271.66
Total feed intake (g)	4478.67	4904.67	5046.99	5051.66	5187.00
Cost per kg feed (N/kg)*	60.58	59.61	58.65	57.69	56.73
Total feed cost (N)	289.49	292.69	296.18	291.34	294.43
Feed cost (kg); weight gain (N/kg)	156.48	140.72	139.05	133.03	129.71
Reduction in cost (kg); weight gain (%)	-	10.07	11.14	14.99	17.11

**Notes: * means calculated on the basis of the prevailing prices of the ingredients at the time of study.*

These results suggest that maize could be substituted with maize grain residue (MGR) without compromising the performance or production indices of broilers. These findings agree with the work of Okah (2004) who observed that maize grain residue could be used in broiler chickens diets without adverse effect on growth and feed utilization of birds. Treatment 5 (100%MGR) recorded the highest (17.11%) percentage reduction in cost/kg of weight gain. Hence, the use of maize grain residue (MGR) as energy source in broiler chickens diets also reduced feed cost and gave better returns in terms of reduction in cost/kg feed and feed cost/kg gain.

Conclusion

The results of this study show that maize could be substituted completely with maize grain residue (MGR) in broiler chicken diets as an energy source without adverse effects on the blood parameters. The economic evaluation also revealed cost effectiveness of this substitution, as feed cost per unit weight gain was drastically reduced. Maize grain residue is cheaper than whole maize and locally available since pap (akamu) is a popular breakfast staple in both rural and urban communities in Nigeria. The feeding value (nutrient value) for broilers is quite acceptable having undergone soaking, fermentation and fine grinding during processing which are known to improve the utilization of many cereal grain residues. The results obtained from the study indicated that maize grain residue can replace 100% of the maize in the diets of broiler chicken. Therefore total substitution of maize with maize grain residue is suitable in broiler chicken diets. Further investigations should cover laying hens and the need for proper drying of maize grain residue to prevent the development of offensive fermentative odour.

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Conflict of interest

The authors confirm that there are no conflict of interest involved with any parties in this research study.

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