



Haematology, serum biochemistry and carcass characteristics of broiler chickens fed two varieties of cassava meal-based diets

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Abstract

A 56-day study was conducted to determine the haematological profile, serum parameters and carcass characteristics of broiler chickens fed with two varieties (white and yellow) of cassava grit based diets. A total of 240, day-old unsexed Arbor acre broiler chicks were assigned to eight dietary treatments in a 2 x 4 factorial arrangement using completely randomized design. Diets were formulated to include two varieties of cassava, TME 419 (white) and TMS 01 1368 (yellow) at four inclusion levels (0, 25, 50 and 75%). Each treatment consisted of 30 birds and three replicates of 10 birds each. The haematological and serum biochemical parameters were measured at the end of the starter (4th week) and finisher (8th week) phases, while the carcass characteristics were measured at the end of the finisher (8th week) phase. At the starter phase, the PCV (40.00%), RBC count ($3.37 \times 10^{12}/L$), total protein (5.07g/Dl), aspartate transaminase (76.00U/L) and thiocyanate (4.17 μ g/ml) were highest ($P < 0.05$) in birds fed 75% yellow cassava grits diet. At the finisher phase, birds fed 75% white cassava grit diet had the highest ($P < 0.05$) PCV (40.67%), Aspartate transaminase (63.67U/L) and thiocyanate (4.70 μ g/ml). The white blood cell counts reduced ($P < 0.05$) across treatments ($13.77 - 11.27 \times 10^9/L$) and ($14.00 - 10.83$) $\times 10^9/L$ as cassava grits inclusion increased in both phases respectively. The results of carcass characteristics showed that birds fed with diet containing yellow cassava grits had the highest breast meat (14.04%) while the least value (11.49%) was obtained with birds fed the control diet. In conclusion, the substitution of maize with yellow cassava grits up to 75% improved the haematology and serum biochemistry at the starter phase, however, the white or yellow cassava grits can be substituted for maize up to 75% at the finishing phase to improve the carcass characteristics of broiler chickens.

Keywords: Haematology, serum biochemistry, carcass characteristics, cassava, broiler chickens

Introduction

Poultry production represents one of the fastest means of correcting shortage of animal protein in Africa. This is because, apart from their very efficient feed conversion, poultry is characterized by the best efficiency of nutrient transformation into high quality animal protein, although the cost of this transformation is very high. Therefore, nutrient supply has to be judiciously manipulated to ensure the production of meat at economic rate (Tewe and Egbunike, 1992).

The rapid growth of human population has intensified the competition between man and livestock for cereals such as maize, resulting in high cost of the grains and consequently high prices of poultry products. Alternative and cheaper sources of energy can replace maize to reduce cost of production and contribute to increased supply of animal protein at an affordable price; one of such economical substitute ingredients for maize is cassava meal (Anthony, 2009).

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Cassava is regarded as one of the world's top calorie producers for human and livestock consumption. Nigeria is the world's leading producer of cassava. In 2018, global cassava production was established at 277 million tonnes. Nigeria contributed about 21% (59.5 million tonnes) of the global output in 2018 (PWC, 2020). It is estimated that most (65%) of cassava crop is used for human consumption, while the remaining is used for animal feed, starch and industrial application (Balogun and Bawa, 1997). The pelletized nature of the cassava grits makes it more desirable for use in poultry feeding than the flour. This is because grits reduce dustiness which causes irritation of the respiratory tract (Apata and Babalola, 2012).

This study was carried out to evaluate the haematological indices, serum parameters and carcass characteristics of broiler chickens fed diets containing white and yellow cassava grits at varying levels as a replacement for maize.

Materials and Methods

Preparation of experimental materials (cassava grits)

Cassava varieties (TME 419 (white) and TMS 01 1368 (yellow)) were obtained and processed into two separate cassava grits. The tubers were peeled, washed, grated and pressed with a hydraulic press to remove water content where 60-70% moisture content was retained in the cassava in order to form grits during frying. The dewatered cassava paste was pulverized and fried using motorized frying machine. The cassava grits were cooled and sieved to separate the particle sizes for the different stages of broiler production. The analysed white cassava grits contained 2.40% crude protein, 3.50% crude fibre, 2.50% ether extract, 1.00% ash and 3154.60kcal/kg metabolizable energy (ME). While the yellow cassava grits

contained 2.57% crude protein, 3.60% crude fibre, 2.00% ether extract, 2.00% ash and 3199.19kcal/kgME.

Experimental diets and design

A total of 240, day-old unsexed broiler chicks were allotted into eight treatments of 30 birds and each treatment was replicated three times with 10 birds each. The experimental design used was completely randomized design in a 2 x 4 factorial arrangement of two cassava varieties TME 419 (white) and TMS 01 1368 (yellow) and four substitution levels (0, 25, 50 and 75 %) of cassava grits in replacement for maize. Experimental diets were formulated for the starter (0- 28 days) and finisher (29- 56 days) phases as shown in Tables 1 and 2 respectively.

Data Collection

Haematology and Serum biochemistry

The haematological and serum chemical parameters were measured at the end of the starter and finisher phases. Two birds per replicate were randomly selected at the end of each phase of the experiments. Blood samples were obtained via the wing vein puncture using needle and syringe into well labeled bottles containing Ethylene diamine tetra acetate (EDTA) as anti-coagulant for determination of haematological parameters (red blood cell count, white blood cell, packed cell volume and haemoglobin). Another 2.5 mls of blood samples were obtained into empty bottles for serum biochemical analysis (total serum protein, serum albumin and globulin, serum glucose, serum thiocyanate, alanine and aspartate transaminase).

Carcass evaluation

At the end of the 56th day of the experiment, 2 birds of average live weight were selected from each replicate, slaughtered, de-feathered and eviscerated. The breast, thigh, drumstick, spleen, kidney, liver, lungs, gizzard, heart and abdominal fat were weighed using sensitive

digital electronic scale. The weights were expressed as percentage of respective live weights

Statistical analysis

The data generated were subjected to Analysis of Variance (ANOVA) in a 2 x 4 factorial arrangement. Significant ($P < 0.05$) differences among treatment means were separated using Duncan's Multiple Range Test as contained in Statistical Analysis Systems (SAS, 2011).

Results

Table 3 showed that the interaction of cassava grits substitution levels and cassava variety were significant ($P < 0.05$) for PCV, Haemoglobin, red blood cell, white blood cell, heterophil and lymphocyte for starting broiler chickens. The PCV, haemoglobin, RBC, heterophil and lymphocyte had the highest values in broiler chickens fed 75 % yellow cassava grits in the diet, while, the other treatment groups had similar values.

At the finishing phase, PCV and haemoglobin had the highest values recorded for birds placed on diet substituted with 75% white cassava grits, while the highest values for the RBC and lymphocytes were obtained for birds placed on diet substituted with 75% yellow cassava grits.

The interactive effects between cassava grits substitution levels and cassava variety had significant ($P < 0.05$) effect on all the serum biochemical parameters measured at the starting phase as shown in Table 4. The total protein, globulin, aspartate transaminase, and thiocyanate levels were highest for birds placed on diet substituted with 75% yellow cassava grits, while the glucose concentration was highest for birds placed on diet substituted with 75% white cassava grits. Broiler chickens fed 75 % cassava grits replacement level notwithstanding the variety

had the ($P < 0.05$) highest alanine transaminase values. The ($P < 0.05$) lowest total protein, albumin and globulin values were recorded in birds fed the control diet under the yellow variety. Thiocyanate values were ($P < 0.05$) highest in broiler chickens fed 75% white cassava variety and those fed 50 and 75 % yellow cassava diets.

During the finishing phase, the total protein and glucose levels were ($P < 0.05$) highest for birds fed diet substituted with 75% yellow cassava grits, while the ($P < 0.05$) highest albumin level was recorded for birds placed on diet substituted with 75% white as well as 75% yellow cassava grit diets. Aspartate transaminase and thiocyanate had the highest values for birds fed diet substituted with 75% white cassava grits.

The interaction between levels of cassava grits and cassava variety had significant ($P < 0.05$) effect on the carcass characteristics measured with the exception of the thigh and gizzard as shown in Table 5. The percentage breast was ($P < 0.05$) highest for birds placed on the 50% yellow cassava grit diet. The percentage wings and drumsticks were ($P < 0.05$) highest at 50% substitution level for white and yellow cassava grit diets. The abdominal fat was ($P < 0.05$) highest for the group fed the control diet of yellow cassava grits while the lowest values were obtained from birds fed 50 and 75% white cassava grit diets. However, similar values were obtained from birds fed 50 and 75 % yellow cassava grit diets. Percentage liver value was ($P < 0.05$) highest in birds fed 75 % yellow cassava grit diets and the lowest from the group fed 50 % white cassava grit diet. Broiler chickens fed 25 % white cassava grit diet had the ($P < 0.05$) highest percentage heart while, the lowest was obtained in birds fed 25 % yellow cassava grit diet.

Table 1: Percentage composition of experimental broiler starter diets (0- 28 days)

| Ingredients | White Cassava Grits | | | | Yellow Cassava Grits | | | |
|-----------------------|---------------------|---------------|---------------|---------------|----------------------|---------------|---------------|---------------|
| | 0% | 25% | 50% | 75% | 0% | 25% | 50% | 75% |
| Maize | 54.00 | 40.50 | 27.00 | 13.50 | 54.00 | 40.50 | 27.00 | 13.50 |
| Cassava grits (white) | - | 13.50 | 27.00 | 40.50 | - | 13.50 | 27.00 | 40.50 |
| Soyabean meal | 13.25 | 13.25 | 13.25 | 13.25 | 13.25 | 13.25 | 13.25 | 13.25 |
| Groundnut cake | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 | 18.00 |
| Wheat offal | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| Fishmeal (72% CP) | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Limestone | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Salt (NaCl) | 0.30 | 0.30 | 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 | 0.25 | 0.25 |
| L- Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| DL- Methionine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Determined Analysis | | | | | | | | |
| Crude Protein (%) | 22.95 | 21.95 | 20.97 | 20.16 | 22.95 | 21.99 | 21.00 | 20.18 |
| Ether Extract (%) | 4.11 | 3.90 | 3.71 | 3.59 | 4.11 | 3.84 | 3.57 | 3.37 |
| Crude Fibre (%) | 3.41 | 3.82 | 3.88 | 4.03 | 3.41 | 3.85 | 3.92 | 4.08 |
| Ash (%) | 5.76 | 5.74 | 5.73 | 5.74 | 5.75 | 5.73 | 5.74 | 5.76 |
| Dry matter (%) | 85.50 | 85.00 | 86.32 | 85.53 | 86.00 | 85.25 | 86.45 | 85.50 |
| ME (kcal/kg)* | 2916.67 | 2894.48 | 2870.64 | 2852.48 | 2916.67 | 2899.56 | 2876.13 | 2858.06 |

ME (kcal/kg) * Calculated metabolizable energy

***Vitamin A- 12,000,000i.u; Vitamin D3- 2,750,000i.u; Vitamin E- 20,000mg; Vitamin K- 2,000mg; Thiamine B1-1,500mg; Riboflavin B2-4,000mg; Niacin-18,000mg; Pantothenic Acid- 7,000mg; Vitamin B6- 2,000mcg; Vitamin B12- 12mg; Folic Acid- 1,000mcg; Biotin-15i.u; Choline Chloride- 150,000mg; Cobalt- 500mg; Copper- 6,000mg; Iodide- 1,100mg; Iron- 20,000mg; Manganese-80,000mg; Selenium-200mg; Zinc-50,000mg; Antioxidant- 125,000mg.

Table 2: Percentage composition of experimental broiler finisher diets (28 – 56 days)

| Ingredients | White Cassava Grits (%) | | | | Yellow Cassava Grits (%) | | | |
|-----------------------|-------------------------|---------------|---------------|---------------|--------------------------|---------------|---------------|---------------|
| | 0 | 25 | 50 | 75 | 0 | 25 | 50 | 75 |
| Maize | 64.00 | 48.00 | 32.00 | 16.00 | 64.00 | 48.00 | 32.00 | 16.00 |
| Cassava grits (white) | - | 16.00 | 32.00 | 48.00 | - | 16.00 | 32.00 | 48.00 |
| Soyabean meal | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| Groundnut cake | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 | 12.00 |
| Wheat offal | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 |
| Fishmeal (72% CP) | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Bone meal | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Limestone | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 |
| Salt (NaCl) | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix*** | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| L- Lysine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| DL- Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Determined Analysis | | | | | | | | |
| Crude Protein (%) | 19.32 | 18.13 | 18.04 | 17.82 | 19.31 | 18.14 | 18.07 | 17.85 |
| Ether Extract (%) | 4.00 | 3.77 | 3.63 | 3.60 | 4.00 | 3.71 | 3.59 | 3.54 |
| Crude Fibre (%) | 3.29 | 3.50 | 3.85 | 3.99 | 3.29 | 3.53 | 3.88 | 4.05 |
| Ash (%) | 3.26 | 3.25 | 3.26 | 3.24 | 3.23 | 3.30 | 3.31 | 3.28 |
| Dry matter (%) | 86.00 | 85.65 | 85.50 | 85.00 | 86.23 | 86.00 | 84.75 | 86.50 |
| ME (kcal/kg)* | 2998.96 | 2981.14 | 2946.23 | 2937.58 | 2998.96 | 2990.06 | 2960.50 | 2941.07 |

ME (kcal/kg)* Calculated metabolizable energy

***Vitamin A- 12,000,000i.u; Vitamin D3- 2,750,000i.u; Vitamin E- 20,000mg; Vitamin K- 2,000mg; Thiamine B1-1,500mg; Riboflavin B2-4,000mg; Niacin-18,000mg; Pantothenic Acid- 7,000mg; Vitamin B6- 2,000mcg; Vitamin B12- 12mg; Folic Acid- 1,000mcg; Biotin-15i.u; Choline Chloride- 150,000mg; Cobalt- 500mg; Copper- 6,000mg; Iodide- 1,100mg; Iron- 20,000mg; Manganese-80,000mg; Selenium-200mg; Zinc-50,000mg; Antioxidant- 125,000mg.

Table 3: Effects of cassava grits substitution levels and cassava variety on the haematology indices of broiler chickens

| Substitution level (%) | Variety | Starter phase (0-28 days) | | | | | | Finisher phase (29-56 days) | | | | | |
|------------------------|---------|---------------------------|---------------------|-----------------------------|----------------------------|---------------------|----------------------|-----------------------------|---------------------|-----------------------------|----------------------------|---------------------|---------------------|
| | | PCV (%) | Hb (g/dl) | RBC (x 10 ^{12/L}) | WBC (x 10 ^{9/L}) | Het (%) | Lym (%) | PCV (%) | Hb (g/dl) | RBC (x 10 ^{12/L}) | WBC (x 10 ^{9/L}) | Het (%) | Lym (%) |
| 0 | White | 35.33 ^b | 9.77 ^b | 2.97 ^b | 13.77 ^a | 30.67 ^b | 65.00 ^{abc} | 33.61 ^{abc} | 9.47 ^{ab} | 2.40 ^{bc} | 13.70 ^a | 30.00 ^{bc} | 57.67 ^d |
| 25 | White | 35.67 ^b | 9.77 ^b | 2.90 ^b | 12.07 ^{bc} | 32.00 ^{ab} | 66.67 ^{ab} | 35.33 ^{abc} | 9.60 ^{ab} | 3.20 ^a | 12.93 ^{ab} | 30.33 ^{bc} | 62.00 ^c |
| 50 | White | 35.67 ^b | 9.67 ^b | 2.97 ^b | 11.90 ^{bc} | 32.67 ^{ab} | 66.67 ^{ab} | 33.67 ^{bc} | 8.80 ^b | 2.27 ^c | 12.27 ^{ab} | 33.67 ^b | 68.00 ^{ab} |
| 75 | White | 35.00 ^b | 9.50 ^b | 2.80 ^b | 11.87 ^{bc} | 33.00 ^{ab} | 67.33 ^{ab} | 40.67 ^a | 11.13 ^a | 2.50 ^{bc} | 12.07 ^{ab} | 39.00 ^a | 67.00 ^{ab} |
| 0 | Yellow | 35.00 ^b | 9.70 ^b | 2.80 ^b | 12.70 ^{ab} | 29.67 ^b | 61.00 ^c | 32.67 ^c | 8.47 ^b | 2.50 ^{bc} | 14.00 ^a | 27.00 ^c | 64.67 ^{bc} |
| 25 | Yellow | 34.67 ^b | 9.47 ^b | 2.90 ^b | 12.17 ^{bc} | 32.00 ^{ab} | 63.00 ^{bc} | 32.00 ^c | 8.57 ^b | 2.80 ^b | 12.10 ^{ab} | 28.00 ^c | 68.00 ^{ab} |
| 50 | Yellow | 35.67 ^b | 10.20 ^{ab} | 2.90 ^b | 11.70 ^{ab} | 33.67 ^{ab} | 66.00 ^{abc} | 36.33 ^{abc} | 9.73 ^{ab} | 2.37 ^c | 11.20 ^b | 29.33 ^{bc} | 67.00 ^{ab} |
| 75 | Yellow | 40.00 ^a | 11.47 ^a | 3.37 ^a | 11.27 ^c | 36.00 ^a | 68.33 ^a | 39.00 ^{ab} | 10.53 ^{ab} | 3.33 ^a | 10.83 ^b | 31.67 ^{bc} | 70.67 ^a |
| Pooled SEM | | 0.50 | 0.19 | 0.05 | 0.19 | 0.60 | 0.66 | 0.79 | 0.26 | 0.09 | 0.29 | 0.86 | 0.88 |
| 0 | - | 35.17 | 9.73 | 2.88 | 12.73 | 32.33 ^{ab} | 66.33 ^{ab} | 34.17 ^b | 8.97 ^b | 2.45 ^b | 13.47 ^a | 32.67 | 68.00 ^a |
| 25 | - | 35.17 | 9.62 | 2.90 | 12.30 | 32.83 ^{ab} | 64.83 ^{ab} | 33.67 ^b | 9.08 ^b | 3.00 ^a | 12.45 ^{ab} | 29.17 | 67.00 ^{ab} |
| 50 | - | 35.67 | 9.93 | 2.93 | 12.02 | 30.17 ^b | 67.83 ^a | 35.00 ^b | 9.27 ^b | 2.32 ^b | 12.08 ^{ab} | 33.00 | 63.33 ^b |
| 75 | - | 37.50 | 10.48 | 3.08 | 11.67 | 34.50 ^a | 63.00 ⁿ | 39.83 ⁻ | 10.83 ^a | 2.92 ^a | 11.55 ^b | 29.67 | 64.17 ^{ab} |
| SEM level | | 0.97 | 0.36 | 0.09 | 0.34 | 0.96 | 1.05 | 1.24 | 0.43 | 0.11 | 0.48 | 1.50 | 1.34 |
| - | White | 35.42 | 9.68 | 2.91 | 12.40 | 32.08 | 66.42 | 36.33 | 9.75 | 2.59 | 12.74 | 33.25 ^a | 67.58 ^a |
| - | Yellow | 36.33 | 10.21 | 2.99 | 11.96 | 32.83 | 64.58 | 35.00 | 9.33 | 2.75 | 12.03 | 29.00 ^b | 63.67 ^b |
| SEM | | 0.71 | 0.25 | 0.07 | 0.27 | 0.80 | 0.86 | 1.11 | 0.37 | 0.12 | 0.39 | 1.06 | 1.09 |
| Normal Ranges | | 23 - 55 | 7 - 18.6 | 1.3 - 4.5 | 13.78 - 14.26 | 15 - 50 | 29- 84 | 23- 55 | 7 - 18.6 | 1.3- 4.5 | 13.78 - 14.26 | 15 - 50 | 29 - 84 |

^{abcd}: Means in the same column with different superscript differ significantly (P < 0.05)

PCV – packed cell volume, Hb – haemoglobin, RBC – red blood cell, WBC – white blood cell, Het – heterophil, Lym – Lymphocyt

Table 4: Effects of cassava grits substitution levels and cassava variety on the serum biochemistry of broiler chickens

| Substitution level (%) | Variety | Starter phase (0-28 days) | | | | | | | Finisher phase (29-56 days) | | | | | | |
|------------------------|---------|---------------------------|--------------------|--------------------|----------------------|--------------------|---------------------|----------------------|-----------------------------|--------------------|--------------------|----------------------|---------------------|---------------------|----------------------|
| | | TP (g/dl) | Alb. (g/dl) | Glob. (g/dl) | Gluc. (mg/dl) | AST(μ /l) | ALT (μ /l) | Thioc. (μ g/ml) | TP (g/dl) | Alb. (g/dl) | Glob. (g/dl) | Gluc. (mg/dl) | AST(μ /l) | ALT (μ /l) | Thioc. (μ g/ml) |
| 0 | White | 4.20 ^b | 2.90 ^a | 1.30 ^d | 112.67 ^b | 59.67 ^b | 24.00 ^{ab} | 2.67 ^{ab} | 4.47 ^b | 1.74 ^c | 2.73 ^a | 111.67 ^b | 44.67 ^b | 29.00 ^{ab} | 4.07 ^{ab} |
| 25 | White | 3.93 ^b | 1.93 ^c | 2.00 ^b | 114.00 ^b | 61.00 ^b | 16.00 ^c | 2.77 ^{ab} | 4.23 ^{cd} | 1.99 ^{bc} | 2.24 ^{ab} | 118.67 ^{ab} | 47.67 ^{ab} | 29.33 ^{ab} | 4.10 ^{ab} |
| 50 | White | 3.50 ^{cd} | 2.30 ^b | 1.20 ^d | 127.00 ^{ab} | 56.67 ^b | 25.00 ^{ab} | 2.87 ^{ab} | 3.78 ^d | 2.16 ^{bc} | 1.62 ^b | 120.67 ^{ab} | 52.00 ^a | 32.33 ^a | 4.40 ^{ab} |
| 75 | White | 3.20 ^d | 2.10 ^{bc} | 1.10 ^d | 132.00 ^a | 62.67 ^b | 30.67 ^a | 3.30 ^a | 4.34 ^{bc} | 2.77 ^a | 1.57 ^b | 121.33 ^{ab} | 63.67 ^a | 28.67 ^{ab} | 4.70 ^a |
| 0 | Yellow | 3.53 ^c | 1.91 ^c | 1.62 ^c | 116.67 ^{ab} | 62.00 ^b | 24.67 ^{ab} | 1.50 ^b | 3.91 ^{bc} | 1.74 ^c | 2.17 ^{ab} | 125.33 ^a | 49.33 ^{ab} | 28.67 ^{ab} | 3.77 ^{ab} |
| 25 | Yellow | 3.57 ^c | 2.10 ^{bc} | 1.47 ^{cd} | 119.33 ^{ab} | 64.00 ^b | 28.00 ^{ab} | 1.67 ^b | 3.97 ^{bc} | 2.10 ^{bc} | 1.87 ^{ab} | 125.67 ^a | 50.67 ^{ab} | 23.67 ^b | 3.40 ^b |
| 50 | Yellow | 4.00 ^b | 2.70 ^a | 1.30 ^{cd} | 121.67 ^{ab} | 58.33 ^b | 21.00 ^{bc} | 4.10 ^a | 4.07 ^{cd} | 2.13 ^b | 1.94 ^{ab} | 125.33 ^a | 54.33 ^{ab} | 25.67 ^{ab} | 3.90 ^{ab} |
| 75 | Yellow | 5.07 ^a | 2.60 ^a | 2.47 ^a | 122.00 ^{ab} | 76.00 ^a | 29.67 ^a | 4.17 ^a | 4.49 ^a | 2.77 ^a | 1.70 ^b | 126.00 ^a | 63.33 ^a | 23.33 ^b | 4.03 ^{ab} |
| Pooled SEM | | 0.12 | 0.08 | 0.09 | 1.89 | 1.62 | 1.19 | 0.24 | 0.13 | 0.09 | 0.08 | 1.52 | 2.06 | 0.89 | 0.12 |
| 0 | - | 3.85 | 2.40 | 1.45 | 115.33 ^b | 57.50 ⁿ | 24.33 | 2.17 | 4.79 ^a | 2.67 ^a | 2.12 | 117.00 ^b | 47.00 ^c | 28.83 | 3.93 |
| 25 | - | 3.75 | 2.02 | 1.73 | 123.17 ^{ab} | 61.83 ^a | 22.00 | 2.40 | 4.32 ^{ab} | 2.45 ^a | 1.87 | 118.67 ^b | 49.17 ^{bc} | 26.50 | 3.98 |
| 50 | - | 3.75 | 2.50 | 1.25 | 127.00 ^{ab} | 62.33 ^a | 25.83 | 3.47 | 3.68 ^b | 1.73 ^b | 1.95 | 121.33 ^b | 58.17 ^{ab} | 29.00 | 4.05 |
| 75 | - | 4.13 | 2.35 | 1.78 | 129.17 ^a | 68.50 ^a | 27.83 | 3.48 | 3.65 ^b | 1.90 ^b | 1.65 | 123.33 ^a | 61.50 ^a | 26.00 | 4.22 |
| SEM level | | 0.21 | 0.14 | 0.15 | 3.37 | 2.91 | 2.34 | 0.41 | 0.20 | 0.11 | 0.15 | 2.07 | 3.02 | 1.74 | 0.25 |
| - | White | 3.71 | 2.31 | 1.40 | 119.92 | 60.00 | 23.92 | 2.86 | 4.08 | 2.20 | 1.88 | 118.08 ^b | 52.50 | 29.83 ^a | 3.78 ^b |
| - | Yellow | 4.04 | 2.33 | 1.71 | 121.42 | 65.08 | 25.83 | 2.93 | 4.10 | 2.18 | 1.92 | 125.58 ^a | 50.42 | 25.33 ^b | 4.32 ^a |
| SEM | | 0.16 | 0.11 | 0.13 | 2.73 | 2.16 | 1.68 | 0.33 | 0.18 | 0.14 | 0.11 | 1.81 | 2.96 | 1.09 | 0.16 |
| Normal Ranges | - | 4.63 - 4.81 | 1.4 - 4.31 | 1.94 - 3.04 | 160 - 230 | 50.20 - 60.50 | 7.67 - 12.33 | 1.3 - 4.27 | 4.63 - 4.81 | 1.4 - 4.31 | 1.94 - 3.04 | 160 - 230 | 50.20 - 60.50 | 7.67 - 12.33 | 1.3 - 4.27 |

^{abcd}: Means in the same column with different superscript differ significantly (P < 0.05)

TP – total protein, Alb. – albumin, Glob. – globulin, Gluc. – glucose, AST – aspartate transaminase, ALT – alanine transaminase, Thioc. – Thiocyanate.

Table 5: Effects of cassava grits substitution levels and cassava variety on the carcass characteristics of broiler chickens

| Substitution level (%) | Variety | LW (g) | EW (g) | Breast (%) | Thigh (%) | Drum stick (%) | Wings (%) | Spleen (%) | Abdominal fat (%) | Gizzard (%) | Liver (%) | Heart (%) |
|------------------------|---------|-----------------------|------------------------|---------------------|-----------|--------------------|--------------------|--------------------|--------------------|-------------|--------------------|--------------------|
| 0 | White | 211.33 ^{bc} | 1800.00 ^b | 11.63 ^b | 8.95 | 9.31 ^{ab} | 8.97 ^{ab} | 0.96 ^b | 1.20 ^b | 2.13 | 2.02 ^{bc} | 1.15 ^{ab} |
| 25 | White | 2170.00 ^b | 1790.00 ^{bc} | 11.56 ^b | 9.00 | 9.38 ^{ab} | 8.94 ^{ab} | 0.99 ^b | 1.08 ^{bc} | 2.36 | 1.93 ^{bc} | 1.45 ^a |
| 50 | White | 2196.67 ^b | 1855.00 ^b | 12.93 ^{ab} | 9.64 | 9.99 ^a | 9.42 ^a | 0.97 ^b | 0.95 ^c | 2.26 | 1.83 ^c | 1.16 ^{ab} |
| 75 | White | 2156.67 ^b | 1800.00 ^b | 11.71 ^b | 9.15 | 9.61 ^{ab} | 8.96 ^{ab} | 0.99 ^b | 0.86 ^c | 2.24 | 2.02 ^{bc} | 1.21 ^{ab} |
| 0 | Yellow | 1946.67 ^d | 1700.00 | 11.49 ^b | 9.05 | 8.80 ^b | 8.77 ^{ab} | 1.01 ^{ab} | 1.46 ^a | 2.12 | 1.99 ^{bc} | 1.21 ^{ab} |
| 25 | Yellow | 2016.67 ^{cd} | 1633.33 | 11.97 ^{ab} | 9.08 | 9.54 ^{ab} | 8.93 ^{ab} | 0.94 ^b | 1.21 ^b | 2.36 | 2.18 ^b | 1.13 ^b |
| 50 | Yellow | 2360.00 ^a | 2066.67 ^a | 14.04 ^a | 10.08 | 10.24 ^a | 9.13 ^a | 1.07 ^a | 1.06 ^{bc} | 2.12 | 2.19 ^b | 1.23 ^{ab} |
| 75 | Yellow | 2098.33 ^{bc} | 1750.00 ^{bcd} | 12.14 ^{ab} | 9.30 | 9.53 ^{ab} | 8.41 ^b | 1.08 ^a | 1.01 ^{bc} | 2.44 | 2.48 ^a | 1.33 ^{ab} |
| Pooled SEM | | 27.27 | 31.59 | 0.26 | 0.16 | 0.13 | 0.11 | 0.01 | 0.04 | 0.05 | 0.05 | 0.03 |
| 0 | - | 2030.00 ^b | 1700.00 ^b | 11.84 | 9.13 | 9.42 | 9.05 | 0.97 ^b | 1.33 ^a | 2.12 | 2.01 ^b | 1.18 |
| 25 | - | 2093.33 ^b | 1711.67 ^b | 11.89 | 9.62 | 9.93 | 8.85 | 0.99 ^{ab} | 1.08 ^b | 2.19 | 2.01 ^b | 1.19 |
| 50 | - | 2147.50 ^{ab} | 1802.50 ^{ab} | 12.21 | 9.04 | 9.46 | 8.94 | 1.02 ^{ab} | 1.05 ^b | 2.34 | 2.06 ^b | 1.27 |
| 75 | - | 2258.33 ^a | 1933.33 ^a | 12.80 | 9.35 | 9.39 | 8.77 | 1.04 ^a | 0.96 | 2.36 | 2.25 ^a | 1.29 |
| SEM level | | 44.73 | 51.88 | 0.51 | 0.28 | 0.25 | 0.21 | 0.02 | 0.06 | 0.08 | 0.08 | 0.05 |
| - | White | 2159.17 | 1811.25 | 11.96 | 9.19 | 9.58 | 9.07 | 0.98 ^b | 1.08 ^a | 2.25 | 1.95 ^b | 1.24 |
| - | Yellow | 2105.42 | 1762.50 | 12.41 | 9.38 | 9.53 | 8.74 | 1.03 ^a | 1.03 ^b | 2.26 | 2.21 ^a | 1.23 |
| SEM Variety | | 36.57 | 41.56 | 0.36 | 0.23 | 0.19 | 0.15 | 0.01 | 0.05 | 0.06 | 0.05 | 0.05 |

^{abcd}: Means in the same column with different superscript differ significantly (P < 0.05)

LW – liveweight, EW – Eviscerated weight

Discussion

The values obtained for all the haematological indices measured fell within the normal range value for broiler chickens in tandem with Pollack *et al.* (2005). However, observed increase in PCV, haemoglobin and RBC of broiler chickens at starter phase across the treatments were higher than the values reported by Ross *et al.* (1976) (30.73% PCV, 8.22g/dl haemoglobin and $2.39 \times 10^{12}/L$ RBC) depicts that the broilers at starter phase were able to cope with the white and yellow cassava grits diet. The increase in heterophil as the level of white and yellow cassava grits increased could be attributed to the increasing level of residual cyanide and fibre content of the diet, thus the increase in these haematological values, for the birds to cope with the stress. This is in agreement with the report of Akapo *et al.* (2014) that increased dietary inclusion levels of cassava root resulted in significant increase in WBC counts, heterophil and serum thiocyanate concentration. Serum biochemical results from this study revealed that all the serum metabolites were within the normal range value for broiler chickens (Carry, 2000). The reduction in total protein of birds fed the white cassava grit based diets agreed with the work of Cao *et al.* (2013) that posited that a higher concentration of cellulose or fibre in diet could lead to a considerable increase in the ingesta volume and intestinal feed passage time which reduced the time of nutrient exposition to digestive enzymes. The reduction in total protein could also be a reflection of the inadequacy of dietary protein in cassava based diet (Adeyemi *et al.*, 2008). However, the increase in total protein and albumin content of birds fed 50 and 75% yellow cassava grits based diets could be as a result of the beta carotene content of the yellow cassava which may have had beneficial effect on pancreas proteolytic enzyme activity, protein content in the pancreatic gland of the birds (Boguslawska-Tryk *et al.*, 2005). Obidinma (2009) observed that higher albumin concentration

in the serum of any animal indicates high plane of nutrition. The increase in glucose concentration of the starter broilers fed the white as well as those fed the yellow cassava grits based diets could be attributed to the alteration of glucose metabolism by residual cyanide resulting in 100% increase in conversion of glucose by the pentose phosphate pathway as reported by Isom (1975). The increased serum thiocyanate level as the level of substitution with white and yellow cassava grits increased was a direct effect of increased cyanide concentration of the diets. Similar report was observed by Akapo *et al.* (2014) for broiler chicks.

The packed cell volume (PCV), haemoglobin, total protein and albumin content of finisher birds increased across treatments and were higher than that obtained for the starter birds, this may be due to the advancing age of the birds and ability to cope with the diet (Kaneko, 1997; Addass *et al.*, 2012). Also, haemoglobin is known to be positively correlated with protein quality and level (Adeyemi *et al.*, 2008). The RBC count was within the normal range in literature (Post *et al.* 2007; Mohammed and Oloyede, 2009). This indicates that the birds were healthy. The reduction in WBC count as the levels of substitution with cassava increased could be attributed to the absence of infection, ability of birds to cope with environmental stress, anti-nutritional factor or high fibre content of the feed (Wendy and Jean-Marc, 1992; Egbunike *et al.*, 2009). The increase in glucose concentration was also observed in the finishing birds as the level of substitution of diets with cassava grits increased. Broiler chickens fed the diets substituted with either 50% white or yellow cassava grits had the highest eviscerated weight. The increased size of liver in broiler chickens fed 75% yellow cassava grits based diet might be due to its metabolic activities on the residual cyanide present in the diet (Uchegbu *et al.*, 2004; Rafiu *et al.*, 2015) in an effort to detoxify cyanide and at

the same time make up for the reduced protein inhibited by anti-nutritional factor through increased production of proteolytic enzymes by the pancreas (Adeyemi, 2003). The slight numerical increase in percentage gizzard as the substitution level of cassava grits increased might be due to higher dietary fibre which promoted higher thickening of the muscle of the gizzard (Onibi *et al.*, 1999). Birds fed the yellow cassava grit-based diet had higher value for spleen, and this could be attributed to the processing and detoxification of the residual cyanide of the yellow cassava variety which was estimated to be higher than that of the white cassava by Eleazu and Eleazu (2012). The lower abdominal fat content of the birds fed the yellow cassava grit-based diet could be due to the higher fibre content of the yellow cassava grits. Adeyemi *et al.* (2012) reported that abdominal fat reduced with increase in fibre content of the diet.

Conclusion and application

1. It can be concluded from this study that 75% yellow cassava grits can be substituted for maize in the broiler starter diet.
2. Substitution with either 75% white or yellow cassava grits at the finishing phase did not have detrimental effect on the well-being of the broiler chickens as haematological and serum biochemical indices were within the normal ranges. Higher live weight and dressed weight were achieved at this level of substitution.

References

Addass, P.A., David, D.L., Edward, A., Zira, K.E and Midau, A (2012). Effect of age, sex and management system on some haematological parameters of intensively and semi-intensively kept chicken in Mubi, Adamawa State, Nigeria. *Iranian Journal of Applied Animal Science*, 2(3): 277- 282

Adeyemi, F.A. (2003). Effect of enzyme supplemented cassava root meal to starter,

grower and laying chickens. *Tropical Agriculture*, 3 (57): 2270 – 2779

Adeyemi, O.A., Eruvbetine, D., Oguntona, T.O., Dipeolu, M.A and Agunbiade, J.A (2008). Feeding broiler chicken with diet containing whole cassava root meal fermented with rumen filtrate. *Archives Zootechnica*, 57(218): 247- 258

Adeyemi, O.A., Adekoya, J.A and Sobayo, R.A (2012). Performance of broiler chickens fed diets containing cassava leaf: blood meal mix as replacement for soya bean meal. *Revist Cientifica UDO Agricola* 12(1): 212- 219

Akapo, A.O., Oso, A.O., Bamgbose, A.M., Sanwo, K.A., Jegede, A.V., Sobayo, R.A., Idowu, O.M.O., Fan, J and Olorunsola, R.A (2014). Effect of feeding cassava root meal on growth performance, HCN intake and haematological parameters of broiler chicks. *Tropical Animal Health Production*, 46(7): 1167-1172.

Anthony, V.P (2009). Utilization of low-grade cassava meal (garri) in the diets of egg type chicks (0-8weeks). *Pakistan Journal of Nutrition* 8:39-41

Apata, D.F. and Babalola, T.O (2012). The use of cassava, Sweet potato and Cocoyam, and their by-products by Non-Ruminants. *International Journal of Food Science and Nutrition Engineering*. 2(4): 54-62.

Balogun, T.F and Bawa G.S (1997). Cassava peels in the diet of young pigs in Nigeria. *Tropical Animal Health and Production*. 29:209-215.

Boguslawska-Tryk, M., Szymeczko, R and Piotrowska, A (2005). The levels of major proteins and minerals in the blood serum of chickens fed diets with pure cellulose. *Foliabiologica* (Krakow) 60: 65-70.

Carry, C. (2000). Blood and Chemistry tables. In: Olsen G, Orosz S. (eds.), *Manual of Avian Medicine*. St. Louis, MO: Mosby.

- Cao, B.H., Zhang, X.P., Guoy, M., Karasawa, Y and Kumao T (2013). Effects of dietary cellulose levels on growth, nitrogen utilization, retention time of diets in digestive tract and caecal microflora of chickens. *Asian Australia Journal of Animal Science*, 16:863-866.
- Egbunike, G.N., Agiang, E.A., Owosibo, A.O and Fafute, A.A (2009). Effects of protein on performance and haematology of broilers fed cassava peel-based diets. *Archives de zootechnia*, 58(224):656.
- Eleazu, C.O. and Eleazu, K.C (2012). Determination of proximate composition, total carotenoid, reducing sugars and residual cyanide level of flours of six new yellow and white cassava varieties. *American Journal of Food Technology* 7(10): 642-649.
- Isom, G.E., Lin, D.H.W and Way, J.L (1975). Effect of sub lethal doses of cyanide on glucose catabolism. *Pharmacology* 24:871-875.
- Kaneko, J.J (1997). Serum proteins and the dysproteinemias. In: *Clinical Biochemistry of Domestic Animals*, 5th edition (Kaneko, J.J., J.W. Harvey, M.L. Bruss, Eds.) Academic Press, San Diego, London, Boston, New York, Sydney, Tokyo, Toronto pp 117-138.
- Mohammed, N.O and Oloyede, O.B (2009). Haematological Parameters of Broiler Chicks Fed *Aspergillus niger* – Fermented *Terminalia catappa* Seed Meal-Based Diet. *Global Journal of Biotechnology and Biochemistry*, 4 (2): 179-183.
- Obidinma, V.N (2009). Brewers dried grain as energy source in poultry production Ph.D. Thesis, Imo State University Owerri, Nigeria.
- Onibi, G.E., Owoyemi A.P and Akinyemi O.O (1999). Diets and dietary ingredients selection by broiler chickens: Effect on growth performance, carcass quality and economics of production. *Nigerian Journal of Animal Production* 26:35-42
- Pollack, C., Carpenter, J. W. and Antenoff, N. (2005). Birds. In: Carpenter J. (ed.), *Exotic Animal Formulary*, 3rd edition. St. Louis Mo: Elsevier Saunders.
- Post, J., Rebel, J.M.J. and Terhurne, A.A.H.M (2007). Automated Blood Cell Count: A Sensitive and Reliable Method to Study Corticosterone-Related Stress in Broilers. ID-Lelystad, Institute for Animal Science and Health, Lelystad, The Netherlands Pp: 777-781.
- PWC (2020). Harnessing the Economic Potential of Cassava Production in Nigeria. www.pwc.com/ng
- Rafiu, T.A., Babatunde, G.M., Giwa, H.O and Jokodola, O.A (2015). Effects of replacement of maize with graded levels of cassava grits on growth performance, nutrient utilization and carcass characteristics of broiler chickens. *International Journal of Agriculture Innovations and Research* 3(5): 1527-1531, ISSN 2319-1473.
- Ross, J.G., Christie G., Halliday W.G and Jones R.M (1976). Determination of haematology and blood chemistry values in healthy six-week old broiler hybrids. *Avian Pathology*, 5:4, 273-281, DOI: 10.1080/03079457608418196
- Statistical Analysis Systems (2011). Version 9.3, SAS, Institute Inc. Cary N.C. USA.
- Tewe, O.O. and Egbunike, G.N (1992). Utilization of cassava in non-ruminant livestock feeds. Pages 28-38 In: *Proceeding of the IITA/ILCA workshop on cassava as Livestock Feed in Africa*, eds. S.K. Hahn, 1. Reynolds. and G.N. Egbunike, Ibadan, Nigeria.

Uchegbu, M.C., Okoli, I.C., Anyanwu, C.E., Etuke, E.B., Esonu, B.O and Udedibie, A.B.I (2004). Performance, carcass and organ characteristics of finisher broilers fed graded levels of raw Napoleona

imperialis seed meal. *Livestock Research for Rural Development*, 16(41): 113.

Wendy, B.B and Jean-Marc, B (1992). *Encyclopedia of Microbiology*, Volume 2, Academic press Inc., pp 269-274.