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# GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY AND BLOOD INDICES OF FINISHING BROILER CHICKENS FED VARYING LEVELS OF PRE-GELATINIZED CASSAVA GRITS AS A REPLACEMENT FOR MAIZE

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## ABSTRACT

Pre gelatinized cassava grit (PGCG) is a new cassava product produced mechanically and commercially for poultry feeding. Five dietary treatments were formulated with PGCG replacing maize at 0, 25, 50, 75 and 100 % in broiler starter (0-4 weeks) and finisher (4-8 weeks) diets. Two hundred (200) day-old broiler chickens were allotted to the five dietary treatments in a completely random design. Each treatment was replicated four times with 10 birds per replicate and 40 birds per treatment. At the end of week 4 and 8 of the experiment, data were collected on growth performance, nutrient digestibility, haematological and serum biochemical indices. Final weight and weight gain were significantly ($P < 0.05$) highest in broilers fed 25 % PGCG diet, followed by those fed control diet. While, ($P < 0.05$) similar and lower values were obtained from broilers fed other PGCG diets. Feed intake decreased ($P < 0.05$) with PGCG in the diets at the starting and finishing phases. Dry matter and crude protein digestibility was ($P < 0.05$) highest in starting broilers fed 25 % PGCG diet, while digestibility ($P < 0.05$) declined with higher levels of PGCG. At the finishing phase, digestibility of all nutrients was similar ($P < 0.05$). Apparent metabolizable energy was ($P < 0.05$) higher in birds fed PGCG diets in the starting and finishing phases. Haematological and serum biochemical indices showed no significant ($P>0.05$) difference in the broiler chickens fed varying levels of PGCG in the diets. Broiler chickens fed PGCG above 25% in the diet had significantly ($P < 0.05$) higher proventriculus values when compared with those fed the control diet and 25% PGCG diet. The study revealed that substituting maize with 25 % PGCG in broiler diets improved growth and nutrient digestibility. Reduction in weight gain and non significant increased thiocyanate at higher PGCG inclusion should be improved for effective utilization of pre gelatinized cassava grit in broiler diets.

**Keywords:** *gelatinization, starch, thiocyanate, organs*

## INTRODUCTION

Scarcity of maize with increase in the price coupled with increase in poultry production is attributing to increase in the demand for energy sources of feed ingredients. Energy cost in poultry feed constitutes up to 60 to 75% of the total diet (Thirumalaisamy *et al*., 2016). Cassava had been used as an alternative for maize; it is gradually becoming a regular feed ingredient in poultry diet. The world's major (70%) cassava producers are Nigeria, Brazil, Indonesia, Democratic Republic of Congo and Thailand (FAO, 2014). The presence of linamarin, a glucoside that releases cyanide (HCN) under certain circumstances strongly influences the use of cassava products (Baltha and Cereda, 2006). Cassava has been processed into various products for feeding poultry and there are still emerging products from cassava to improve the quality and safety. Many of these processing methods are traditional and labour intensive, which require upgrading for commercial operations (Falade and Akingbala, 2011). In order to maintain cassava's competitiveness as a replacement for maize on a large scale, there is need to improve processing efficiency that can dry it to low moisture content and HCN with high nutritive values. Different methods had been used in the processing of cassava in feeding poultry which include acid hydrolysis, ensiling, sun drying and roasting (Gomez *et al*., 1988; Okoli *et al*., 2012). Each of the operations involved during processing can have either positive or negative impact on the quality and influence birds' performance (Ravindran and Amerah, 2008).

The inconsistencies reported for cassava meal products in broiler diets may be as a result of cultivar differences, cassava processing or poor utilization of cassava (Obikaonu and Udedibie, 2006).

One of the new products from cassava tuber is the pre-gelatinized cassava grit, which is mechanically produced and available commercially in feed mills. The aim of this study is to the effect of partial and complete replacement of maize with pre-gelatinized cassava grits in broiler chicken's diets on growth performance, haematological and serum biochemical indices.

## MATERIALS AND METHODS

### *Preparation of test ingredient*

Pre-gelatinized cassava grit was obtained from Starchem Product Manufacturing Company; a cassava processing centre at Oke –popo Ilora. Oyo State, Nigeria. The whole process involved the use of machines from the first stage of washing through the final stage of drying. TME 419 cassava roots variety were washed, grated, partially cooked and dried with a flash dryer. Pre-gelatinized cassava grit obtained was analysed to contain 91.12 % dry matter, 2.78 % crude protein, 1.33 % ash, 2.34 % crude fibre, 0.97 % ether extract and 0.12 mg/100g hydrogen cyanide. The metabolizable energy was calculated to be 3184.73 Kcal/kg using Pauzenga (1985)

### *Experimental birds and design*

A total of two hundred, day-old broiler chicks of Arbor acre strain were allotted to the five dietary treatments on weight equalization basis in a completely randomized design. Each treatment was replicated four times with ten (10) birds per replicate group.

### *Experimental diets*

Five dietary treatments were formulated with pre- gelatinized cassava grit replacing maize at 0, 25, 50, 75 and 100 % respectively in the diets as shown in Tables 1 and 2 for starter (0-4weeks) and finisher (4-8weeks) phases respectively.

### *Data collection*

Initial weight of the chicks were taken at the beginning of the experiment, data were collected on daily feed intake and body weight on weekly basis, feed conversion ratios were calculated from the records of the feed intake and weight gain of the birds on replicate group basis. Mortality was recorded all through the experimental period and calculated as percentage of stocked birds.

***Apparent nutrient digestibility and metabolizable energy***

At the end of the fourth and eighth week of the feeding experiment, two birds were selected randomly per replicate group. The birds were housed separately in individual compartment for seven days. The birds were acclimatized for the first three days, starved for one day but given water only to empty their gut. A known quantity of feed was fed at twenty-four hours interval and their droppings were collected for three consecutive days. The droppings collected were weighed and oven dried at 105°C for 24 hours. The dried droppings and experimental diets were analysed for proximate composition according to (AOAC, 2000). Apparent metabolizable energy was carried out according to Hill *et al* (1960).

Apparent nutrient digestibility =

$$\frac{\text{(DM nutrient in feed (g))} - \text{(DM nutrient in droppings voided (g))}}{\text{DM nutrient in feed (g)}}$$

Apparent metabolizable energy was calculated thus:

$$\frac{\text{(feed intake(kg) x gross energy of feed (kcal/kg))} - \text{(Excreta voided(kg) x gross energy of excreta(kcal/kg))}}{\text{Feed intake (kg)}}$$

***Collection of Blood for haematological and serum chemistry indices***

At the end of the forth and eight week of the feeding experiment, 5mls of blood samples were collected from the wing vein of each of the sampled bird (two birds per replicate) in which 3 mls was collected into ethylene diamine tetra acetic acid (EDTA) bottles for haematological assay and 2 mls into plain sample bottles for the measurement of biochemical metabolites. Packed cell volume (PCV) was determined using Wintrobe's microhaematocrit kit according to the method of Schalm *et al*. (1975), haemoglobin concentration was measured by cyanomethaemoglobin method, red blood cell and white blood cell were determined using the improved Neubauer haemocytometer (Jain, 1986).

The total serum protein was determined using the Biuret method, albumin was carried out by the method of Grant (1987), uric acid was determined using enzymatic colorimetric method (Fossati *et al*., 1980), creatinine was determined by the colorimetric method, cholesterol was determined using the method of Roeschlau *et al*. (1974) and the enzyme activities of Alanine aminotransferase (ALT), Aspartate aminotransferase (AST) and alkaline phosphatase (ALP) were determined by standard methods according to Bergmeyer (1983) using Randox test kits (Randox® Laboratories, Antrim, United Kingdom).

***Organ Weights***

At the end of the experiment (56 days of age), 8 birds per treatment group (2 birds per replicate group) were randomly selected, stunned, and then killed by cervical dislocation and eviscerated to remove the organs.

The weights of the birds' liver, heart, kidneys, gizzard and pancreas were recorded as percentage of liveweight of the birds using the digital sensitive scale (Mettler®, Mettler-Toledo, Leicester, UK).

***Statistical analysis***

Data were analysed using analysis of variance technique as contained in SAS version 9.1 (SAS, 2010). Differences in means were separated using Tukey test of the same package at 5 % probability level.

**Table 1: Percentage composition of starting broiler experimental diets (0-4 weeks)**

| | **Pre gelatinized cassava grit (PGCG) replacement for maize (%)** | | | | |
|---|---|---|---|---|---|
| Ingredient | 0 | 25 | 50 | 75 | 100 |
| Maize | 51.00 | 38.25 | 25.50 | 12.75 | 0.00 |
| PGCG | 0.00 | 12.75 | 25.50 | 38.25 | 51.00 |
| Fishmeal (72%CP) | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Soyabean meal | 34.50 | 34.50 | 34.50 | 34.50 | 34.50 |
| Wheat offal | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| Bone meal | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| Oyster shell | 2.50 | 2.50 | 2.50 | 2.50 | 2.50 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | |
| Methionine | 0.20 | 0.20 | 0.20 | 0.10 | 0.20 |
| Broiler starter premix* | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| Table salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Determined analysis | | | | | |
| Crude protein (%) | 23.75 | 23.08 | 22.71 | 22.24 | 21.77 |
| Crude fat (%) | 3.62 | 3.34 | 3.07 | 2.90 | 2.73 |
| Crude fiber (%) | 3.03 | 3.14 | 3.29 | 3.47 | 3.68 |
| Calculated values | | | | | |
| Hydrogen cyanide (mg/kg) | 0.00 | 15.30 | 30.60 | 45.90 | 61.20 |
| Metabolizable energy (kcal/kg) | 2778.20 | 2759.44 | 2743.69 | 2736.93 | 2720.17 |

*Broiler starter premix composition: A 2.5kg of premix contain vitamin A:12,000,000iu, vitamin $D_3$: 2,500,000iu vitamin E: 30,000iu, vitamin K: 2,000mg, vitamin B:2,250mg, vitamin $B_2$: 6,000mg, vitamin B6: 4,500mg, vitamin $B_{12}$: 15mg, Niacin: 40,000mg, Pantothenic Acid: 15,000mg Folic Acid: 1,500mg, Biotin: 50mg, choline chloride: 300,000mg, Manganese: 80,000mg Zinc: 50,000mg, Iron: 20,000mg, Copper: 5,000mg, Iodine: 1,000mg, Selenium: 200mg, Cobalt: 500mg, Antioxidant: 125,000mg.

**Table 2: Percentage composition of finishing broiler experimental diets (4-8weeks)**

| | Pre gelatinized cassava grit (PGCG) replacement for maize (%) | | | | |
|---|---|---|---|---|---|
| Ingredients | 0 | 25 | 50 | 75 | 100 |
| Maize | 60.00 | 45.00 | 30.00 | 15.00 | 0.00 |
| PGCG | 0.00 | 15.00 | 30.00 | 45.00 | 60.00 |
| Fishmeal (72% CP) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Soyabean meal | 27.00 | 27.00 | 27.00 | 27.00 | 27.00 |
| Wheat offal | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Oyster shell | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 |
| Lysine | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| Methionine | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Broiler finisher premix* | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Table salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Determined analysis | | | | | |
| Crude protein (%) | 20.74 | 20.40 | 19.86 | 19.72 | 19.28 |
| Crude fat (%) | 3.57 | 3.02 | 2.96 | 2.41 | 2.15 |
| Crude fibre (%) | 3.20 | 3.44 | 3.58 | 3.62 | 3.86 |
| Calculated values | | | | | |
| Hydrogen cyanide (mg/kg) | 0.00 | 18.00 | 36.00 | 54.00 | 72.00 |
| Metabolizable energy (kcal/kg) | 2888.75 | 2865.80 | 2852.85 | 2844.90 | 2836.95 |

*Broiler finisher premix: A 2.5kg of premix contain vitamin A:12,000,000iu, vitamin $D_3$: 2,500,000iu vitamin E: 30,000iu, vitamin K: 2,000mg, vitamin B:2,250mg, vitamin $B_2$: 6,000mg, vitamin B6: 4,500mg, vitamin $B_{12}$: 15mg, Niacin: 40,000mg, Pantothenic Acid: 15,000mg Folic Acid: 1,500mg, Biotin: 50mg, choline chloride: 300,000mg, Manganese: 80,000mg Zinc: 50,000mg, Iron: 20,000mg, Copper: 5,000mg, Iodine: 1,000mg, Selenium: 200mg, Cobalt: 500mg, Antioxidant: 125,000mg.

## RESULTS

Growth performance of starting broiler chickens fed pre gelatinized cassava grit (PGCG) as a replacement for maize was significantly ($P < 0.05$) affected as shown in table 3. Average final weight and weight gain values were ($P < .001$) highest in birds fed 25 % PGCG diets, followed by those fed control diet while, birds fed 50, 75 and 100 % PGCG diets had the least and similar values. Feed intake significantly ($P < .001$) decreased as the level of PGCG in the diets increased. Feed conversion ratio (FCR) (P <. 001) improved with PGCG diets, the best feed conversion was from birds fed 25 % PGCG.

At the finishing phase, birds fed 25 % PGCG diets had the highest final weight and weight gain. Similar weight gain values were observed in birds fed 0, 50 and 75 % PGCG diets, while the least final weight and weight gain values were from broiler chickens fed 100 % PGCG diet. Feed intake was (P < .0001) lower in birds fed PGCG diets compared to those fed the control diet. Feed conversion ratio (P < .0001) improved among birds fed 25 and 50 % PGCG diets.

**Table 3: Growth performance of finishing broiler chickens fed varying levels of pre gelatinized cassava grits (PGCG) as a replacement for maize in the diets**

| | Level of replacing maize with PGCG in diets (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | 0 | 25 | 50 | 75 | 100 | SEM | P-value |
| 0 – 4 weeks | | | | | | | |
| Average initial weight (g) | 46.00 | 46.00 | 46.00 | 46.00 | 46.00 | 0.00 | 0.0000 |
| Average final weight (g) | 710.16b | 723.35a | 683.94c | 683.79c | 690.31c | 3.74 | <.0001 |
| Average weight gain (g) | 664.16b | 677.35a | 637.94c | 637.79c | 644.31c | 3.74 | <.0001 |
| Average feed intake (g) | 1231.92a | 1182.25b | 1173.03c | 1172.36c | 1166.93d | 5.48 | <.0001 |
| Feed conversion ratio | 1.85a | 1.75c | 1.84ab | 1.83ab | 1.82b | 0.11 | <.0001 |
| Mortality (%) | 0.00 | 0.58 | 0.00 | 0.00 | 0.58 | 0.16 | 0.5732 |
| 4 – 8 weeks | | | | | | | |
| Average initial weight (g) | 710.16b | 723.35a | 683.94c | 683.79c | 690.31c | 3.74 | <.0001 |
| Average final weight (g) | 1940.23b | 1974.68a | 1914.64c | 1912.50c | 1894.67d | 6.44 | <.0001 |
| Average weight gain (g) | 1230.08b | 1257.32a | 1233.70b | 1228.72b | 1204.11c | 3.57 | <.0001 |
| Average feed intake (g) | 2453.62a | 2370.92c | 2326.76d | 2392.04b | 2393.17b | 17.33 | <.0001 |
| Feed conversion ratio | 1.99a | 1.89c | 1.89c | 1.92b | 1.99a | 0.16 | <.0001 |
| Mortality (%) | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.20 | 0.4380 |

abcd Means with different superscripts within the same row are significant at P<0.05

Table 4 showed the nutrient digestibility of broiler chickens as affected by varying levels of pre gelatinized PGCG in the diets. At the starting phase, dry matter and crude fibre digestibility percentages were (P = 0.0381, 0.0379) affected by dietary treatments. However, crude fibre, ether extract and ash digestibility were not significantly (P > 0.05) affected. Pre gelatinized cassava grits had no significant (P > 0.05) effect on nutrient digestibility of finishing broiler chickens. Although, slight reduction (P < 0.054) was observed in dry matter digestibility of broilers fed PGCG diets. Apparent metabolizable energy was significantly (P < .0001) higher in birds fed PGCG diets at the starting and finishing phases of study.

**Table 4: Nutrient digestibility of finishing broiler chickens fed varying levels of pre gelatinized cassava grits (PGCG) as a replacement for maize in the diets**

| | Level of replacing maize with PGCG in diets (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter(% digestibility) 0 – 4 weeks | 0 | 25 | 50 | 75 | 100 | SEM | P-value |
| Dry matter | 72.16c | 77.64a | 74.89b | 68.33d | 65.83e | 1.37 | 0.0381 |
| Crude protein | 54.38a | 53.23b | 53.06b | 52.78bc | 52.42c | 0.70 | 0.0379 |
| Crude fibre | 63.80 | 60.12 | 61.20 | 68.35 | 57.10 | 1.69 | 0.2377 |
| Ether extract | 75.85 | 80.81 | 78.75 | 75.80 | 74.57 | 0.99 | 0.1534 |
| Ash | 53.51 | 56.04 | 58.49 | 54.01 | 53.58 | 1.05 | 0.0635 |
| Metabolizable energy (kcal/kg) | 2876.95c | 2895.59b | 2980.98a | 2979.36a | 2991.28a | 11.20 | <.0001 |
| 4 – 8 weeks | | | | | | | |
| Dry matter | 75.93 | 74.12 | 73.61 | 70.78 | 67.61 | 1.03 | 0.0564 |
| Crude protein | 54.24 | 54.06 | 53.90 | 53.04 | 51.96 | 0.83 | 0.6019 |
| Crude fibre | 77.58 | 76.32 | 72.59 | 72.42 | 71.90 | 1.38 | 0.1334 |
| Ether extract | 88.23 | 86.36 | 84.86 | 81.41 | 80.16 | 1.91 | 0.4396 |
| Ash | 66.32 | 67.02 | 63.88 | 64.94 | 63.09 | 0.77 | 0.5012 |
| Metabolizable energy (kcal/kg) | 2880.08b | 2895.96b | 2977.65a | 2984.28a | 2987.28a | 10.89 | <.0001 |

[abcde] Means with different superscripts within the same row are significant at P<0.05

Haematological indices of broiler chickens fed varying levels of pre-gelatinized cassava grit as a replacement for maize as shown in table 5 indicated no significant (P > 0.05) effect on measured parameters. Packed cell volume, haemoglobin, red blood cell and white blood cell were not affected (P > 0.05) at the starting and finishing phases.

**Table 5: Haematological indices of broiler chickens fed varying levels of pre-gelatinized cassava grits (PGCG) as a replacement for maize in the diets**

| Parameter | Level of replacing maize with PGCG in diets (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 75 | 100 | SEM | P-value |
| 0 – 4 weeks | | | | | | | |
| Packed cell volume (%) | 38.00 | 35.60 | 42.00 | 41.67 | 38.00 | 0.98 | 0.5671 |
| Haemoglobin (g/dl) | 11.70 | 11.57 | 13.47 | 12.50 | 12.07 | 0.32 | 0.2924 |
| Red blood cell (x1012/L) | 2.87 | 2.80 | 3.40 | 3.15 | 3..20 | 0.09 | 0.1714 |
| White blood cell (x109/L) | 12.07 | 12.70 | 14.40 | 13.57 | 12.09 | 0.26 | 0.2002 |
| 4 – 8 weeks | | | | | | | |
| Packed cell volume (%) | 33.50 | 32.00 | 33.75 | 33.25 | 32.50 | 1.23 | 0.6230 |
| Haemoglobin (g/dl) | 11.13 | 11.50 | 11.03 | 11.25 | 11.75 | 0.41 | 0.5628 |
| Red blood cell (x1012/L) | 2.25 | 2.86 | 2.74 | 2.75 | 2.35 | 0.09 | 0.2184 |
| White blood cell (x109/L) | 12.25 | 12.60 | 12.17 | 11.50 | 11.36 | 0.40 | 0.6212 |

The effect of feeding PGCG as a replacement for maize in broiler chicken diets had no significant ($P > 0.05$) influence on the serum chemistry measured at the starting and finishing phase. At the starting phase, serum thiocyanate increased slightly ($P = 0.0571$) as the level of replacement increased in the diet. Similar not significant ($P = 0.1438$) thiocyanate trend was observed at the finishing phase.

The organ weights presented as the percentage live weight of the birds were not significantly ($P > 0.05$) different across the dietary treatment groups except the proventriculus. Percentage proventriculus had significant ($P < 0.05$) higher values in broiler chickens fed PGCG the diets above 25% PGCG replacement level.

**Table 6: Serum chemistry indices of broiler chickens fed varying levels of pre-gelatinized cassava grits (PGCG) as a replacement for maize in the diets**

| | **Level of replacing maize with PGCG in diets (%)** | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | 0 | 25 | 50 | 75 | 100 | SEM | P-value |
| 0 – 4 weeks | | | | | | | |
| Total protein (mg/dl) | 3.87 | 4.00 | 3.37 | 3.78 | 3.20 | 0.15 | 0.1556 |
| Albumin (mg/dl) | 2.77 | 2.33 | 1.97 | 2.60 | 1.83 | 0.15 | 0.5503 |
| Globulin (mg/dl) | 1.10 | 1.77 | 1.40 | 1.16 | 1.36 | 0.08 | 0.1738 |
| Glucose (mg/dl) | 147.00 | 161.70 | 131.70 | 152.70 | 121.70 | 7.23 | 0.2466 |
| Cholesterol (mg/dl) | 60.00 | 62.67 | 56.00 | 77.00 | 53.67 | 2.67 | 0.2893 |
| Thiocyanate (mg/dl) | 0.71 | 0.73 | 1.17 | 1.27 | 1.37 | 0.10 | 0.0571 |
| Aspartate aminotransferase (U/L) | 51.67 | 58.00 | 51.67 | 49.33 | 46.67 | 1.55 | 0.0914 |
| Alanine aminotransferase (U/L) | 24.67 | 22.67 | 27.00 | 24.00 | 31.67 | 1.19 | 0.1708 |
| Alkaline phosphatase (U/L) | 81.00 | 62.00 | 75.00 | 71.67 | 74.00 | 8.77 | 0.1939 |
| 4 – 8 weeks | | | | | | | |
| Total protein (mg/dl) | 4.77 | 4.47 | 4.20 | 3.96 | 3.80 | 0.26 | 0.2063 |
| Albumin (mg/dl) | 3.13 | 3.16 | 2.90 | 2.77 | 2.70 | 0.18 | 0.0800 |
| Globulin (mg/dl) | 1.64 | 1.35 | 1.30 | 1.21 | 1.10 | 0.16 | 0.2887 |
| Glucose (mg/dl) | 110.50 | 110.25 | 113.20 | 113.50 | 121.00 | 2.68 | 0.6429 |
| Cholesterol (mg/dl) | 67.00 | 65.20 | 64.36 | 62.75 | 61.00 | 2.98 | 0.6523 |
| Thiocyanate (mg/dl) | 1.57 | 1.64 | 1.86 | 2.03 | 2.27 | 0.24 | 0.1438 |
| Aspartate aminotransferase (U/L) | 49.20 | 51.00 | 46.67 | 53.00 | 51.86 | 2.37 | 0.0760 |
| Alanine aminotransferase (U/L) | 23.30 | 24.66 | 23.46 | 24.00 | 23.78 | 1.31 | 0.2005 |
| Alkaline phosphatase (U/L) | 68.26 | 69.50 | 71.00 | 69.90 | 71.20 | 2.86 | 0.6856 |

**Table 7: Organ weight of 8-week old broiler chickens fed varying levels of pre-gelatinized cassava grits (PGCG) as a replacement for maize in the diets**

| | Level of replacing maize with PGCG in diets (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| Organ (% live weight) | 0 | 25 | 50 | 75 | 100 | SEM | P-value |
| Heart | 0.48 | 0.43 | 0.44 | 0.40 | 0.46 | 0.03 | 0.7612 |
| Liver | 2.21 | 2.23 | 2.31 | 2.40 | 2.36 | 0.01 | 0.6208 |
| Kidney | 0.06 | 0.06 | 0.05 | 0.06 | 0.05 | 0.01 | 0.5301 |
| Proventiculus | 0.44c | 0.45c | 0.71a | 0.60b | 0.71a | 0.04 | 0.0132 |
| Gizzard | 2.23 | 2.26 | 2.60 | 2.51 | 2.37 | 0.07 | 0.3205 |

abc Means with different superscripts within the same row are significant at P<0.05

## DISCUSSION

The improvement in final and weight gain of starting and finishing broiler chickens fed 25 % PGCG diet could be attributed to the additive effects of PGCG to the diet. The processing method involved in preparing PGCG was able to keep most of the nutrient available in cassava and reduced hydrogen cyanide (HCN) content, which enables PGCG to compare with maize to a certain level. Reduction in weight gained with increased PGCG in diets may be as a result of reduced feed intake and low protein content in cassava, resulting in pronounced protein/amino acids deficiency at higher PGCG inclusion level. Montagnac *et al*. (2009) reported that boiled cassava root keep major high nutrients than other cassava products. Gomes *et al*. (2005) indicated that cassava starch is more digestible than maize starch due to the higher amylopectin in cassava. Cassava had been observed to contain low protein with very low essential amino acids (Olugbemi *et al*., 2010). Chickens fed highly digestible starch had been observed to have less body weight gain than those with slowly digestible starch; high digestible starch can be converted to glucose quickly when other nutrients are yet to be absorbed which hinders amino acid absorption in the small intestine (Weurding *et al*., 2003).

Akinfala *et al*. (2002) observed reduced growth of 13 and 19% in broiler chickens fed whole cassava replacing maize at 12.5 and 25% respectively. Tang *et al*. (2012) found reduction in growth of broilers when maize was completely substituted with cassava pellets or chips.

Dry matter digestibility at the starter phase correlated to the final weights of the birds. The crude protein digestibility at the starting phase was in relation to the crude protein available in each diet, this was not evident at the finishing phase. Hidalgo *et al*. (2004) found crude protein decrease as the level of cassava grit increased in broiler chicken diets. Similar (P > 0.05) digestibility coefficients of nutrients observed at the finishing phase was indicative that PGCG could substitute for maize in broiler diets. Rafiu *et al*. (2013) reported that broiler birds placed on cassava grit had highest digestibility potential than the control, these values increased as the level of inclusion increased. The apparent metabolizable energy in broiler chickens fed high inclusion of PGCG in the diets might be as a result of partial cooking in the processing of PGCG. Gelatinizing has been reported to have the ability to improve starch digestibility (Liu *et al*., 2013) and a greater digestive rate than ground maize (Jane *et al*., 2002). Nalle *et al*. (2013) reported enhanced apparent ileal starch digestibility due to gelatinization, by making starch more liable to enzyme degradation.

The non significant effect of the haematological and serum biochemical indices of broiler chickens indicates that PGCG in the diet did not pose any health hazards to the birds. The packed cell volume showed that the level of oxygen carried to the tissues as well as carbon dioxide returned to the lungs is adequate. Enyenihi *et al*. (2008) obtained similar trend in laying hens fed wetted sun-dried cassava tuber meal, while Oladunjoye *et al*. (2010) obtained higher PCV values in point of lay Haco strain pullets fed diets containing sun–dried cassava peel meal. The concentration of total protein irrespective of PGCG inclusion was indicative of adequate diet for the chickens. The plane of nutrition in diets is a measure of the total protein level (Obidinma and Ekenyem, 2010). The low globulin in broilers fed PGCG was an indication of reduced anti nutritional factor in the diet. Glick (1998) reported that high globulin in the serum is due to stimulation of the immune system in the birds. The non significant increase in the thiocyanate level of the broiler chickens fed PGCG diets showed that the methionine content in the diets was adequate to detoxify the amount of hydrogen cyanide (HCN) in the blood of the chickens. Garcia and Dale (1999) observed that HCN in the liver changed into thiocyanate by the enzyme rhodanase and this process uses sulphur from methionine. Similarity ($P > 0.05$) observed in the tissue enzymes suggested that the consumption of the diets did not result in tissue, cell or organ damages. Rivetz *et al*. (1975) found that the main cause for serum ALP reduction is damage of intestine. Liver damage often resulted in the release of these enzymes (alanine aminotransferase and aspartate aminotransferase) into the blood (Kaplan *et al*., 2003).

The proventriculus is the portion of the digestive tract which mixes the feed with acids and digestive enzymes, the increased in size observed in broilers fed high level of PGCG could be as a result of secretion of more amylase enzyme into the system. Granfeldt *et al*. (2000) observed that starch in its native state is resistant to enzymatic digestion and that amylase hydrolysis rate increased by the degree of gelatinization. When raw starch granules were gelatinized during cooking, the disruption of starch structure increases its susceptibility to enzymatic degradation (Holm *et al*., 1988).

## CONCLUSION

Pre gelatinized cassava grit at 25 % substitution for maize in the diets of broiler chickens could improve broiler chickens growth performance and nutrient digestibility without any negative effect on blood indices. However, with reduced performance due to decline in the average final weight, weight gained, dry matter and protein digestibility with increased in PGCG in the diets. It is recommended that feed additives that can improve the utilization of PGCG should be included in broiler diets.

## STATEMENT OF ANIMAL RIGHTS

The study was performed in accordance with ethical standards.

## CONFLICT OF INTERREST STATEMENT

There is absolutely no conflict of interest with any individual or organisation regarding the materials discussed in the manuscript.

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