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# NUTRIENT DIGESTIBILITY AND BLOOD PROFILE OF STARTER BROILER CHICKENS FED DIETS WITH VARYING LEVELS OF CASSAVA GRITS AS REPLACEMENT FOR MAIZE

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## ABSTRACT

Nutrient digestibility and blood profile of animals indicate physiological, pathological and nutritional status and can be used to determine dietary value. This 4week study determined effects of cassava grits (CG) as replacement for dietary maize on the apparent nutrient digestibility and blood profile of two strains of starter broiler chickens. Data were collected on digestibility of dry matter, crude protein, ether extract, crude fibre and nitrogen free extract as well as Packed Cell Volume, Haemoglobin, Red Blood Cell and White Blood Cell for haematology, white blood cells differentials, while Total Protein, Albumin, Globulin, Creatinine and Uric Acid were studied for serum biochemistry using 240 day old broiler chicks. The birds comprising of Arbor Acre plus (120) and Marshal Strains (120) were randomly allocated to four treatments where CG replaced 0, 15, 30 and 45% of dietary maize. At 3 weeks, 2 birds were selected per replicate for apparent nutrient digestibility study following standard procedures while blood samples (5ml) were collected from 4 birds per replicate via the jugular vein into EDTA bottles for haematology and plain bottles for serum biochemistry and analysed. Data obtained were analysed using ANOVA. Results revealed that dietary CG and strain had no significant ($p>0.05$) effect on apparent nutrient digestibility. Blood parameters were not significantly ($p>0.05$) influenced by strains and dietary treatments except ($p<0.05$) creatinine. Broiler chickens on 15% CG treatment had highest ($p<0.05$) creatinine (4.35mg/dl). Interaction between broiler strains and CG levels had no influence ($P>0.05$) on total serum parameters of the experimental birds. Replacement of dietary maize with CG up to 45% level had no deleterious effects on the nutrient digestibility and general well-being of starter broiler chickens.

**Keywords: Haematology, serum biochemistry, cassava grits, broiler chicken, digestibility**

## INTRODUCTION

Increasing cost of feed resources in livestock production has been identified as a serious impediment to meeting the demand for animal protein particularly in developing countries (Adejinmi *et al*., 2000). Feed cost may account for between 40 and 80% of total cost of livestock production depending on species and system of production. For intensive poultry production system, it is about 60-80% (Daghir, 1995; Tewe, 1997; Oruseibio and Smile, 2001). Poultry production in Nigeria is affected by the high cost

of feedstuffs (Okoye, 2002; Bot *et al*., 2013) which has invariably led to increase in the prices of poultry products. Poultry products are getting unaffordable for the average man in Nigeria and many other developing countries.

Among the poultry feed components, energy sources, maize in particular, takes 50-60% which represents the largest proportion of the feed components (Afolayan *et al*., 2002, USDA, 2015). However, maize is one of the major staple foods and is also used for various industrial purposes including production of biofuel in some parts of Africa (Morghan and Choct, 2016). These contending needs make maize usually in short supply for feed production and often very expensive. It was opined that fluctuating supply and high cost of feed ingredients may cause imbalanced nutrition and consequent poor performance of animals (Irekhore *et al*., 2016). Hence, the need for appropriate alternative feed resources which can fully or partly replace maize in the diets of poultry at least cost.

Cassava is a major source of calories in developing tropical countries and has been widely studied as an alternative for maize in animal feeds (USDA, 2015; Morghan and Choct, 2016). It contains about 92.2 percent carbohydrates and 3.2 percent protein in its dry matter and is a major crop in Nigeria (Phillips *et al.*, 2004). The nation produces about 49million metric tonnes/annum, being the largest producer in the world (FAO, 2010). Cassava is hardy, easier and less expensive to produce compared to maize. According to a report by NCPPPP (2015), cassava yield in Nigeria is an average of 13.9 tonnes/hectare. However, it can be up to 40 – 50 tonnes/hectare, far above maize with improved varieties and correct cultural practices. This is a great potential in filling the energy supply gap for poultry production at reasonable prices. However, the challenge of high water content, fast deterioration as well as the anti-nutritive compounds are limiting factors to cassava use (Chauynarong *et al.*, 2009). Anti-nutritive compounds have effect on digestion (Oude *et al.*, 1986). Phillips (1984) noted that the efficiency of utilization of ingested feed is affected by digestion. Only those feed nutrients that are digested can be absorbed and utilized to promote growth, body maintenance and reproduction. Nutrient digestibility has been used as a veritable tool to determine animal performance vis-a-vis feedstuff utilization. Digestibility is a measure of the overall gastrointestinal function and refers to digestible part of foods or nutrients proportion which is not excreted in the faeces and is therefore assumed to be absorbed by the animal (McDonald *et al*., 2007).

Over the years, digestibility has been identified to be influenced by animal and nutrition factors (Eusebio, 1980; Oude *et al.*, 1986). Concepts of digestibility are thus commonly used to describe the nutritional value of feeds for animals (Dierick, 1991). Nonetheless, there is dearth of information on digestibility of Cassava Grits (CG) in the ration of starting broilers. Agunbiade *et al*. (2002) stated that the utilization of dietary energy and other nutrients of feed ingredients is influenced by many factors including composition, the rate of inclusion, ease of digestion and assimilation. Meanwhile, assimilation of digested nutrients is usually through blood and other physiological processes. Furthermore, blood components of animals are affected by many factors of which nutrition is a major one (Schalm *et al.*, 1975; Addass *et al.*, 2012). According to Esonu *et al.* (2001), haematological constituents reflect the health status and other physiological responsiveness such as age of the animals while the influence of diet on haematological traits is very strong (Church *et al.*, 1984). Hence, this study aimed to provide information on apparent nutrient digestibility and blood profile of starter broiler chickens fed diets containing varying levels of CG as replacement for maize.

## MATERIALS AND METHODS

The research was carried out at SLIDEN Africa Poultry Unit, Alagbede village, Odeda Local Government Area, Ogun State, Nigeria. This region lies within South-Western part of Nigeria at Latitude 7.16°N and Longitude 3.34°E and has humid climate with mean annual rainfall of 1039mm, and altitude of 760mm above the sea level with average temperature $35.7^0$C.

**Test ingredient and dietary composition**

Cassava Grits was obtained from a reputable commercial outfit. It was used to replace maize at 0%, 15%, 30% and 45% replacement levels for broiler starter diets. The diets were formulated to meet the nutritional requirements of starter broiler chickens and they contained crude protein range of between 22.8 and 23.4% and energy between 2986 and 3100Kcal/kg (Table 1).

**Table 1: Broiler starter (0-4 weeks) diets containing varying levels of Cassava Grits as energy source**

| | Maize replacement levels with Cassava Grits (%) | | | |
|---|---|---|---|---|
| **Ingredients (kg/ton)** | **0%** | **15%** | **30%** | **45%** |
| Maize | 450 | 382.5 | 315 | 247.5 |
| Groundnut cake | 180 | 185 | 205 | 200 |
| Soybean meal | 120 | 125 | 105 | 110 |
| Fish meal | 30 | 30 | 30 | 30 |
| Cassava Grits | 0 | 67.5 | 135 | 202.5 |
| Palm kernel cake | 63 | 100 | 100 | 118 |
| Wheat offal | 100 | 58 | 58 | 40 |
| Bone meal | 20 | 25 | 25 | 25 |
| Oyster shell | 30 | 20 | 20 | 20 |
| Lysine | 1 | 1 | 1 | 1 |
| Methionine | 1 | 1 | 1 | 1 |
| Premix | 2.5 | 2.5 | 2.5 | 2.5 |
| Salt | 2.5 | 2.5 | 2.5 | 2.5 |
| **Total** | **1000** | **1000** | **1000** | **1000** |
| **Diet composition** | | | | |
| Metabolizable Energy (kcal/kg) | 3100.39 | 3059.32 | 2996.30 | 2986.36 |
| Crude protein (%) | 22.79 | 23.42 | 22.97 | 23.41 |
| Ether extract (%) | 4.48 | 4.60 | 4.44 | 4.47 |
| Crude fibre (%) | 5.23 | 5.94 | 5.89 | 6.38 |
| Calcium (%) | 1.6 | 1.62 | 1.62 | 1.64 |
| Phosphorus (%) | 0.51 | 0.51 | 0.51 | 0.49 |
| Lysine (%) | 1.00 | 1.02 | 0.97 | 1.20 |
| Methionine (%) | 0.44 | 0.44 | 0.42 | 0.49 |

**Experimental birds and management**

Two hundred and forty (240) day-old broiler chicks of two different strains comprising of 120 Arbor Acre plus and 120 Marshal were obtained from reputable hatcheries and used for the study. Birds of each strain were randomly divided into four (4) dietary treatments each with three replicates of 10 birds/replicate. The birds were housed and managed using deep litter system while the birds in each treatment were placed on respective diets. Feed and water were given at *ad-lib.* Routine management practices such as

vaccination, medication, changing of wood shavings were carried out as needed. The study lasted for 4 weeks.

**Data collection**

**Nutrient digestibility**

Metabolic trial was carried out beginning from the end of the third week. Two birds were taken at random from each replicate and housed individually in metabolic crates. The birds were acclimatized for three days. On the fourth day, the birds were starved of feed in order to empty their gastro-intestinal tract. From the fifth day, a known quantity of the designated diet on treatment basis was fed to each bird and the voided droppings collected daily for 4 days. The droppings were collected in foil paper, weighed and oven dried at 65°C. Dried excreta of each bird according to treatment and replicate were bulked and samples were analysed for proximate composition. CG and the experimental diets formulated were also analysed for proximate composition according to method of AOAC (2000).

For each nutrient, apparent nutrient digestibility was calculated as follows:

$$\frac{\text{Nutrient intake} - \text{Nutrient voided}}{\text{Nutrient intake}} \times 100$$

While, Nitrogen free extract (%) was calculated as:

Expression = 100 - (% Moisture + % CF + % CP + % EE + % Ash)

Where CF = crude fibre, CP = crude protein, EE = ether extract

**Blood Profile**

At the fourth week of the study, 4 birds were selected from each replicate for blood analysis. Blood sample (5ml each) was collected through jugular vein puncture from each bird at 7.00hour of the day using sterilized needle and syringe, and emptied into two bottles. One of the bottles contained EDTA for haematology while the other was non-EDTA for serum chemistry. Samples for the haematological parameters were analysed using standard procedures as described by Bush (1975), for haemoglobin, red blood cells (RBC), packed cell volume (PCV) and white blood cells (WBC). White blood cells differentials (eosinophils, neutrophils, lymphocytes, monocytes and basophils) were analysed as described by Tripathi *et al.* (2008). Blood samples for serum biochemical parameters were analysed as outlined by Bush (1975).

**Data Analysis**

Data obtained were subjected to Analysis of Variance (ANOVA) in a 2×4 factorial arrangement using SAS (2009) statistical package. Significant differences were separated using Duncan Multiple Range Test of the package.

## RESULTS AND DISCUSSION

**Main effect of strain on apparent nutrient digestibility by broiler chickens at starter phase (0-4 weeks)**

Strain of the broiler chickens had no significant ($p>0.05$) effects on all parameters of apparent nutrient digestibility measured at starter phase (Table 2).The dry matter digestibility was 69.52% for Arbor Acre strain of broiler chicken while Marshal recorded a value of 72.85%. Values obtained for apparent crude protein was 64.04% and 66.88% for Arbor Acre and Marshal Strains, respectively. Birds of Arbor Acre recorded a value of 26.22% for crude fibre digestibility while Marshal recorded a value of 25.82%. Ether extract digestibility obtained for Arbor Acre was 85.88% while 89.13% was recorded for Marshal. Values obtained for ash were 26.63% and 38.12% for Arbor Acre and Marshal, respectively. Nitrogen free extract digestibility for Arbor Acre was 84.52% which was similar to 84.50% obtained for Marshal. This indicate that Arbor Acre and Marshal Strains of broiler chickens compared in

apparent nutrient digestibility. The opinion of Sogunle *et al.* (2009) who reported none significant relationship in the performance of two strains of broiler chickens gives credence to this finding.

This result is at variance with the findings of Jaroni *et al*. (1999) who reported variations in the nutrient digestibility of two strains of Leghorn hens fed dietary wheat middlings and enzyme supplementation. The reason could be as result of the feedstuff and age of the birds. According to Eusebio (1980) and Oude *et al.* (1986) age of animal and fibre content determine nutrient digestibility. In this study, the broiler chickens were between 0-4weeks while the Leghorn hens cold be more than 30weeks old. Thus the Leghorn hens could probably have well developed digestive tract for nutrient utilization. Similarly, the test ingredients were not the same. Enzyme was used in the Leghorn study and enzyme has been reported to aid digestion.

The results obtained in this broiler study can be attributed to the fact that the birds were similar in age and probably of the same genetic quality as broilers are bred for high feed efficiency and fast growth.

**Table 2: Main effect of strain of broiler chickens on apparent nutrient digestibility at starter phase**

| | Strain of Broiler Chickens | | |
|---|---|---|---|
| **Parameters (%)** | **Arbor Acre** | **Marshal** | **SEM** |
| Dry matter | 69.52 | 72.85 | 1.59 |
| Crude protein | 64.04 | 66.88 | 2.00 |
| Crude fibre | 26.22 | 25.82 | 4.56 |
| Ether extract | 85.88 | 89.13 | 1.12 |
| Ash | 26.63 | 38.12 | 3.84 |
| Nitrogen free extract | 84.52 | 84.50 | 0.91 |

SEM = Standard error of mean.

**Main effect of levels of CG on apparent nutrient digestibility of broiler chickens at starter phase**

Apparent nutrient digestibility of diets containing CG by broiler chickens at starter phase was not significantly ($p>0.05$) affected by replacement levels (Table 3). Apparent digestibility of crude protein, crude fibre, ether extract, ash and nitrogen free extract were similar ($p>0.05$) across dietary treatment. This result reveals that the broiler chicks digested the CG diets well as observed in maize based diet (control). This could be due to the fact that the diets were formulated to be iso-caloric and iso-nitrogenous, thus having similar physiological effect on the birds. Nutrient digestibility is reportedly affected by dietary fibre (Sauer *et al*., 1991; McDonald *et al*., 2010) and anti-nutrients content (Kumar and D'Mello, 1995) among other factors. Hence CG diets in this study could be assumed to contain fibrous materials and anti-nutrients in quantities that did not interfere with digestion. More so, the CG utilized in this study was produced through fermentation process. Akinola *et al*. (2015) reported reduction in anti-nutrients with fermentation which has also been identified to positively influence digestibility. CG utilized in this study was observed to contain a mean value of 11.7ppm hydrogen cyanide. This is low compared to findings of Okafor and Njoku (2008) who reported 44.03ppm for low Cynanide in cassava used for animal feed in Nigeria, the range of 52 – 91ppm reported by Burns *et al*. (2011) for cassava food products in Africa and 30ppm reported by Hernaez (2006) in Philippine cassava. Therefore, fermentation could be said to

have helped reduce cyanide content of cassava and consequently enhance digestibility of CG diets.

**Table 3: Main effect of diet on apparent nutrient digestibility of broiler chickens at starter phase**

| | Replacement level of Maize with Cassava Grits | | | | |
|---|---|---|---|---|---|
| **Parameter (%)** | **0%** | **15%** | **30%** | **45%** | **SEM** |
| Dry matter | 70.36 | 72.92 | 69.66 | 71.80 | 1.59 |
| Crude protein | 61.60 | 69.26 | 63.18 | 67.81 | 2.00 |
| Crude fibre | 26.36 | 27.00 | 20.54 | 30.18 | 4.56 |
| Ether extract | 86.68 | 89.44 | 88.36 | 85.55 | 1.12 |
| Ash | 25.94 | 36.85 | 31.69 | 34.99 | 3.84 |
| Nitrogen free extract | 84.85 | 83.43 | 83.89 | 86.03 | 0.91 |

SEM = Standard error of mean

**Interactive effects of strain and CG diets on apparent nutrient digestibility of broiler chickens at starter phase**

The interaction between Strain of broiler chickens and CG inclusion in diets of broiler chickens at starter phase (0-4weeks) had no significant effects on all apparent nutrient digestibility parameters except ($p<0.05$) ether extract (Table 4). Ether extract digestibility was significantly ($p<0.05$) highest (91.89%) with Marshal Strain birds fed diet in which CG replaced 45% of maize. This value compared ($p<0.05$) with that of Marshal on diet with 30% maize replacement and Abort Acre on diet with 15% replacement. The result suggests that CG diets have equal digestibility as maize-based diets by both strains of broiler chickens at starter phase. This finding is at variance with the report of Hidalgo *et al.* (2004) who observed that broilers placed on CG had higher digestibility potential than the control.

**Table 4: Interactive effect of strain and diet on apparent nutrient digestibility by broiler chickens at starter phase**

| | Replacement Level of Maize with Cassava Grits (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Arbor Acre | | | | Marshal | | | | |
| **Parameters %** | **0** | **15** | **30** | **45** | **0** | **15** | **30** | **45** | **SEM** |
| Dry matter | 71.86 | 75.57 | 65.61 | 65.04 | 68.86 | 70.27 | 73.71 | 78.56 | 1.59 |
| Crude protein | 64.65 | 71.79 | 59.50 | 60.22 | 58.55 | 66.74 | 66.85 | 75.40 | 2.00 |
| Crude fibre | 31.44 | 37.25 | 16.69 | 19.49 | 21.27 | 16.74 | 24.40 | 40.88 | 4.56 |
| Ether extract | 88.46$^{a}$ | 91.00$^{a}$ | 84.95$^{ab}$ | 79.12$^{b}$ | 84.90$^{ab}$ | 84.95$^{a}$ | 91.77$^{a}$ | 91.98$^{a}$ | 1.12 |
| Nitrogen free extract | 86.33 | 85.55 | 81.93 | 84.29 | 83.37 | 81.31 | 85.85 | 87.77 | 0.91 |
| Ash | 28.59 | 40.42 | 19.70 | 17.80 | 23.29 | 33.29 | 43.69 | 52.18 | 3.89 |

ab: means on the same row with different superscripts are significantly different ($P<0.05$)
SEM = Standard error of mean

**Main effect of broiler strain on haematological indices and white blood cells differentials of starter broiler chickens**

The main effect of strain on haematological indices and white blood cells differentials of starter broiler chickens is presented in Table 5. Strain of broiler chickens had no significant ($p>0.05$) effect on packed cell volume, haemoglobin, red blood cells, white blood cells and white blood cells differentials of broiler chickens at starter phase. According to Esonu *et al.* (2001), haematological constituents reflect the physiological responsiveness of the animals. Therefore the starting broilers fed diets containing CG as replacement for maize could be described as healthy birds.

**Table 5: Main effect of strain on haematological parameters and white blood differentials of broiler chickens at starter phase**

| | **Strain of Broiler** | | |
|---|---|---|---|
| **Parameter** | **Arbor Acre** | **Marshal** | **SEM** |
| Packed cell volume (%) | 26.71 | 28.21 | 0.48 |
| Haemoglobin (g/dl) | 8.70 | 9.24 | 0.15 |
| Red blood cell ($X10^{12}$/L) | 2.25 | 2.28 | 0.04 |
| White blood cell ($X10^{9}$/L) | 12.08 | 12.83 | 0.28 |
| **White blood differentials** | | | |
| Heterophil (%) | 33.42 | 32.54 | 0.62 |
| Lymphocytes (%) | 64.01 | 69.21 | 0.60 |
| Eosinophil (%) | 0.54 | 0.87 | 0.11 |
| Basophil (%) | 0.83 | 0.83 | 0.14 |
| Monophil (%) | 1.13 | 1.54 | 0.16 |

SEM = Standard error of mean.

**Main effect of CG on hematological parameters and white blood differentials of broiler chickens at starter phase**

Table 6 shows the main effect of replacement levels of CG for maize on hematological parameters and white blood cells differentials of broiler chickens at starter phase. The replacement of dietary maize with CG had no significant ($p>0.05$) influence on haematological parameters and white blood differentials of broiler chickens at starter phase. Therefore, CG used in this study could be said to be of no deleterious effect on the blood constitutes and white blood differentials of the broiler chickens at the starting phase. Agunbiade *et al*. (2002) stated that the utilization of dietary energy and other nutrients of feed ingredients is influenced by many factors among which are their composition, ease of digestion and assimilation. It could imply that CG diet was well assimilated into the blood stream. Since blood components of animals are affected by many factors including nutrition, it is an indication that the nutrition status of the birds was ideal as opined by Addass *et al. (*2012). Babatunde *et al*. (1992) reported that diet has very strong influence on haematological parameters and both are positively related. It suffices to say that diets in this study met the nutrient requirements at the starter phase and this was responsible for none significant variation recorded in the haematological parameters. Moreover, all the haematogical parameters measured were within the range

reported by Obun *et al*. (2013) for broiler chicks. Abu *et al*. (2013) reported none significant effects of grits from three cassava varieties as replacement for maize on haematology of broiler chickens. The result of Abu *et al.* (2013) also gave credence to finding of this study.

**Table 6: Main effect of replacement levels of CG for dietary maize on hematological parameters and white blood cells differentials of broiler chickens at starter phase**

| | Replacement level of Maize with Cassava Grits | | | | |
|---|---|---|---|---|---|
| **Parameter** | **0%** | **15%** | **30%** | **45%** | **SEM** |
| Packed cell volume (%) | 27.00 | 27.92 | 27.42 | 27.50 | 0.48 |
| Haemoglobin (g/dl) | 8.92 | 9.06 | 9.00 | 8.89 | 0.16 |
| Red blood cell ($X10^{12}$/L) | 2.26 | 2.31 | 2.23 | 2.25 | 0.04 |
| White blood cell ($X10^{9}$/L) | 13.56 | 12.91 | 12.66 | 12.29 | 0.28 |
| **White blood differentials** | | | | | |
| Heterophil (%) | 32.67 | 32.00 | 34.08 | 33.17 | 0.62 |
| Lymphocytes (%) | 63.83 | 64.92 | 62.67 | 65.00 | 0.60 |
| Eosinophil (%) | 0.75 | 0.67 | 0.92 | 0.50 | 0.11 |
| Basophil (%) | 1.00 | 1.08 | 0.75 | 0.50 | 0.14 |
| Monocyte (%) | 1.58 | 1.33 | 1.58 | 0.83 | 0.16 |

SEM= standard error of mean

**Interactive effect of strain and replacement levels of CG for maize on hematological indices and white blood differentials of broiler chickens at starter phase**

There was significant ($p<0.05$) effect of interaction between broiler strain and replacement levels of CG on packed cell volume (PCV), haemoglobin and red blood cells (RBC) of the broiler chicks (Table 7). Marshal strain of broiler chicks on 0% replacement level of maize with CG had significantly ($p<0.05$) higher PCV (29.33%) compared with the 24.67% recorded for their Arbor Acre counterparts on the same diet. However, the PCV value of Marshal fed control diet was similar ($p>0.05$) to those of the birds of both strains on diets with 15, 30 and 45% replacement levels of maize. Likewise for Arbor Acre on control diet. This result is similar to that obtained by Abu *et al*. (2013) who reported no significant variation in the PCV of broiler chicks fed 50% grits as replacement for maize.

Values obtained for haemoglobin concentration (Hb) in this study followed the same trend as the PCV. Hb values ranged between 8.12 and 9.72g/dl. This range is slightly higher than that of Obun *et al*. (2013) who reported Hb range of between 6.00 and 9.5g/dl in broiler chicks fed diets supplemented with graded levels sun-cured Neem (*Azadirachta indica* A. Juss). Variation in the Hb range could be due to the test ingredients. Meanwhile, higher Hb range obtained in this study could be an attestation to the energy potential of CG and oxygen carrying ability of the Hb of the experimental birds as well as healthy nature of the experimental birds. The normal range of haemoglobin for a healthy bird is 7g/dl to 18.6g/dl (Pellet and Young, 1980). CG diets used for broiler starter diet in this study could therefore be adjudged adequate in protein and other nutrients requirement and supply for broiler chicks. This is according to Eggum (1989) who opined that haematocrits, erythrocytes and haemoglobin tend to be positively correlated with protein quality and level. Also, CG as replacement for maize in this study had no negative effect on oxygen transport of the birds.

The results (Table 7) also revealed that RBC ($2.47x10^{12}$/L) of the Arbor Acre chicks fed diet containing 15% CG replacement level for maize was significantly ($p<0.05$) higher than values observed for birds of the same strain on 0 and 30% replacement levels but similar to those on 45% and Marshal broiler chicks at all replacement levels. There was no significant ($p>0.05$) effect of interaction between strain and CG replacement levels on white blood cells ($12.08 – 13.67x10^{9}$/L) and differentials on heterophil, lymphocyte, eosinophil, basophil and monocyte of broiler chicks. This finding is supported by that of Abu *et al*. (2013) and Obun *et al*. (2013). Broiler starter fed diets containing varying CG were of good immune system and are generally healthy. Cynthia (2005) who opined that white blood cells play a vital role in the body's immune system that is, the primary defense mechanism against invading pathogens and highly effective immune system to destroy foreign substances gave credence to the result obtained since there was no rise in white blood cells differentials levels.

**Table 7: Interactive effect of strain and replacement levels of CG for maize on hematology and white blood differentials of broiler chickens at starter phase**

| | Replacement Level of Maize with Cassava Grit (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Arbor Acre | | | | Marshal | | | | |
| **Parameter** | **0** | **15** | **30** | **45** | **0** | **15** | **30** | **45** | **SEM** |
| Packed cell volume (%) | $24.67^{b}$ | $28.00^{ab}$ | $26.30^{ab}$ | $27.67^{ab}$ | $29.33^{a}$ | $27.83^{ab}$ | $28.33^{ab}$ | $27.33^{ab}$ | 0.48 |
| Haemoglobin (g/dl) | $8.12^{b}$ | $9.08^{ab}$ | $8.70^{ab}$ | $8.88^{ab}$ | $9.72^{a}$ | $9.03^{ab}$ | $9.30^{ab}$ | $8.90^{ab}$ | 0.16 |
| Red blood cell ($X10^{12}$/L) | $2.08^{b}$ | $2.47^{a}$ | $2.08^{b}$ | $2.35^{ab}$ | $2.43^{a}$ | $2.13^{ab}$ | $2.37^{ab}$ | $2.15^{ab}$ | 0.04 |
| White blood cell ($X10^{9}$/L) | 13.67 | 12.67 | 12.70 | 12.50 | 13.45 | 13.15 | 12.62 | 12.08 | 0.28 |
| Heterophil (%) | 33.33 | 32.00 | 33.33 | 35.00 | 32.00 | 32.00 | 38.43 | 31.33 | 0.62 |
| Lymphocytes (%) | 64.17 | 65.00 | 63.33 | 63.50 | 63.50 | 64.83 | 62.00 | 66.50 | 0.60 |
| Eosinophil (%) | 0.50 | 0.50 | 1.00 | 0.17 | 1.00 | 0.83 | 0.83 | 0.83 | 0.11 |
| Basophil (%) | 0.50 | 1.33 | 0.67 | 0.83 | 1.50 | 0.83 | 0.83 | 0.17 | 0.14 |
| Monocyte (%) | 1.17 | 1.17 | 1.67 | 0.50 | 2.00 | 1.50 | 1.50 | 1.17 | 0.16 |

[ab]: means with different superscript across are significantly different ($P\leq0.05$)
SEM: standard error of mean

**Effect of strain on serum chemistry of broiler chickens at starter phase**

There was no significant ($p>0.05$) effect of strain on total protein (g/dl), albumin (g/dl), globulin (g/dl), creatinine (mg/dl) and uric acid (mg/dl) of broiler chickens at starter phase (Table 8). Broiler chickens, irrespective of trade name or breeder company, are bred for high genetic quality and component thus similarity in blood profile.

**Table 8: Main effect of strain on serum chemistry of broiler chickens at starter phase**

| | Strain of broiler chickens | | |
|---|---|---|---|
| **Parameters** | **Arbor Acre** | **Marshal** | **S.E.M** |
| Total protein (g/dl) | 3.03 | 2.96 | 0.06 |
| Albumin (g/dl) | 1.75 | 1.68 | 0.05 |
| Globulin (g/dl) | 1.28 | 1.28 | 0.05 |
| Creatinine (mg/dl) | 3.85 | 4.01 | 0.11 |
| Uric acid (mg/dl) | 7.43 | 6.86 | 0.39 |

SEM= standard error of mean

**Main effect of replacement level of CG for maize on serum chemistry of broiler chickens at starter phase**

There was no significant ($p>0.05$) effect of replacement level of CG for maize on total protein (g/dl), albumin (g/dl), globulin (g/dl) and uric acid (mg/dl) of broiler chickens at starter phase (Table 9). The values of total protein implied adequate use of the protein in the experimental diets. Even though, CG is low in protein compared to maize, the diets formulated using CG could be regarded adequate in protein requirement of broiler chicks. Thus CG did not affect the protein use of the diets. Earlier reports by Iyayi and Tewe (1998) and Abu *et al*. (2013) are in support of this finding. More so, total protein value in this study ranged between 2.96 and 3.08g/dl which fall within the normal range of 2.5-9g/dl recommended for healthy chicken (Altman, 1979). Total protein values less than 2.5gm/dl indicate a grave prognosis and birds with severe hypoproteinemia rarely survive because of chronic renal or hepatic disease, malnutrition, mal-absorption (e.g. intestinal parasitism), or chronic blood loss (Altman, 1979). Broiler chicks fed with diets containing CG in this study could be assumed to be free of chronic renal of liver disease and malnutrition.

However, significant ($p<0.05$) variations were observed in the creatinine values of the broiler chicks. Whilst the variation did not follow any particular trend, the highest creatinine value (4.35mg/dl) was obtained for birds fed 15% replacement level of CG while the lowest value (3.60mg/dl) was obtained for those on control diet. The creatinine values recorded for birds on 30% and 45% replacement levels were however similar to those of birds in the other two groups. This result reflects that the variations in the creatinine levels recorded for the birds may not be due to the dietary treatments. Oke (1978) reported that the high level of creatinine are sometimes seen in the kidney diseases due to the kidney's job of excreting creatinine, muscle degeneration and exposure to toxic compounds which impair kidney function. The result obtained for creatinine did not follow a particular trend. This suggested that the diets with cassava inclusion had no pathological effect on the birds. Moreover, result of creatinine could not be taken in isolation. There is no indication of chronic renal, hepatic disease, malnutrition or mal-absorption (due to parasitic infection) as this were not indicated in the result of white blood cells differential in this study. It therefore suggested further investigation on the creatinine values of broiler chickens fed CG at starter phase.

Effect of replacement level of CG for maize on serum chemistry of broiler chickens at starter phase (Table 9) also revealed that CG had no significant ($p>0.05$) influence on the uric acid of the experimental birds. According to Chandra *et al.* (1983), diets high in protein and urea will elevate serum uric acid due to an increase in uric acid biosynthesis. In this study, CG diets could be said to be adequate in protein and consequently normal uric acid record which still fall within the

range recommended for healthy chicken of 2 to 15 mg/dl (Chandra *et al.*, 1983).

**Table 9: Main effect of replacement level of CG for maize on serum chemistry of broiler chickens at starter phase**

| | Replacement level of Maize with Cassava Grits | | | | |
|---|---|---|---|---|---|
| **Parameter** | **0%** | **15%** | **30%** | **45%** | **SEM** |
| Total protein (g/dl) | 2.96 | 3.08 | 2.96 | 2.98 | 0.05 |
| Albumin (g/dl) | 1.76 | 1.63 | 1.75 | 1.73 | 0.05 |
| Globulin (g/dl) | 1.20 | 1.44 | 1.21 | 1.26 | 0.05 |
| Creatinine (mg/dl) | $3.60^{b}$ | $4.35^{a}$ | $3.90^{ab}$ | $3.87^{ab}$ | 0.11 |
| Uric acid (mg/dl) | 6.52 | 7.65 | 6.91 | 7.50 | 0.39 |

[ab]: means with different superscript across a row are significantly different (P<0.05)

**Interactive effect of strain and replacement level of CG for maize on serum chemistry of broiler chickens at starter phase**

Interaction between broiler strains and dietary treatments of CG had no significant (P>0.05) influence on total protein, albumin, globulin, creatinine and uric acid of the experimental birds (Table 10). From the fore going, broiler chickens at starter (0-4weeks) phase fed diets containing CG as replacement for maize had adequate protein supply and were generally healthy with no indication of chronic renal or hepatic disease, malnutrition or mal-absorption (due to parasitic infection). Reports of Oke (1978), Altman (1979), Chandra *et al.* (1983), Iyayi and Tewe (1998) and Abu *et al*. (2013) give credence to this result.

**Table 10: Interactive effect of strain and replacement level of CG for maize on serum chemistry of broiler chickens at starter phase**

| | Replacement Level of Maize with Cassava Grits (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Arbor Acre | | | | Marshal | | | | |
| **Parameters** | **0** | **15** | **30** | **45** | **0** | **15** | **30** | **45** | **SEM** |
| Total protein (g/dl) | 3.10 | 3.08 | 2.90 | 2.97 | 2.82 | 3.07 | 2.97 | 3.00 | 0.06 |
| Albumin (g/dl) | 1.82 | 1.72 | 1.83 | 1.63 | 1.70 | 1.55 | 1.67 | 1.82 | 0.51 |
| Globulin (g/dl) | 1.28 | 1.37 | 1.12 | 1.33 | 1.12 | 1.52 | 1.30 | 1.18 | 0.05 |
| Creatinine (mg/dl) | 3.67 | 4.38 | 3.60 | 3.75 | 3.53 | 4.32 | 4.20 | 3.98 | 0.11 |
| Uric acid (mg/dl) | 7.75 | 6.57 | 6.58 | 8.80 | 5.28 | 8.73 | 7.23 | 6.20 | 0.39 |

SEM – Standard error of mean

## CONCLUSION

It can be concluded that strain had no influence on apparent nutrient digestibility and blood profile of broiler chickens at starter phase. Use of cassava grits as energy feedstuff to substitute up to 45% of maize in the diets of broiler chicken had no negative influence on nutrient digestibility, blood profile and general health conditions of broiler

chickens at starter phase (0-4weeks). Therefore cassava grits could be used as replacement for up to 45% of maize in commercial starting broiler production.

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