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Performance, serum biochemical indices and crude protein utilisation by broiler chickens fed diets *b*ased on two varieties of cassava *(Manihot esculenta* Crantz*)* grits I. Starter Phase

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Abstract

Effect of dietary inclusion of cassava grits (Manihot esculenta Crantz) from two cassava varieties TME 419 and TMS 01/1371 as replacement for maize on performance, serum biochemical indices and crude protein utilization of broiler chicks was investigated in a three-week trial with Abor Acre plus broiler chicks (n=210). In a completely randomized design, birds were allotted to seven treatments, each replicated thrice with 10 birds per replicate. Diet 1 comprised 50 % maize and 0 % cassava grits, diets 2, 3 and 4 had their respective maize content replaced at 25, 50 and 75 % with cassava grits from TMS 01/1371 while diets 5, 6 and 7 was replaced correspondingly with cassava grits from TME 419 at 25, 50 and 75 %, respectively for a duration of 21-day. Increased dietary cassava grits significantly lowered (P<0.05) weight gain and metabolizable crude protein of broiler chicks. Birds on diets 3, 4, 6 and 7 had similar weight gain, feed conversion ratio and metabolizable crude protein. Except for significantly increased (P<0.05) total protein and alkaline phosphatase due to interactions of cassava varieties and inclusion levels, effects of cassava varieties and inclusion levels on other serum indices were similar (P>0.05). Regression of metabolizable crude protein on graded cassava grit inclusion for both varieties were negative and significant (P<0.05) for TME 419 (R^2=0.355) and highly significant (P<0.01) for TMS 01/1371 (R^2=0.6639). Both graphs clearly depicted decreased metabolizable crude protein due to increased cassava grits in the diets. Increased dietary cassava grits of both varieties resulted in lowered metabolizable crude protein and serum indices with concomitant increased feed conversion ratio of broiler starter chicks.

Keywords: Performance, serum biochemical indices, cassava grits, metabolizable crude protein, starter phase

Introduction

Broiler diets are formulated using various ingredients such as maize, wheat, soya bean, animal protein amongst others to meet the nutrient requirement. Maize, the main energy source in feedstuff of poultry diets is usually included from 40 to 60% of the formulated diets for broiler chickens (PAN, 2005; Dairo, 2011). Inadequate and unsteady production of maize and intense competition between humans and livestock for maize has made poultry feed expensive hence, the need for alternative dietary energy source becomes very imperative in Nigeria. There have been previous documentations on non-conventional feedstuff like cassava to replace maize partially (Akinfala *et al.,* 2002; Dairo, 2011) or completely (Tada *et al.,* 2004; Anaeto and Adighibe, 2011; Ngiki *et al.,* 2014) in the diets of poultry. Cassava grits and chips have also been extensively used for laying

and broiler chickens in Nigeria as alternative sources of energy in poultry (Tewe, 2005; Oyewumi, 2013; Ologhobo *et al*., 2016). Cassava is high in carbohydrate, thus, studies on cassava based diets in poultry have been focused more on the energy utilization (Salami and Odunsi, 2003; Dairo, 2011).

In aquaculture, studies (Bergot, 1979; Bergot and Breque, 1983; Abu *et al*., 2009) revealed the effects on crude protein utilization when conventional source of carbohydrate was replaced with cassava. Thus, energy source could equally influence crude protein utilization by chickens as has been similarly discovered in fish trials. However, crude protein utilization when main conventional energy source which is maize was replaced with cassava is yet to be undertaken in poultry. Therefore, this study was aimed at determining the performance, serum biochemical indices and crude protein utilization in broiler chickens when fed cassava grits based diets prepared from TMS 01/1371 and TME 419.

Materials and methods

Experimental site

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria located on latitude 7^0 20^1N, longitude 3^0 50^1E, and 200m above the sea level, in tropical rain forest vegetation zone. The laboratory analyses were carried out at the Department of Animal Science, University of Ibadan, Ibadan.

Test materials

Tubers from two different cassava varieties; TME 419 and TMS 01/1371, aged 12 months were collected from the International Institute of Tropical Agriculture, Ibadan, Nigeria. Cassava grits was processed from cassava tuber of TME 419; the conventional variety and the biofortified β-carotene TMS 01/1371, as described (Tewe, 2005).

Experimental diets

Seven iso-nitrogenous and iso-caloric broiler starter diets were formulated for the chickens. Diet 1 was maize-soya diet (0% cassava grits), diets 2, 3 and 4 had their maize replaced with TMS 01/1371 at 25, 50 and 75%, respectively while diet 5, 6 and 7 had maize replaced with TME 419 grits at 25, 50 and 75%, respectively. Details of the experimental starter and finisher diets have been documented (Ogunwole *et al.,* 2015; 2016a, b) and are shown in Table 1

Experimental animals

One-day old Abor Acre broiler chicks (n=210) from Siebrier Hatchery, Awe, Oyo State, Nigeria, were used for the study. The chicks were randomly distributed to seven dietary treatments. Each treatment was in triplicate of ten broilers per replicate. Birds were raised in a deep litter pen that was partitioned into 21 cubicles each of three square meter dimension with separate feed and water trough. Feed and water were offered to birds *ad libitum* while the offered and feeds left over were weighed daily.

Data collection

Performance characteristics

The trial lasted for 21 days, during which the feed consumption were quantified on daily basis. The chicks were weighed at the start of the experiment and subsequently on weekly basis**.** Parameters measured and calculated were weight gain, feed intake, feed conversion ratio (FCR).

Serum collection and analysis

At day 21, blood was collected from six chicks per treatment for the determination of serum biochemical indices; collection was by jugular vein puncture of the chicks using needles and syringes. Approximately 3 mL of blood was drawn into properly tilted sterile blood tubes without

Table 1: Gross composition (g/100g DM) of the experimental starter diet

	Inclusion Levels of Cassava Grits (%)						
		TMS 01/1371			**TME 419**		
Ingredient	Diet 1 control(0)	Diet 2 25	Diet 3 50	Diet 4 75	Diet5 25	Diet6 50	Diet7 75
Maize	50.00	37.50	25.0	12.50	37.50	25.00	12.50
TME 419	0.00	0.00	0.00	0.00	12.50	25.00	37.50
TMS 01/1371	0.00	12.50	25.00	37.50	0.00	0.00	0.00
soybean meal (42% CP)	35.90	39.00	41.50	43.14	39.50	42.00	44.00
wheat offal	8.24	5.14	2.64	1.00	4.64	2.14	0.14
DL-Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
L-lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Palm oil	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50
*Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Avatec	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated values							
ME (Kcal/kg)	3080.39	3091.87	3098.37	3097.73	3093.52	3097.52	3097.37
Crude Protein (%)	20.98	20.89	20.64	20.19	20.93	20.61	20.17
Methionine (%)	0.52	0.51	0.50	0.49	0.52	0.51	0.49
Lysine (%)	1.30	1.33	1.36	1.37	1.34	1.37	1.38
Available Phosphorus (%)	0.52	0.52	0.52	0.51	0.52	0.52	0.51
Calcium (%)	0.98	1.00	1.03	1.05	1.00	1.03	1.05
	95.30	92.97	90.25	86.95	93.30	90.58	87.52

Note M.E: Metabolizable Energy

**Each 1.25kg vitamin/mineral premix contain: vitamin A -10,0000,0000 I.U, vitamin D $_3$-22000000 I.U., vitamin E -10,000mg, vitamin K $_3$-2,000, Folic Acid -500mg, Niacin -15,000mg, Calpan-5000mg, vitamin B $_2$-5,000mg, vitamin B12-10mg, vitamin B1-1500mg, vitamin B6-1500mg, Biotin-20mg, antioxidant-125,000mg, selenium-200mg, iodine-1000mg, iron -40,000mg, cobalt 200mg, manganese -70,000mg, copper -4000mg, Zinc -50,000mg, choline chloride 150,000mg and yolk colorant.*

anticoagulant and the serum harvested using rotary centrifuge. Total serum protein was determined by Biuret method as described (Reinhold, 1953). Serum albumin was determined using bromocresol green method (Peter *et al.,* 1982). Globulin was calculated by subtraction of albumin from total serum protein while albumin/globulin ratio was calculated by dividing albumin by the globulin value. Serum creatinine and urea nitrogen were determined with the method of Toro and Ackermann (1975). Alkaline phosphatase (ALP), aspartate amino transferase (AST) and alanine amino transferase (ALT) were determined spectrophotometrically (Reitman and Frankel, 1957).

Metabolizable crude protein determination

At week 3, two birds per replicate were moved to the metabolic cage for the determination of crude protein digestibility. Birds were allowed to adjust for a period of three days, followed by subsequent total collection of feacal samples the following three days. Feaces were allowed to drop into 3% sulphuric acid, collected at 24 hours intervals, and oven dried at 105 ^{o}C for 48 hours. Dietary and feacal crude proteins were analyzed according to AOAC (1995). Metabolizable crude protein (MCP) was obtained using the equation:

$$MCP = \frac{\text{Ingested crude protein} - \text{excreted crude protein}}{\text{Ingested crude protein}} \times 100$$

Statistical analysis

Data were subjected to analysis of variance using SAS (2002) at $\alpha_{0.05.}$ Means were separated using Duncan multiple range test of the same software.

Results

Performance characteristics of broiler chickens fed cassava grits based diet at the starter phase is shown in Table 2. Results showed that daily feed intake, daily weight gain FCR, MCP and crude protein intake were significantly influenced (P<0.05) by dietary inclusion levels of the two varieties of cassava grits.

Daily feed intake (DFI) of chicks on diet 5 differed significantly (P<0.05) from those fed other diets. Birds on diet 5 recorded lower DFI (34.54g) while higher value was recorded for birds on diet 2. Daily weight gain differed significantly (P<0.05), birds on diet 1 (control) had higher weight gain (34.25g) compared with lower value (19.82g) for birds on diet 5. The FCR were significantly different (P<0.05). Birds on control diet had lower FCR of 1.41, while higher FCR (1.60g) was recorded for birds on diet 7. The MCP differed significantly (P<0.05) among treatments; Birds on diet 1 had higher MCP of 82.27% while least value was recorded for birds on diet 7 (71.0%). Dietary treatment had effect (P<0.05) on birds on diet 1 recorded higher crude protein intake of 11.64g while least value of 8.46g was recorded for birds on diet 5.

Table 2: Performance characteristics of broilers fed cassava grits based diet at the starter phase

		Inclusion level of cassava grits (%)						
		TMS 01/1371			TME 419			
Parameters	**Diet 1 Control(0)**	**Diet 2 25**	**Diet 3 50**	**Diet 4 75**	**Diet 5 25**	**Diet 6 50**	**Diet 7 75**	**SEM**
Initial weight/birds (g)	54.97	63.50	58.98	61.80	58.97	58.85	61.30	0.85
Final weight/birds (g)	774.15^{a}	716.38^{ab}	677.76^{b}	666.38^{b}	475.17^{c}	668.98^{b}	699.22^{ab}	21.37
Daily feed intake/ birds (g)	48.43^{a}	49.24^{a}	44.88^{a}	45.42^{a}	34.54^{b}	43.73^{a}	48.71^{a}	1.66
Daily weight gain/birds (g)	34.25^{a}	31.09^{ab}	29.51^{b}	28.80^{b}	19.82^{c}	29.07^{b}	30.38^{ab}	1.41
Feed conversion ratio	1.41^{b}	1.59^{ab}	1.52^{ab}	1.59^{ab}	1.81^{a}	1.50^{ab}	1.60^{ab}	0.11
Metabolizable crude protein (%)	82.27^{a}	79.96^{ab}	74.94^{abc}	68.83^{c}	80.88^{ab}	78.15^{abc}	71.00^{bc}	3.28
Daily crude protein intake (g)	9.75^{b}	11.64^{a}	9.82^{b}	8.94^{cb}	8.46^{c}	8.80^{cb}	9.16^{cb}	0.25

*Note. *Means no unit;* ^{abcde}*:Means in the same row with different superscript differ ed significantly (P<0.05).*

TME 419: Cassava grits from cassava varieties TME 419 SEM: Standard Error of Mean

TMS 01/1371: Cassava grits from cassava varieties TMS 01/1371

The interactive effects of cassava grit varieties and inclusion levels on performance of broiler starters are shown in Table 3. There were significant differences (P<0.05) in the daily feed intake and weight gain of birds. Birds on 25% TMS 01/1371 diet recorded higher DFI and daily weight gain (P<0.05) of 49.24 g and 31.09g, respectively while least DFI and weight gain was recorded in birds on T5 with values of 34.54 g and 19.82g, respectively. The FCR were not significantly affected (P>0.05) by the interactions of cassava grits and inclusion levels. There were however, significant differences (P<0.05) in the MCP due to both main and interactive effects of varieties and inclusion levels. Birds on diet 4 had lower MCP of 68.83% while higher MCP of 80.88 % was recorded for those on diet 5. Daily crude protein intake were significantly affected (P<0.05) by interactive effects of cassava grits varieties and inclusion levels. Birds on diet 2 had higher crude protein intake of 11.63g while lower value (8.46g) was recorded for those on diet 5.

Table 3: I nteractive effects of cassava grits varieties and inclusion levels on performance of broiler starters

	Inclusion levels of cassava grits (%)						
	TMS 01/1371			TME 419			
Parameters	**25**	**50**	**75**	**25**	**50**	**75**	**SEM**
Initial weight/birds(g)	63.50	58.98	61.80	58.97	58.85	61.23	1.83
Final weight/birds(g)	716.38^{ab}	677.76^{b}	666.58^{b}	475.17^{c}	668.98^{b}	699.22^{ab}	31.70
Daily feed intake/ birds (g)	49.24^{a}	44.88^{a}	45.42^{a}	34.54^{b}	43.73^{a}	48.71^{a}	1.79
Daily weight gain/birds (g)	31.09^{a}	29.51^{a}	28.80^{a}	19.82^{b}	29.07^{a}	30.38^{a}	1.52
Feed conversion ratio	1.59	1.52	1.59	1.81	1.50	1.60	0.12
Metabolizable crude protein (%)	79.96^{a}	74.94^{ab}	68.83^{b}	80.88^{a}	78.15^{ab}	71.00^{ab}	3.41
Daily crude protein intake (g)	11.63^{a}	9.82^{b}	8.94^{bc}	8.46^{c}	8.80^{bc}	9.16^{bc}	0.38

^{abcde}:Means in the same row with different superscript differed significantly (P<0.05).
SEM: Standard Error of Mean TME 419: Cassava grits from cassava varieties TME 419 TMS01/1371: Cassava grits from cassava varieties TMS 01/1371

The main effects of grits from two cassava varieties and inclusion levels on serum biochemical indices of broiler starter birds is shown in Table 4. There were significant differences (P<0.05) in the total protein and albumin. Birds on control (0% cassava grits) recorded higher total protein (4.25 g/dL) and albumin (1.88 g/dL), while those on both 25% dietary TMS 1371 and 25 % dietary TME 419 cassava grits recorded lower total protein (3.65 and 3.70 g/dL) and albumin (1.47 and 1.43 g/dL), respectively. There were no significant differences (P>0.05) in globulin, albumin/globulin (A/G) ratio and alanine amino transferase (ALT). There was also no significant difference (P>0.05) in aspartate amino transferase, serum urea nitrogen, alkaline phosphatase and creatinine values due to dietary treatments.

Table 4 : Serum biochemical indices of broiler s tarter chicken fed varying inclusion levels of cassava grits

	Inclusion levels of cassava grits (%)							
		TMS 01/1371			TME 419			
Parameters	0	25	50	75	25	50	75	SEM
Total Protein (g/dL)	4.25^{a}	3.65^{b}	4.07^{ab}	3.83^{ab}	3.70^{b}	3.77^{ab}	3.93^{ab}	0.22
Albumin (g/dL)	1.88^{a}	1.47^{ab}	1.68^{ab}	1.67^{ab}	1.43^{b}	1.70^{ab}	1.63^{ab}	0.19
Globulin (g/dL)	2.37	2.23	2.22	2.15	2.27	2.07	2.30	0.29
Albumin:Globulin ratio	0.88	0.67	0.70	0.67	0.65	0.85	0.73	0.19
Aspartate amino transferase µL	208.67	212.00	202.50	209.50	200.83	213.17	214.00	19.43
Alanine amino transferase µL	28.00	22.17	26.50	27.17	23.83	26.83	27.33	2.62
Alkaline Phosphatase µL	56.33	55.00	67.17	67.17	52.83	56.67	62.50	6.57
Serum urea nitrogen (mg/dL)	0.48	0.52	0.62	0.52	0.58	0.48	0.67	0.12
Creatinine (mg/dL)	0.58	0.57	0.58	0.52	0.67	0.62	0.68	0.12

*Note. *Means no unit;^{abcde}:Means in the same row with different superscript differed significantly (P<0.05).*
TME 419: Cassava grits from cassava varieties TME 419 SEM: Standard Error of Mean
TMS 01/1371: Cassava grits from cassava varieties TMS 01/1371

Effect of interactions of cassava varieties and inclusion levels on serum biochemical indices of broiler starters is shown in Table 5. There were significant differences (P<0.05) only in total protein and ALP. Other serum biochemical indices had similar (P<0.05) values. Birds on diet with 50 % cassava grits recorded significantly higher (P<0.05) total protein (4.07 g/dL) while those on 25 % TMS 01/1371 dietary

inclusion recorded lower value (3.65 g/dL). The ALP was lower in birds fed 25% TMS 01/1371 (55.00 µL) and corresponding chicks on TME 419 (52.83 µL) while those on 50 and 75% TMS 01/1371 (67.17 µL) were higher.

Table 5: Interactive effects of cassava grit varieties and inclusion levels on serum biochemical indices of broiler starters

	Inclusion level of cassava grits (%)						
	TMS 01/1371			TME 419			
Parameters	**25**	**50**	**75**	**25**	**50**	**75**	**SEM**
Total Protein (g/dL)	3.65^{b}	4.07^{a}	3.83^{ab}	3.70^{ab}	3.77^{ab}	3.93^{ab}	0.13
Albumin (g/dL)	1.47	1.68	1.67	1.43	1.70	1.63	0.12
Globulin (g/dL)	2.23	2.22	2.15	2.27	2.07	2.30	0.19
Albumin:Globulin ratio	0.67	0.70	0.67	0.65	0.85	0.73	0.12
Aspartate amino transferase µL	212.00	202.50	209.50	200.83	213.17	214.00	13.82
Alanine amino transferase µL	22.17	26.50	27.17	23.83	26.83	27.33	1.87
Alkaline Phosphatase µL	55.00^{ab}	67.17^{a}	67.17^{a}	52.83^{b}	56.67^{ab}	62.50^{ab}	4.89
Serum urea nitrogen (mg/dL)	0.52	0.62	0.52	0.58	0.48	0.67	0.09
Creatinine (mg/dL)	0.57	0.58	0.52	0.67	0.62	0.68	0.08

Note. Means no unit; ^{abcde}*:Means in the same row with different superscript differed significantly (P<0.05).*
TME 419: Cassava grits from cassava varieties TME 419 SEM: Standard Error of Mean
TMS 01/1371: Cassava grits from cassava varieties TMS 01/1371

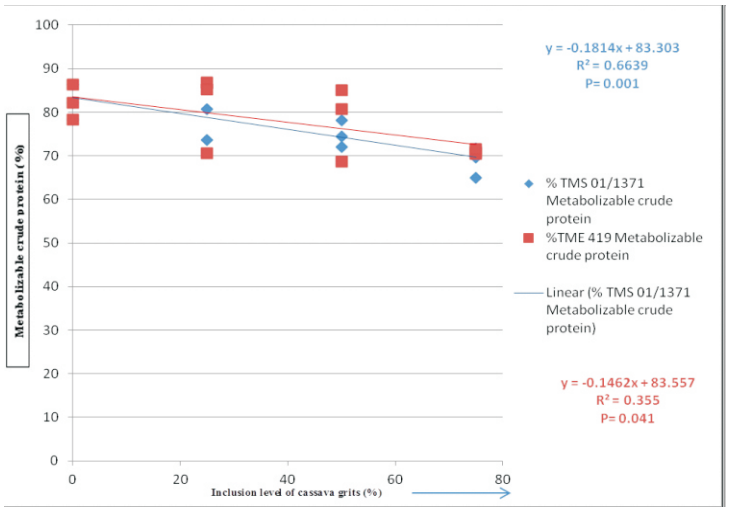

Figure 1: Relationships between metabolizable crude protein and dietary inclusion of two varieties of cassava grits for starter broiler chickens

Discussion

The relative higher feed intake of birds on TMS 01/1371cassava grits based diets could be due to yellow colouration and higher carotenoids level as earlier observed (Ogunwole *et al.,* 2015). Increased dietary TMS 01/1371 cassava grits resulted in lower daily weight gain as was earlier observed in other study (Akinfala *et al.,* 2002). Conversely, birds on diets based on TME 419 recorded increased weight gain with higher dietary inclusion. The deviation could however be adduced to variety differences employed in preparing the whole cassava plant meal by Akinfala *et al.* (2002). Lower FCR range of 1.41 to 1.81

for birds in this trial compared favourably with documented range of 1.79-2.26 (Akinfala *et al.,* 2002) and 1.50 (Goodarzi *et al.* 2013) for starter broiler chicks.

The MCP of birds on diets 2, 3, 5 and 6 were similar ($P<0.05$) with the control but differed from those on diets 4 and 7. The relatively lowered MCP could be due to the different levels of wheat offals which was one of the main fibre sources. As reported (Zhang *et al*., 2013; Ngiki *et al.,* 2014), fibre reduces ingesta viscosity and increased transit time in the gastro intestinal tract thereby limiting the absorption of protein in the small intestine. Increased dietary cassava grits of TMS 01/1371 led to decreased daily crude protein intake of birds while converse response was observed with increased dietary TME 419 which resulted in higher net crude protein intake. The decreased MCP with higher inclusion of cassava grit conformed to earlier observation (Ngiki *et al.,* 2014) of depressed crude protein utilization with increased cassava root-leaf meal mixture in the diet of broiler chickens.

Serum biochemical assay are commonly employed in monitoring the status of vital organs as well as to quantify available dietary proteins in birds (Iyayi and Tewe, 1998). Similar serum total protein in diets 1 (4.25), 3 (4.07), 4 (3.83), 6 (3.77) and 7 (3.93) revealed that test diets were of equal quality and that fed birds metabolized protein similarly (Lewis *et al.*, 1977). Total serum protein range of 3.65-4.25 were within reported values (3 -5 g/dL) for birds (Coles and Campbell, 1986; Coleman *et al.,* 1988) but lower compared to documented range of 8.00-12.00 (Duwa *et al.,* 2014). The observed wide variability could however be attributed to the different protein sources, geographical zone, strain and age of the birds. Liver is the usual site of albumin synthesis and the level in serum subject to liver health (Cheeke and Dierenfeld, 2010). Serum albumin range of 1.43 to 1.88 g/dL compared favourably with 1.72±0.29 documented for broiler (Silva *et al.,* 2007). This implies that liver of birds were not diseased; synthesis of albumin in diseased birds are markedly decreased with resultant disturbance in the osmotic balance in plasma and tissue fluids.

Globulin level is however, a measure of immune strength of birds to infections; in that antibodies are products of globulin which attacks disease agents (Cole, 1974; Agboola *et al.,* 2013). The levels of globulin in birds due to varying inclusion of different varieties of cassava grits compared favourably with the control which indicated that birds' immune status was not compromised. Aspartate (AST) and alanine (ALT) amino transferases are enzymes responsible for inter conversion of amino acids through transfer of amino groups *in vivo*. Similarity in AST and ALT and of birds due to different dietary inclusion of cassava grits revealed that the inclusion had no adverse effect on liver functions and health of birds. Serum urea of birds fed graded dietary inclusion of grits from the two cassava varieties were similar to those on control diets as shown in Table 4. This is indicative of similar dietary protein absorption and utilization by birds on different treatments. Elevated alkaline phosphatase (ALP) results from increased osteoblastic activity including traumatic, neoplastic and infectious disease states (Kendal, 2006). The values of ALP was however, expected to be higher in starter birds due to higher bone formation notable in young chick compared to those of old age (Silva *et al.,* 2007)

The serum creatinine is a measure of waste product from muscle phosphocreatin which is an energy rich compound (Gracey, 1981). The creatinine of birds were similar across

the diets and values compared favorably to those earlier reported (Silva *et al.,* 2007) and were also within the documented range of 0.2-3 mg/dL (Mitruka and Rawnsley, 1981). Serum urea nitrogen can be used to test renal functions, protein breakdown, hydration status and liver failure. However, the concentration of urea also depends on diet especially those with high protein content (Agboola *et al.,* 2013). Serum urea of birds fed cassava grits based diet was similar to the control which implies there was neither any renal nor liver malfunctioning and/or protein malmetabolism.

The relationship of MCP and inclusion levels of the two varieties of cassava is shown in Figure 1. Metabolizable crude protein linearly correlated ($P<0.01$) highly with the graded dietary inclusion of TMS 01/1371 and is represented by the equation:

$Y= -0.1814x + 83.303$ ($R^2 = 0.66639$; $P=0.001$)…… (1)

Also, regression of MCP on varying dietary inclusions of TMS 419 was also negative, linear and significant ($P<0.05$) and is represented by the equation:

$Y= -0.1462x + 83.557$ ($R^2 = 0.355$; $P = 0.041$)…….. (2)

Both equations revealed progressive MCP reductions due to increased dietary inclusion levels of both cassava varieties. However, increased dietary TMS 01/1371in this study, resulted in much more lowered MCP compared with corresponding inclusion levels of TMS 419**.**

Conclusion

Progressive replacement of dietary maize with grits from two varieties of cassava (TMS 01/1371 and TME 419) in broiler chick starter diets had no gross deleterious effects on chicks' performance and serum biochemical indices. However, metabolizable crude protein of birds was lowered as a result of increased inclusion levels of cassava to varying degrees according to varieties, much more by TMS 01/1371.

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