Haematological and serum biochemical indices of broiler chickens fed varying dietary levels of Sundried cassava (*Manihot esculenta*) peel meal supplemented with enzyme (MAXIGRAIN®).

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ABSTRACT

An eight week feeding trial was conducted at the Poultry Unit of the Teaching and Research Farm, Ambrose Alli University Ekpoma to evaluate the haematological and serum biochemical indices of broiler chickens fed varying levels of sundried cassacva peel meal supplemented with emzyme (MAXIGRAIN). A total of one hundred and twenty day-old Anak 2000 broiler chicks was used for this experiment. Forty chicks were randomly selected based on their average initial weights to each of the four treatment diets. (T_1 to T_4) with T_1 serving as control and T_2 to T_4 having an inclusion levels of Sundried cassava peel meal (SDCPM) at 20, 40, and 60% replacement levels for maize with Maxigrain® enzyme supplementation at the rate of 100mg/kg in a complete randomized design (CRD). The chicks were brooded and fed for four weeks with comercial starter diet. Thereafter they were fed formulated finisher diets for 4 weeks. Result on the haematological parameters revealed that haemoglobin was significantly (P<0.05) higher from birds fed 40% sundried cassava peel meal plus maxigrain supplement (SDCPM+Maxg) with mean value of 41.68g/dl. Red blood cell was also significantly (P<0.05) highest ($7.35x10^6$/ml) from birds fed 40% (SDCPM+Maxg). MCV and Platelet values were also significantly (P<0.05) influenced by the treatment diets with highest values of (59.58fl and $3.21x10^3/mm^3$). Neutrophil and monocyte values were significantly (P<0.05) higher from birds fed 40% (SDCPM+Maxg) with an average values of (29.02% and 4.33%). Serum biochemical indices of broiler chickens fed the treatment diets showed that glucose and cholesterol were significantly (P<0.05) influenced by the various dietary treatments with highest values (113.68mmol/L and 116.20mmol/L) recorded from birds placed on the control diet. The overall result in this study showed that sun dried cassava peel meal supplemented with maxigrain can successfully be included in broiler ration up to 40% level without any adverse effect on the blood quality of broiler chickens.

Keywords: Haematology, serum biochemistry, Maxigrain, Broiler chicken,Sundried Cassava peel meal

INTRODUCTION

Feed is of utmost importance in broiler chicken production (Alikwe and Nodu, 2013); it amounts to about 60-75 % of the total cost of production for intensively reared stocks (Enyenihi *et al*., 2013). This has been attributed to the trend of competition between humans and livestock as a result of high cost of conventional feed stuff which in turn affects animal protein intake by man (Ewa *et al*., 2012). In an attempt to combat the challenges of feed, researchers have stressed the need for utilization of cheaper, locally available and nutritionally viable alternative feedstuffs far removed from human and industrial interests, thereby limiting the dependence on maize for livestock (Iyayi and Fayoyin, 2004; Okah, 2004). Effort has also been geared towards the utilization of relatively cheaper and available root and tubers in recent years. Example of such root and tuber is cassava.

Cassava (*Manihot esculenta Crantz*) is a tuber crop widely cultivated in Nigeria with an average annual production estimate of 45 million tonnes (FAO, 2002). It is the highest supplier of carbohydrate among energy staple food stuff (FAO, 2003). Also, it offers a great potential as cheap, alternative energy feedstuff in rations for livestock (Eruvbetine *et al*., 2003). Cassava peel is an abundant and less expensive agro- industrial by-product, farm waste or crop residue resulting from the processing of cassava roots for human consumption which can be exploited as alternative feed resource in the diets of monogastric stocks to high energy cereals particularly maize (Fajemisin *et al*., 2012). However, the use of cassava peel has largely remained under utilized as livestock feed due to its high cyanide and fibre content, poorer protein quality and powdery nature of its meal compared to cereal grains. As a cyanide-bearing waste, fresh cassava peel has to be processed in order to reduce its cyanide level which is deleterious to growth and

development of poultry (Tewe, 2004) and promote its acceptability and utilization in finished feeds. As a result, several processing methods such as sun-drying, ensiling and fermentation have been reported to effectively reduce the concentration of the anti-nutritional factors in cassava meal to tolerable levels (Aro *et al.,* 2008a).

Fermentation technology has been used as a method of improving the nutritional value of cassava peel meal by reducing the anti-nutritional factors, high crude fibre content and enriching the protein content in livestock feeds (Oboh and Akindahunsi, 2003; Aro *et al*., 2008b). An improvement was also reported in the crude protein concentration of cassava root meal when fermented with fresh rumen filtrate with source of nitrogen or the use of other synthetic enzymes (Adeyemi, 2007 and Dairo *et al*., 2011). Feed enzyme such as maxigrain application in farm animal diet supplements the enzyme complement of young animals in which the rate of endogenous enzyme production may be limiting (Bimrew, 2014). Phytase supplementation of P-deficient diets resulted in improved growth performance of pigs Zyla *et al.,(*2000) and improved P and Ca utilization (Nasi, 1990; Adeola,1995). Enzyme supplementation has also being reported to improve average daily weight gain and feed intake of young pigs and poultry (Cadogan et al., 2003). It also enhance total tract digestibility of dry matter and nitrogen (Mavromichalis *et al.,* 1990). The various functions of the blood are made possible by the individual and collective actions of its constituents the haematological and biochemical components. Generally speaking, both the haematological and biochemical blood components are influenced by the quantity and quality of feed and also the level of anti-nutritional elements or factors present in the feed (Akinmutimi, 2004). Biochemical components are sensitive to elements of toxicity in feeds (Ahamefule *et al*. 2003). Haematological components of blood are also valuable in monitoring feed toxicity especially with feed constituents that affect the formation of blood (Oyawoye and Ogunkunle, 1998). This study is therefore aimed at investigating the haematological and serum biochemical indices of broiler chickens fed varying dietary levels of cassava peel meal supplemented with enzyme (MAXIGRAIN®)

MATERIALS AND METHODS

Location and duration of the study

The experiment was carried out at the Poultry Unit of the Livestock, Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria for a period of eight (8) weeks.

Sourcing And processing of Cassava peel

Fresh cassava (*Manihot esculenta*) peels was collected from local cassava processing centers or in-house cassava processors in Ekpoma Esan west local government area of Edo state. The cassava peels were soaked in water inside a metal drum for three (3) days, after which they were removed and drained with a basket and sun-dried for five (5) days before milling to fine particles of 2mm in diameter, using a hammer mill. The resultant product was incorporated into broiler's diets at varying levels stipulated in the study.

CHEMICAL ANALYSIS

feed samples were analyzed for proximate composition according to the method of AOAC (1990) as shown in table 1

Table 1: Proximate composition of sundried cassava peel

Parameters	SCPM	Maize
Moisture	10.03	10.09
Crude protein	4.80	9.80
Crude fibre	16.91	2.70
Ether extract	1.38	2.40
Crude ash	5.52	5.57
NFE	61.36	69.44
Carbohdrate	22.23	43.21
ME (Kal/kg)	3015.40	3315.45

MANAGEMENT OF EXPERIMENTAL BIRDS AND DESIGN

A total of one hundred and twenty (120) day old Anak 2000 broiler chickens were used for the experiment. They were randomly sub-divided into 4 dietary treatments of three replicates, with ten birds each in a completely randomized design. Feed and water was given to the birds' *ad-libitum.* Lighting source was provided using electricity bulbs during the night. The birds were administered anti-stress and

vitamin/mineral premix orally at the recommended dosage after randomization before the commencement of the experiment. The birds were reared on deep litter in an open-sided wire mesh constructed poultry house to allow for adequate ventilation. Medications, vaccinations and other routine management practices were strictly followed. The birds were offered experimental diets and cool, clean water *ad-libitum* throughout the eight weeks period of the experiment.

EXPERIMENTAL DIETS AND TREATMENTS

Four experiment diets were formulated to contain Maxigrain enzyme supplemented cassava peel meal to replace maize at 0, 20, 40 and 60% as T1, T2, T3 and T4 respectively. Treatment 1 was the control diet with no cassava peel meal and enzyme inclusion while diets 2, 3 and 4 contained Maxigrain® enzyme supplementation at the rate of 100mg/kg. The experimental diets composition is presented in Table 2

Table 2: Gross composition of experimental broiler finisher diets

	Inclusion levels of SDCPM+Maxg (%)			
	0	20	40	60
	Diets			
Ingredients	**1**	**2**	**3**	**4**
Maize	40.00	30.00	20.00	10.00
SCPM	0.00	10.00	20.00	30.00
Soya bean meal	25.00	25.00	25.00	25.00
Wheat offal	10.00	10.00	10.00	10.00
Palm kernel meal	18.00	16.00	17.00	16.00
Fish Meal	1.00	2.00	3.00	5.00
Oyster shell	1.50	1.50	1.50	1.50
Bone meal	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.50	0.50	0.50	0.50
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Crude protein	**21.00**	**21.00**	**21.00**	**21.00**
ME (Kcal/Kg)	**2902**	**2895**	**2896**	**2893**

HAEMATOLOGICAL AND SERUM BIOCHEMICAL STUDIES

At about 8 weeks, 3 over night fasted birds were selected per treatment making a total of 12 birds and blood samples were collected through wing veins of the birds. A set of samples were collected into sterilized tubes containing ethylene diamine tetra-acetic acid (EDTA) labeled bottle for haematological studies, while another set of blood samples were collected from the same birds into heparinised tubes for serum chemistry determination. Packed cell volume (PCV), red blood cell (RBC), white blood cell (WBC) and haemoglebin (Hb) was determined using improved Neubar's haemaetometer after dilution, and cyanomethamoglobin methods as described by Dacie and Lewis (1991), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), Mean corpuscular haemoglobin concentration (MCHC) and serum metabolites such as total protein, albumin, creatinine, and urea was determined by the method of Hyduke (1995), while globulin was estimated by the subtraction of albumin value from serum total protein value (Dacie and Lewis, 1991)

STATISTICAL ANALYSIS

All the data collected were subjected to analysis of variance (ANOVA) and differences between means and treatments were determined using Duncan's multiple range test (DMRT) at 5 percent level of probability. All statistical procedures was according to (Steel and Torrie, 1990) using SAS (1999) package

RESULTS

Haematological Indices of broiler chickens fed sundried cassava peel meal with Maxigrain supplementation.

Haematological indices of broiler finisher as influenced by the dietary treatments are depicted in (Table 3). Haematological parameters such as Haemoglobin, red blood cell, mean corpuscular volume, platelet and neutrophil were significantly (P<0.05) influenced by the dietary treatment while packed cell volume, Mean corpuscular haemoglobin, Mean corpuscular haemoglobin concentration, White blood cell, lymphocyte and monocytes were not significantly (P>0.05) affected by the treatment diets. Mean corpuscular volume (MCV) was Significantly (P<0.05) highest in birds fed 40% (SDCPM+Maxg) with a mean value of 59.58fl, followed by those placed on 60% (SDCPM+Maxg) with the value 58.23fl and least value of 56.92fl was obtained in birds fed the control diet. Platelet values were Significantly (P<0.05) highest in birds fed 40% (SDCPM+Maxg) with a mean value $3.21x10^3/mm^3$, followed by those placed on 0% (SDCPM+Maxg) with the value $2.38\ x10^3/mm^3$, and least value of $1.37\ x10^3/mm^3$ was obtained in birds fed 20% (SDCPM+Maxg) based diet. Neutrophil values were Significantly (P<0.05) highest in birds fed 40% (SDCPM+Maxg) with a mean value 29.02%, followed by those placed on 60% (SDCPM+Maxg) with the value 19.21%, and least value of 16.68% was obtained in birds fed 0% (SDCPM+Maxg) based diet. Monocytes values were Significantly (P<0.05) highest in birds fed 40% (SDCPM+Maxg) with a mean value 4.33%, followed by those placed on 60% (SDCPM+Maxg) with the value 2.66%, while least value of 1.68% was obtained in birds fed 20% (SDCPM+Maxg) based diet. However, PCV, MCH, MCHC, lymphocyte and eosinophils values were not significantly (P>0.05) different among the birds fed the dietary treatments.

Table 3: Haemotological indices of broiler finisher Fed the treatment diets

	Inclusion levels of SDCPM+Maxg (%)				
	0	20	40	60	
			Diets		
Parameters	1	2	3	4	SEM±
Packed cell volume (%)	12.24	12.33	13.12	12.26	0.19
Haemoglobin (g/dl)	13.33^c	11.24^c	14.68^a	13.67^b	0.34*
Red blood cell (x 10^9/L)	6.28^c	6.60^b	7.35^a	6.26^c	0.09*
White blood cell($x10^3/mm^3$)	14.11	14.33	14.67	14.26	1.82
MCV (fl)	56.92^c	57.25^c	59.58^a	58.23^b	2.52*
MCH (fl)	16.28	16.54	17.44	16.72	0.27
MCHC (Pg)	30.32	31.07	32.67	31.56	0.38
Platelet ($x10^3/mm^3$)	2.38^b	1.73^d	3.21^a	2.24^c	0.61*
Neutrophil (%)	16.68^c	17.24^c	29.02^a	19.21^b	1.15*
Lymphocyte (%)	62.24	63.68	74.21	62.26	7.05
Monocytes	2.04^c	1.68^d	4.33^a	2.66^b	0.04*
Eosinophil	1.68	1.72	2.03	1.69	0.37

abcd: means in the same row with varying super script differ significantly (P>0.05)
SEM±: standard error of means
SDCPM+Maxg: Sundried cassava peel meal + Maxigrain

Serum biochemistry of broiler chickens fed sundried cassava peel meal with Maxigrain supplementation

Table 4 shows the serum biochemical indices of broiler chickens as influenced by the treatment diets. The result revealed that total protein, Globulin, albumin, urea and creatinine were not significantly (P>0.05) affected by the treatment diet. However, significant (P<0.05) variation were observed in the values of glucose and cholesterol. Glucose values were significantly (P<0.05) influenced by the treatent diets with highest value (120.32mmol/L) from broiler chickens maintained on 0% (SDCPM+Maxg), followed by (113.68mmol/L) from birds fed 40% (SDCPM+Maxg) while least value of (106.26mmol/L) was recorded from birds placed on 20% (SDCPM+Maxg). Cholesterol values showed significant (P<0.05) variation among the treatent diets with highest value (116.20%) from broiler chickens maintained on 0% (SDCPM+Maxg), followed by (98.26%) from birds fed 60% (SDCPM+Maxg) while least value of (95.67) was recorded from birds placed on 60% (SDCPM+Maxg).

Table 4: Serum biochemical indices of Broiler finisher fed experimental diets

	Inclusion levels of SDCPM+Maxg (%)				
	0	20	40	60	
	Diets				
Parameters	1	2	3	4	SEM±
Total protein (g/dl)	6.29	6.80	7.09	6.83	0.08
Globulin (g/dl)	4.45	4.36	4.28	4.02	0.15
Albumin (g/dl)	2.74	2.44	2.81	2.63	0.27
Glucose (mmol/L)	120.32[a]	106.26[c]	113.68[b]	108.30[c]	1.72*
Cholesterol (mmol/L)	116.20[a]	95.67[c]	96.33[c]	98.26[b]	6.46*
Urea (g/dl)	12.24	13.06	14.75	13.12	0.38
Creatinine (g/dl)	1.08	1.03	1.53	1.58	0.04

abc: means in the same row with varying super script differ significantly (P<0.05),
SEM±: standard error of mean
SDCPM+Maxg: sundried cassava peel meal + maxigrain

DISCUSSION

Haematological indices of broiler chickens fed sundried cassava peel meal with maxigrain supplementation.

Blood is important and reliable medium for assessing the physiological and health status of individual animals (Oduye, 1976; Egbe-Nwiyi et al., 2000). According to James (2004), the life of all flesh is the blood and it is useful for atonement for human soul. Blood is useful for assessing the health status, clinical evaluation for survey of physiological/pathological conditions and diagnostic and prognostic evaluation of various types of diseases in animals (Obasoyo *et al.,* 2005; Alade *et al.,* 2005; Amel *et al.,* 2006). The similarity (P>0.05) recorded in the packed cell volume of broiler fed varying levels of cassava peel meal with maxigrain supplementation made it obvious that their was an effective use of the energy sources. This finding is in agreement with reported of Afolayan *et al*. (2014) who reported a no significant difference in the Packed Cell Volume value of local grower chickens fed palm kernel cake meal. The values however fall below the normal range of (31-33.5%) reported by Mitruka and Rawnsley (1977). There were significant (P<0.05) differences in Haemoglobin, red blood cell and mean corpuscular volume, the values of Hb obtained were slightly higher than the normal range for chickens (7-13g/l) as stated by Bernerjee, 2009. This result indicated that the nutrients were adequately utilized by the broilers and posed no problem to the birds. It explains why the birds were healthy, not anaemic and were capable of withstanding stress. This finding negate the report of Okosun and Eguaoje, (2017) who observed no significant (P>0.05) diffrence in the Hb, RBC and MCV values of cockerel chickens fed varying levels of Cassava grit supplemented with moringa leaf meal. The similarity in the Mean corpuscular haemoglobin and Mean corpuscular heamoglobin concentration values. The normal MCH and MCHC indicated the absence of normocytic anaemia which was reported to be characterized by a normal PCV and only detected by a decreased number of RBC or PVC (Coles, 1986). The values of MCH and MCHC were not significantly different (P>0.05) and fell within the normal physiological ranges for broilers (Mitruka and Rawnsley, 1977; Merck's manual, 1998). The MCV, MCH and MCHC values though favoured birds on 40% SDCPM+Maxg, the normal ranges nevertheless suggested the absence of hypochromasia, because under this condition, MCHC is lower than normal (Olafadehan, 2011). There was also no macrocytic (regenerative) or microcytic (non-regenerative) anaemia since the MCV was normal (Jain, 1986). The significant variation in the platelet, neutrophil and monocytes values with highest numerical values recorded among broiler chickens fed 40% SDCPM+Maxg indicated that the birds on this diet has the ability to withstand infections or infestation of any foreign bodies. This agrees with the finding of Ngiki *et al.,* (2014). Who reported a significant variation in the platelet values of broiler chickens fed cassava grit based diet. The higher white blood cell, lymphocyte and eosinophil values recorded among birds fed 40% SDCPM+Maxg suggested adequate defense against infectious agents (Kaneko, 1989). This is probably due to adequate protein in the diets. It suffices to say that the nutrient profiles of the diets were adequate to support the performance of the pigs based on the comparable results obtained since Jain (1986) reported that nutritional deficiency

particularly that of protein reduced most haematological and serum parameters. The blood trait findings in this study were similar to the reports of Unigwe (2011), Hassan *et al*. (2012) and Ngiki *et al.(*2014), all gave diets with varying levels of cassava root meal to broiler chickens and found no significant difference (P>0.05) in their haematological parameters and as well fell within the physiological normal ranges.

Serum biochemistry of broiler chickens fed sundried cassava peel meal with maxigrain supplementation.

The use of chemical indices as a pointer or indicator to conditions that can not be readily noticed by performance indices can not be over emphasized. Serum protein albumin and globulin synthesis is related to the availability of protein and micro-nutrient (Hofferberg *et al.,* 1996). The highest total Protein value recorded in birds placed on 40% SDCPM+Maxg may be due to the supplementary role of Maxigrain in the diet being an enzyme breaks fibrous materials to generate energy and protein and makes it avaliable for the use of the animal it also catalizes some metabolic activities in the body of the animal that enhances the blood quality in the long run. The significant increase in the glucose and cholesterol level among the broiler chicken fed the control diet compare to those on diets containing maxigrain is a pointer to the fact that those on control diet has tendences for fat accumulation compare to those on other treatment diets. This finding agrees with the report of Unigwe *et al.,(*2016) who reported a significant variation in the glucose and cholesterol levels of weaner pigs fed varying levels of cassava peel meal supplemented with maxigrain. Serum urea is known to be a function of the protein quality ingested by the animal, energy deficiency and disease condition which impair protein utilization. When diet is deficient in essential amino acid, the amino acid present will be deaminated resulting to an increase in urea excretion (Ranyhon, 2001). In this present study the inclusion of SDCPM+Maxg gave a comparable urea values in birds fed the treatment diets. Eggum (1970) reported that creatinine is an indirect measure of protein utilization in poultry birds the non significantly differences observed in the Creatinine values in the broiler finisher has suggest protein utilization as sundried cassava peel replaced maize. It is noted that high level of Creatinine could lead to tissue wastage.

CONCLUSION

The overall result in this study showed that sun dried cassava peel meal supplemented with maxigrain can successfully be included in broiler ration up to 40% level without any adverse effect on the blood quality of broiler chickens.

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REFERENCES

Adeola, O. 1995. Digestive utilization of mineral by weanling pigs fed copper and phytase supplemented diets. *Canadian Journal of Animal Science., 75: 603-610.*

Adeyemi, O.A., Eruvbetine, D., Oguntona, T., Dipeolu, M.A. and Agunbiade, J.A. (2007). Enhancing the nutritional value of whole cassava root meal by rumen filtrate fermentation. *Archivos de Zootecnia* 56: 261-264.

Afolayan, M. Bawa G.S., Sekoni A.A., Abeke F.O. Inekwe V.O. (2014). nutritional evaluation of locust bean (parkia biglobosa) fruit pulp. Nig. Soc. for Anim. Prod. 16 - 19 March, 2014. Babcock Univ. Ilishan-Remo, Ogun State, Nigeria

Ahamefule, F. O., Eduok, G. O., Usman, A., Ahamefule, K. U., Obua, B. E. and Ogunike, S. A. (2006). Blood chemistry and haematology of weaner rabbits fed sun dried, ensiled and fermented cassava peel based diets. *Pakistan Journal of Nutrition., 5: 248-253.*

Akinmutimi, A.H. 2004. Evaluation of sword beans (*Canavali agladiata*) as alternative feed source for broiler chicken. PhD Thesis, Micheal Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Alade, A. A., Bambose, A. M., Oguntona, E. B. and Fanimo, A. O. (2005). Haematological parameters, serum metabolites, carcass characteristics of weaner rabbits fed yam peel meal diets. *Proceedings of 10th Annual Conference of Animal. Science Association of Nigeria., Dairo: 280-282*.

Alikwe, P.C.N. and Nodu, M.B. (2013). Performance and carcass characteristics of finisher broiler feed on graded levels of farm (*Asplenium barter*) leaf meal. *Proceedings of the 38th Conference of the Nigerian Society for Animal Production*. 17th - 20th March 2013, Rivers State University of Science and Technology, Port-Harcourt. Pp 406-409.

Amel, O. B., Mariam, S. A., Ehsan, A. S., El-Badwi, M. A. S. (2006). Some biochemical values in the young and adult sundaneese geese, *Anser anser Journal of Advance Animal Veterinary ., 5:24-26.*

AOAC, (1990). Official Method of Analysis 15th Edition, Association of Official Analytical Chemist (AOAC) Washington D.C. USA.

Aro SO, Aletor VA, Tewe OO, Fajemisin AN, Usifo B, Falowo AB (2008a). Preliminary investigation on the nutrients, anti-nutrients and mineral composition of microbially fermented cassav a starch residues. *Proceedings of 33rd Annual Conference of Nigerian Society for Animal Production (NSAP), Ayetoro, Ogun State, Nigeria: 24 8.251*.

Aro, S.O., Aletor, V.A., Tewe, O.O., Fajemisin, A.N., Usifo, B. and Adesida, A.A. (2008b). Studies on the nutritional potentials of cassava tuber waste collected from a cassava starch factory. *Proceedings of the 4th Annual Conference of School of Agriculture and Agricultural Technology held at The Federal University of Technology, Akure, Nigeria. 21st May 2008, Pp 86-92*.

Benerjee, G.C. (2008).Textbook of Animal Husbandry. Bidhan Chandra Krishi Viswadyala. Oxford and IBH publishing company. PVT. LTD

Bimrew, A. 2014. The effect of common feed enzymes on nutrient utilization of monogastric animals. *International Journal of Biotechnology and Molecular Biological Resources. 5(4): 27-34.*

Cadogan, D. J., Choct, M. and Campbell, R. G. 2003. Effects of storage time and exogenous xylanase supplementation of new season wheats on the performance of young male pigs. *Canadian Journal of Animal Science.,* 83: 105-112.

Coles, E.H., 1986. Veterinary Clinical Pathology. 4th edn. (ed. E.H. coles), W.B. Saunders Company, Philadelphia.

Dacie, J.V and Lewis, S.M (1991). Practical Haematology 8th Edition Longman Group Limited. Pp 22-28.

Dairo, F.A.S., Aina, A., Omoyeni, L. and Adegun, M.K. (2011). Ensiled cassava peel and caged layers' manure mixture as energy source in broiler starter diet. *Journal of Agricultural Science and Technology.* 1: 519-524.

Egbe-Nwiyi, T. N., Nwaosu, S. C. and Salami, H. A. (2000). Haematological values of apparently healthy sheep and goats as influenced by age and sex in arid zone in Nigeria. *African Journal of Biomedical Research, (32):109-115.*

Eggum, B. O. (1970). The protein quality of cassava leaves. British Journal of Nutrition, 24: 761- 768.

Enyenihi, G.E., Esiegwu, A.C., Esonu, B.O., Uchegbu, M.C. and Udedibie, A.B.I. (2013). Gelatinization of fermented cassava tuber meal and its nutritive value for broilers. *Nigerian Journal of Animal Prodution. 40(2): 71-79.*

Eruvbetine, D., Tajudeen, I.D., Adeosun, T. and Olojede, A.A. (2003). Cassava (*Manihot esculenta*) leaf and tuber concentrate in diets for broiler chickens. *Bioresource and Technology. 86: 227-281*.

Ewa, U.E., Osuagwu, D. Eburuaja, A.S. and Akinmutimi, A.H. (2012). Proximate, gross energy and mineral composition of sword bean (*Canavalia gladiate*). *Proceeding of the 37th Nigerian Society of Animal Production,* Pp 629-631.

Fajemisin, A.N., Omotoso, O.B., Fadiyimu, A.A. and Shuaibu, A.Y. (2012). Nutrient intake and utilization by West African Dwarf goats fed cassava peels substituted with *Cajanus cajan* hay. In: Agricultural Transformation Strategies and Policies for Livestock Development in Nigeria. *ASAN-NIAS Proceedings of the 17th Annual Conference* held at the International Conference Centre, Opposite Radio House, Area 8, Abuja. 9th - 13th September, 2012. Pp 636-639

FAO. (2002). FAOSTAT statistics database. (*http//aps.fao.org*). Accessed July, 2002.

FAO. (2003). Production Year Book. (Food and Agricultural Organization). FAOSTAT. *Data base. http//appl.fao.org* (Consulted February, 2003).

Hassan, A. M., Tamburawa, M. S., Alphonsus, C. And Yusuf, J. H. (2012). Studies on growth, organs weight and haematological parameters of broiler chicken fed graded level of sun dried cassava root meal. *Bayero Journal of Pure and Applied Science., 5(1): 98-102.*

Hofferberg, R. and Block, J.F. (1996). Serum metabolites. *Journal of clinical investigations. 45:143-150.*

Hyduke, R.R (1995). Chemical Biochemistry Laboratory Manual. The University of IOWA Medical Technology Programme. Iowo City. USA.

Iyayi, E.A. and Fayoyin, F.K. 2004. Expanding rural production through the use of low cost cassava fruit coal as alternative fibre source for broilers. *Proceedings of the DeutscherTropentag Conference on International Agricultural Research for Development*, Berlin, Germany, Pp 1-8.

Jain, N. C. (1986) Schalm"s Veterinary Heamatology 4th edition, (ed. N.C. Jain), Philadelphia: Lea and Febiger, pp.20-86.

James, T. (2004). Medline Plus Medical Encyclopedia: RBC Indices. Available at: en.wikipedia.org/wiki/red_blood_cell_indices

Kaneko, J.J (1989). Clinical biochemistry of domestic animals(4th Edn Academic press ltd, London. Pp 898.

Mavromichalis, I. Hancock, J. D., Senne, B. W., Gugle, T. L., Kennedy G. A., Hines, R. H., Maxwell, M. H., Robertson, G. W., Spences and McCongrouodala, C. C. 1990. Composition of haematological values in restricted and ad libitum fed domesticated fowls. RBC characteristics. *British Poultry Journal, 60:1474-1484.*

Merck Manual (2012). Haematologic reference ranges. Mareck Veterinary Manual. Merck Manuals.com

Mitruka, B.M. and H.M. Rawnsley, (1977). Clinical Biochemical and Haematological reference value in normal experimental animal. Masson Publ. Co. New York, pp: 102-117.

Nasi, M. 1990. Microbial phytase supplementation for growing availability of plant phosphorus in the diet of the growing pigs*. Journal of Agricultural Science., 62:435-442.*

Ngiki, Y. U., Igwebuike, J. U. and Moruppa, S. M. (2014). Implications of Replacing Varying Dietary Levels of Maize with Cassava Root-Leaf Meal Mixture on Haematology and Carcass Characteristics of Broiler Chickens*. International Journal of Science and Technology, 3 (6): 363-373.*

Obasoyo, D. O., Bamgbose, A. M. and Omoikhoje, S. O. (2005). Blood profile of broilers fed diets containing different animal protein feedstuffs. *Proceedings.of the 10th Annual Conference. of Animal Science Association of Nigeria., 155-154.*

Oboh G, Akindahunsi AA (2003). Chemical changes in cassava peels fermented with mixed culture of Aspergillus nigerand two species of Lactobacillus integrated bio-system. *Applied Tropical. Agriculture. 8: 63-68*

Oduye, D. (1976). William Hewson (1739-74). The father of haematology. *British Journal of Haematology., 133:375-381.*

Okah, U. (2004). Effect of dietary replacement of maize with maize processing waste on the performance of broiler starter. *Proceedings of the 19th Annual Conference of Animal Science Association of Nigeria.*Ebonyi State University, Abakaliki, Nigeria, 13th - 16th September 2004, Pp 2-4.

Okosun, S. E. and Eguaoje, S. A.(2017). Nutrient retention, haematology and serum biochemistry of cockerels fed graded levels of cassava (*Manihot esculenta*) grit supplemented with moringa (*Moringa oleifera*) leaf meal. Nigerian Journal of Animal Production. In press

Olafadehan, O. A. (2011). Haematological parameters, serum constituents and organ developmentof growing rabbits as affected by feeding processed cassava peels. Anim. Nutri and Feed Technol., 11: 41-51.

Oyawoye EO, Ogunkunle M (1998). Physiological and biochemical effects of raw jack beans on broilers. Proceedings of annual Conference of Nigerian Society of Animal Production. 23: 141-142.

Ranyhon, S.K. (2001). Animal nutrition in the tropics 5th Edition Vilas publishing House PVT New Delhi India. Pp 576.

SAS (1999). SAS Users Guide Statistics. SAS Institute Cary, North Carolima, USA.

Steel, R.G.D and Torrie, J.H (1990). Principle and procedure of statistics. A Biometrical Approach 3rd

Edition. MacGraw Hill Book Co. New York.
Tewe.O.O.2004): The Global Cassava Development Strategy: Cassava for livestock feed in Sub-SaharaAfrica.ICAD and FAO.
Thompson, R. B. (1974). A short textbook of haematology. 3rd ed. Garden City Press LTD, Letchworth, Hertfordshire, UK.
Unigwe, C.R; Marire, B.N; Omeke, B. C. O ;Abonyi, F.O.; Oladipo,T.A and Adebayo, D. M (2011). Effects of maize-replaced fermented cassava peels and enzymesupplemented diet on haematology and serum biochemistry of cross-bred female pigs. *International Journal of Advance Research in Biological Sciences. (2016). 3(6): 198-208.*
Zyla, K., Wikiera, A., Koreleski, J. Swiatkiewicz, S., Piironen, J, and Ledoux, D. R. 2000. Comparison of the efficacies of a novel Aspergillus niger mycelium with separate and combined effectiveness of phytase, acid phosphatase and pectinase in dephosphorylation of wheat-based feeds fed to growing broilers. *Journal of Poultry Science., 79: 1434- 1443.*