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Effects of maize-replaced fermented cassava peels and enzyme-supplemented diet on haematology and serum biochemistry of cross-bred female pigs

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Abstract

Fresh cassava peels were collected at Orile-Ilugun; an industrial layout in Oyo State, Nigeria, where cassava is being processed to garri. The peels were washed, subjected to submerged fermentation and sundried for 3-5 days till they were crispy dry. A group of 27 weaner gilts (Large-White x Duroc), aged 8-9 weeks and weighed 10.61±0.27kg were fed fermented cassava-peels-based-diets. The weaner gilts were allotted to three treatments comprising T_1 (control), T_2 (fermented CPM) and T_3 (fermented CPM + maxigrain^R enzyme) in a completely randomized design. Blood was aseptically collected after 22 weeks of feeding for haematology and serum biochemistry. Data on haematology and serum biochemistry were analysed using one-way analysis of variance and statistical means separated using Duncan's Multiple Range Test. The haematological and serum biochemical parameters fell within normal ranges except for Hb, RBC, lymphocytes, and glucose that were slightly higher in T_1 whereas significant differences ($P<0.05$) were observed in RBC, neutrophil, monocyte and glucose. There was no detrimental effect of fermented cassava peels in respect of haematology and serum biochemistry. It is therefore recommended that fermented cassava peels based diet can be used with or without enzyme cocktail supplementation since it shows no negative effect on the haematological and serum biochemical parameters, thus proves good for compounding diets for pigs.

Keywords: Fermented cassava peels, enzyme cocktail, pigs, haematology, serum biochemistry.

Introduction

Pig production remains one of the veritable sources of supply of animal protein (Pinchason et al., 1985; Apata and Ojo, 2000; Udofia et al., 2007). The task of bridging protein intake gap appears formidable. Dietary contents affect the blood profile of healthy animals (Odunsi et al., 1999; Yeong, 1999; Iheukwumere and Herbert, 2002; Kurtoglu et al., 2005). According to Oyewoye and Ogunkunle (2004) and Isaac et al. (2013), haematological components are valuable in measuring toxicity, especially with feed constituents that affect the blood as well as the physiological and health status of farm animals. Afolabi et al. (2010) posited that changes in haematological parameters are often used to determine stresses due to nutrition and other factors.

Haematological parameters are those parameters that are related to the blood and blood forming organs (Waugh and Grant, 2001; Bamishaiye et al., 2009) and are good indicators of the physiological status of animals (Khan and Zarfar, 2005). Haematological analysis involves the determination of different blood

parameters which can be done using either electronic quantification or the manual quantification (Etim et al., 2013). Haematological studies have been found useful for disease prognosis and for therapeutic as well as feed stress monitoring (Togun and Oseni, 2005). Balogun and Fetuga (1980) suggested that nutritional studies should not only be limited to carcass quality and nitrogen utilization in broiler chickens, but also should include its blood constituents because it can be used to monitor flock health and to identify nutritional approaches to the improvement of animal production (Udoyong et al., 2010).

Both the haematological and biochemical blood components are influenced by the quantity and quality of feed and also the level of antinutritional elements or factors present in the feed (Akinmutimi, 2004). Biochemical components are sensitive to elements of toxicity in feeds. They can also be used to monitor protein quality of feeds. 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). Cassava peel, an energy component of the test diets in this study contained cyanogenic glycosides-lotaustralin and linamarin (Smith, 1988; Cardoso et al., 2005); both compounds are hydrogen cyanide derivatives. The substance (HCN) has been shown to be toxic to livestock (McDonald et al., 1995) and therefore limits the use of cassava peels in the raw state as feed for livestock (Smith, 1988).

Feed enzyme 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). This can be explained by the fact that in newly hatched chicks; the enterocyte is poorly developed, limiting the bird's digestion and absorption abilities (Yang et al., 2010). During this maturation period, the gut lacks the competency to fully digest feedstuffs and absorb smaller molecules because of a lack of brush-border enzymes, inadequate maintenance of absorptive mechanisms and low surface area caused by immature villus height (Langhout et al., 2000). Early weaned pigs have limited amylase, protease and lipase activity and enhancement of the extent of digestion of nutrients would improve performance and reduce the incidence of the diarrhea that results from undigested nutrients reaching the hindgut and being fermented by bacteria (Bimrew, 2014). Phytase supplementation of P-deficient diets resulted in improved growth performance of pigs (Nasi, 1990; Cromwell et al., 1993; Han et al., 1997; Zyla et al., 2000) and improved P and Ca utilization (Nasi, 1990; Adeola, 1995). Adding carbohydrases to a wheat-based diet fed to young pigs resulted in improved average daily gain (ADG) and average daily feed intake (ADFI) (Cadogan et al., 2003), increased total tract digestibility of DM and N (Mavromichalis et al., 1990) and improved energy digestibility in wheat-soybean meal diet (Li et al., 1996). The limitation imposed by a nutrient may attenuate the response that another enzyme may produce (Cowieson and Adeola, 2005). For example, when ME is limiting, the presence of phytase may fail to produce improvement in performance, even though P is liberated from phytate. In contrast, limitation imposed by insufficient P in the absence of phytase may limit the response to additional ME made available by the use of carbohydrases (Olukosi et al., 2007). The kind of interactions described above may require simultaneous use of enzymes with many different activities that are able to target different components of feedstuffs used. When an enzyme cocktail containing several activities is used, it is more likely to have greater effect than when they are used separately. Zyla et al. (1996) demonstrated in-vitro that complete dephosphorylation of phytate will only occur if a cocktail of enzymes is used.

Efforts were made in this study to assess and determine the effect of processing method (fermentation) and enzyme (maxigrain^{R}) supplementation of cassava peels on the haematology and serum biochemical components of pigs fed such cassava peel-based diets.

Materials and Methods

The experiment was carried out at the piggery unit (Bora Farm) of the Research Farm of The Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Oyo State.

Source of ingredients, processing and feed formulation

Fresh cassava peels were sourced from Orile-Ilegun; an industrial layout in Ibadan, Oyo State, Nigeria; where women that bought cassava root tubers from markets and farms for garri processing come together to peel and heap the wastes. The fresh cassava peels were collected in 25kg bags for onward washing with clean borehole water, immersed in clean bore-hole water in a plastic container (vat) and left at an ambient temperature of 26-30°c for four days. Sign of fermentation which included foaming was looked out

for. After four days, the cassava peels were separated from the broth and spread on a clean polythene sheet under the full blare of the sunlight for 3-5 days during which it dried to constant weight (Okpako *et al*., 2008; Naa *et al*., 2010). The feeds were formulated thus:-

T_1 = Conventional maize-based diet (control).

T_2 = Diet with 40% maize-replaced fermented cassava peels.

T_3 = Diet with 40% maize-replaced fermented cassava peels supplemented with maxigrain^R enzyme.

Constituent of maxigrain^R enzyme includes Cellulase = 10,000 IU, Beta-glucanase =200 IU, Xylanase = 10,000 IU and Phytase = 2500 IU.

The above compounded diets were analyzed for proximate chemical composition using procedures of Association of Official Analytic Chemistry (AOAC, 1990).

Experimental animals, sanitation and management

A group of 35 female weaner pigs (Largewhite x Duroc) between 9.5-11.8 kg body weight and 8-9 weeks old with good body conformation was randomly selected from many and kept under one big compartment for stabilization for 2 weeks during which they were placed on a conventional diet (16.5% crude protein and 2800kcal/kg metabolizable energy) *ad-libitum* with ample supply of clean bore-hole water. The pigs were also prophylactically taken care of against endo- and ectoparasites using ivomec^R (ivermectin) injection at the dose of 1ml/33kg body weight, subcutaneously. There was also administration of long acting oxytetracycline injection at the dose rate of 1ml/10kg body weight (im) which was repeated after 72hours to help eliminate possible pathogenic bacteria that had not manifested as disease(s). The pig pens were swept, cleaned, washed with detergent solution and disinfected using dettol^R and diazinon^R. The pens were not stocked for two weeks to ensure that the residues of the disinfectants disappeared from the environment. In the same vein, the surrounding of the piggery house was kept clean by cutting and clearing around it at regular intervals. After which, there was a randomized allotment of 27 healthy and stabilized female weaner pigs into their respective pens according to treatments and replicates using completely randomized design (Obi, 2002). The above treatments were replicated thrice with each replicate containing three weaned pigs. The pigs were given the diets based on 4% of their body weights on daily basis (Santiago and Tegbe, 1987, Onyimonyi, 2002) for 22 weeks. Similarly, clean drinking water sourced from the borehole in the farm was supplied *ad-libitum* to the pigs.

Data collection

Blood collection and analysis:- Blood was aseptically collected on the 20th, 24th and 28th week of age for haematological and serological laboratory analyses. The bleeding was done in the morning before feeding (after sterilizing the skin with methylated spirit). Using a sterile 10ml syringe and 21 gauge needle, 10ml of whole blood was collected and 5ml dropped into a sterilized EDTA-sample bottle and rolled gently till the fresh blood mixed properly with the anticoagulant for haematological analyses which included red blood cell (RBC) count, white blood cell (WBC) count and the differentials (monocytes, lymphocytes, neutrophils, basophils and eosinophils), packed cell volume (PCV) and haemoglobin (Hgb) concentration as described by Makinde *et al*. (1991), Mafuvadze and Erlwanger, (2007) and Tripathi *et al*. (2008). Others such as mean corpuscular volume (MCV), mean corpuscular haemaglobin (MCH) and mean corpuscular haemaglobin concentration (MCHC) were calculated according to standard formula (Schalm *et al*., 1975). The remaining 5ml for serum analysis was put into test tubes without anticoagulant where coagulation occurred after about 10 minutes. The supernatant serum decanted into sterile bijoh bottles for laboratory analyses to include the serum metabolites (total protein, albumin, globulin, creatinine, cholesterol, glucose and serum urea nitrogen). Total protein was determined by the Biuret method (Peters, 1968) and albumin by the bromocresol green method (Doumas *et al*., 1971).

Statistical analysis

All the data were subjected to one way analysis of variance (ANOVA) while statistical difference in means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results

Table 2 shows the heamatological and serum biochemical characteristics of pigs fed diets containing treated cassava peel meal (CPM). The results showed that there was no significant difference ($P>0.05$) amongst pigs in the treatments in respect of packed cell volume (PCV), haemoglobin concentration (Hb),

white blood cell (WBC), platelets, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) with the values of 40.33±2.33% [T_1], 37.33±0.33% [T_2] and 38.67±0.33% (T_3) for PCV, 13.10±0.85g/dl (T_1), 12.33±0.18g/dl [T_2] and 12.63±0.30g/dl [T_3] for Hb, 14.00±1.53x10^3/µL [T_1], 14.33±1.86x10^3/µL [T_2] and 14.67±0.88x10^3/µL [T_3] for WBC, 2.36±0.36+10^5/µL [T_1], 1.70±0.13x10^5/µL [T_2] and 2.23±0.16x10^5/µL [T_3] for platelets, 56.90±2.24fl [T_1], 57.25±2.55fl [T_2] and 59.58±1.89fl [T_3] for MCV, 18.54±0.92pg [T_1], 18.53±0.75pg [T_2] and 19.44±0.18pg (T_3) for MCH, 32.56±0.37g/dl [T_1], 32.38+0.25g/dl [T_2] and 32.67±0.75g/dl [T_3] for MCHC. In respect of RBC, there was, however, a significant difference [P<0.05] when T_1 [7.35±0.09x10^6/ µL] was compared with T_2 [6.29±0.09x10^6/ µL] and T_3 [6.50±0.22x10^6/ µL] but not [P>0.05] when T_2 and T_3 were compared. The serum biochemical parameters showed that there was no significant difference [P>0.05] among all the pigs in the three treatments in respect of lymphocyte, eosinophil, total protein, globulin, albumin, cholesterol and creatinine. The results revealed 82.00±6.08% [T_1], 62.33±7.62% [T_2] and 63.67±7.31% [T_3] for lymphocytes, 1.67±0.67% [T_1], 1.67±0.33% [T_2] and 3.33±0.88% [T_3] for eosinophils, 6.80±0.29g/dl [T_1], 7.07±0.35g/dl [T_2] and 6.83±0.28g/dl [T_3] for total protein, 4.43±0.23g/dl [T_1], 4.73±0.49g/dl [T_2] and 4.20±0.26g/dl [T_3] for globulin, 2.93±0.13g/dl [T_1], 2.93±0.26g/dl [T2] and 2.90±0.20g/dl [T_3] for albumin, 112.00±7.77 mmol/L [T_1], 95.67±8.57 mmol/L [T_2] and 96.33±6.69 mmol/L [T_3] for cholesterol, and 1.07±0.09mg/dl [T_1], 1.03±0.03mg/dl [T_2] and 1.53±0.07mg/dl [T_3] for creatinine. There was however significant difference [P<0.05] among the treatments in respect of neutrophil, monocyte, glucose and BUN. The values of 16.67±1.76% [T_1], 19.67±0.88% [T_2] and 29.00±2.08% [T_3] were obtained for neutrophil, 2.00±0.01% [T_1], 3.00±0.58% [T_2] and 4.33±0.88% [T_3] for monocytes, 121.33±6.23mg/dl [T_1], 105.33±1.20mg/dl [T_2] and 113.67±1.76mg/dl [T_3] for glucose and 12.27±0.37mg/dl [T_1], 13.33±1.45mg/dl [T_2] and 12.33±1.45mg/dl [T_3] for BUN. In the neutrophil content, T_3 was significantly different [P<0.05] when compared with T_1 and T_2 but non significant (P>0.05) when T_1 and T_2 were compared. The monocyte showed that T_3 was significantly different (P<0.05) from T_1 and T_2 whereas, T_1 was also significantly different [P<0.05] from T_2. In the glucose, T_1 was statistically different (P<0.05) from T_2 but not T_3 while T_2 and T_3 were statistically different [P<0.05]. The BUN shows significant difference [P<0.05] when T_3 was compared to T_1 and T_2 but not significant [P>0.05] when T_1 was compared with T_2.

Table 1:- Dietary composition of pig's grower diets

	T_1	T_2	T_3
Maize	40.00	-	-
CPM	-	40.00	40.00
PKC	20.00	29.50	29.50
BDG	14.00	10.00	10.00
GNC	12.50	11.00	11.00
BLM	5.00	5.00	5.00
Palm oil	4.00	4.00	4.00
Bone meal	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00
Methionine	0.20	0.20	0.20
Lysine	0.75	0.75	0.75
Premix	0.40	0.40	0.40
Salt	0.15	0.15	0.15
Total	100	100	100
C.P. (%)	20.82	20.47	20.47
ME (kcal/kg)	2871.50	2759.23	2759.23

Vitamin-mineral premix/kg diet: Vitamin A–8,000 IU, Vitamins D3 –3,000 IU, Vitamins E–8 IU, Vitamin K –2mg, Vitamin B1– 1 mg, Vitamin B2–0.2 mg, Vitamin B12–5 mg, Nicotinamide –10 mg, Selenium– 0.1 mg, Ca Pantothenate – 5 mg, Folic acid –0.5 mg, Choline Chloride –150 mg, Iron –20 mg, Manganese –80 mg, Copper –8 mg, Zinc –50 mg, Cobalt –0.225mg, Iodine –2 mg Antioxidant – 0.1ppm

Key:- CPM = Cassava peels meal, PKC = Palm kernel cake, GNC = Groundnut cake, BDG = Brewer's dried grain, BLM = Blood meal, C.P. = Crude protein, ME = Metabolizable energy.

Table 2: Haematological and serum biochemical parameters of non-gravid pigs fed CPM-based diets

PARAMETER	T_1	T_2	T_3	* Normal
PCV (%)	40.33±2.33	37.33±0.33	38.67±0.33	36-43
HB (g/dl)	13.10±0.85	12.33±0.18	12.63±0.30	9-13
RBC ($x10^6$/µL)	7.35±0.09[a]	6.29±0.09[b]	6.50±0.22[b]	5-7
WBC ($x10^3$/µL)	14.00±1.53	14.33±1.86	14.67±0.88	11-22
MCV (fl)	56.90±2.24	57.25±2.55	59.58±1.89	52-62
MCH (pg)	18.54±0.92	18.53±0.75	19.44±0.18	17-24
MCHC (g/dl)	32.56±0.37	32.38±0.25	32.67±0.75	29-34
Platelet ($x10^5$/µL)	2.36±0.36	1.70±0.13	2.23±0.16	2-5
Lymphocyte (%)	82.00±6.08	62.33±7.62	63.67±7.31	35-75
Neutrophil (%)	16.67±1.76[b]	19.67±0.88[b]	29.00±2.08[a]	20-70
Monocyte (%)	2.00±0.01[b]	3.00±0.58[ab]	4.33±0.88[a]	0-10
Eosinophil (%)	1.67±0.67	1.67±0.33	3.33±0.88	0-15
Protein (g/dl)	6.80±0.29	7.07±0.35	6.83±0.28	5.8-8.3
Globulin (g/dl)	4.43±0.23	4.73±0.49	4.20±0.26	3.9-6
Albumin (g/dl)	2.93±0.13	2.93±0.26	2.90±0.20	2.3-4
Glucose (mmol/L)	121.33±6.23[a]	105.33±1.20[b]	113.67±1.76[ab]	66.4-116.1
Cholesterol (mmol/L)	112.00±7.77	95.67±8.57	96.33±6.69	81.4-134.1
BUN (mg/dl)	12.27±0.37	13.33±1.45	12.33±1.45	8.2-24.6
Creatinine (mg/dl)	1.07±0.09	1.03±0.03	1.53±0.07	0.8-2.3

ab:- means on the same row with different superscripts are statistically different ($P<0.05$)
* Merck's Manual (1998).

Discussion

Heamatological analysis involves the determination of different blood parameters which can be done using either the electronic or the manual quantifications [Etim et al., 2013]. Heamatological studies have been found useful for disease prognosis and for therapeutic and feed stress monitoring [Togun and Oseni, 2005]. As reported by Onyedili et al. [1991] and Togun et al. [2007], haematological studies represent a useful process in the diagnosis of many diseases as well as investigation of the extent of damage to blood. Ovuru and Ekweozor [2004] and Isaac et al. (2013) stated that haematological studies are of ecological and physiological interests in helping to understand the relationship of blood characteristics and environment. Haematological parameters are also good indicators of the physiological status of animals [Khan and Zafar, 2005]. Isaac et al. [2013] reported that animals with good blood composition are likely to show good performance. Heamatological values could serve as base line information for comparison in condition of nutrient deficiency, physiology and health status of farm animals [Daramola et al., 2005]. Heamatology and blood chemistry are routinely used in veterinary medicine to evaluate the health status of animals and poultry [Mafuvadze and Erlwanger, 2007]. All the haematological parameters fell within normal range in this study as supported by other authors [RAR, 2009; Etim et al., 2013; Coronado, 2014]. According to Togun et al. [2007], when haematological values fall within the normal range established for the animal, it is an indication that diets did not show any adverse effect during the experimental period. Though there was no significant difference [$P>0.05$], the WBC count was higher in the pigs fed CPM-based (T_2) diets with the enzyme (T_3) accentuating this. This is in consonance with the report of Ajuonuma and Uchendu (2013) who stated that, with increasing CPM inclusions, diets led to a slight increase in the values of total white blood cells counts. Though there was no significant difference [$P>0.05$] among the treatments, the PCV was higher in T_1 [control], closely followed by T_3 [CPM + enzyme] and lastly the T_2 [CPM only] with no defined order or trend. This contradicts the result of Sogunle et al. [2007] and Oladunjoye et al. [2010] that obtained higher PCV values in growing pullets fed CPM diet supplemented with cashew nut reject meal. In a similar vein, Adesehinwa et al. [2011] obtained a similar result in CPM-based and CPM + Farmazyme-3000 based diets in growing pigs where the enzyme slightly increased PCV but not above maize-based diet. Also, Adesehinwa et al. [2008] similarly recorded lower PCV in a CPM based diet with Avizyme-1300 supplement.

In contrast, Olafadehan [2011] recorded a higher PCV in rabbits fed retted CPM but not in ensiled and sundried CPM based diets where the control was better. In terms of the Hb, the result of this experiment was in tandem with that of Adesehinwa et al. [2008], Olafadehan [2011] and Adesehinwa et al. [2011] who had control having the highest Hb followed by those with enzyme supplementation with the CPM-based diet alone having the least. However, it contradicts the result of Udoyong et al. [2010] who got broiler chickens in control diet with lowest Hb and highest in broiler chickens on CPM + maxigrain^{R} enzyme supplementation in respect of RBC. This result shows that enzymes help to make available more nutrients for absorption. This also suggests that the level of anti-nutritional factors in cassava peel had been depressed to a tolerable non-lethal level, no wonder all the haematological parameters fell within the normal ranges [The Merck's Veterinary Manual, 1998]. This corroborates the findings of Church et al. [1984] and Maxwell et al. [1990] who asserted that ingestion of dietary components had measurable effect on blood composition and may be considered as appropriate measure of long term nutritional status [Olabanji et al., 2007]. Therefore, whatever affects the blood such as nutrition will certainly affect the entire body adversely or moderately in terms of health, growth, maintenance and reproduction [Oke et al., 2007]. Isaac et al. [2013] stated that the haematological components are valuable in monitoring feed toxicity especially with feed constituents that affect the blood as well as the health status of farm animal. Aro and Akinmoegun [2012] and Aro et al. [2013] posited that haematological parameters are used in routine screening for the health and physiological status of livestock and even humans. Etim et al. [2014] documented that haematological traits especially PCV and Hb were correlated with the nutritional status of animals. PCV and other haematological parameters are useful aids to prognosis and may reveal adverse condition even when the animal did not display obvious clinical signs of ill health [Eze et al., 2010]. That the haematological traits concentration values did not decline below normal in this study was an indication that anti-nutritional factors which may be present in small quantity did not influence these haematological parameters negatively. The RBC concentration recorded in this study was similar to that of Enyenihi et al. [2008]. The trend in the RBC, PCV and Hb in this study could be ascribed to the direct relationship among RBC, PCV and Hb [Jain, 1986]. This also showed that there was adequate protein in the diets since Sirois [1995] concluded that haematological parameters like Hb, RBC and PCV are primarily affected by protein intake. The normal PCV indicated the absence of normocytic anaemia which was reported to be characterized by a normal MCV and MCH and only detected by a decreased number of RBC or PVC [Coles, 1986]. The values of MCV and MCHC were not significantly different [P>0.05] and fell within the normal physiological ranges for pigs [Mitruka and Rawnsley, 1977; Merck's manual, 1998]. The MCV, MCH and MCHC values though favoured CPM diets, the normal ranges nevertheless suggested the absence of hypochromasia, because under this condition, MCHC is lower than normal [Thompson, 1974; Olafadehan, 2011]. There was also no macrocytic [regenerative] or microcytic [non-regenerative] anaemia since the MCV was normal [Jain, 1986]. The normal WBC and their differentials 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

The creatinine levels in the study showed that there was no significant difference [P>0.05] and all the values fell within the normal physiological values [Merck's Manual, 1998]. This is in tandem with the results of Omole and Sonaiya [1981] and Ahamefule et al. [2006] who had no significant difference [P>0.05] as well as having values fell within normal physiologic values. This suggests that there was no wasting or catabolism of muscle tissues and that the animals were not surviving at the expense of the body reserve [Ahamefule et al., 2006]. This indicated that dietary proteins were well utilized by the pigs and the residual HCN in the treated CPM did not interfere with the nutrient utilization [Olafadehan, 2011]. The blood urea concentration in this study had no significant difference [P>0.05] among the treatments with lower numerical value in T_3 (the enzyme-treated CPM diet) and the lowest in T_1 (control). This trend could suggest that there was no kidney damage due to HCN or other anti-nutrients in the diets possibly due to

its tolerable level occasioned by fermentation. Its lower quantity, ie, T_3 as compared to T_2 could be due to the effect of cocktail enzyme that probably enhanced maximal utilization of protein in the diet. Increased serum urea concentration may suggest an increase in activities of urea enzymes: - ornithine, carbonyl transferase and orginase which may also indicate kidney damage [Ajagbonna et al., 1999] or due to catabolism from fever or tissue necrosis. The normal range also implied that the dietary proteins of the treated CPM based diets and control were well utilized [Reinhold, 1953]. The normal BUN in this study could also indicate that the amino acids of the test diets were balanced because amino acid imbalances result in an increase in BUN [Eggum, 1970]. Ranjhan [2001] affirmed that in a diet deficient in amino acid, the available amino acid will be deaminated and hence results in an increase in the excretion of urea. The BUN concentration of treated CPM diet supplemented with maxigrain^R enzyme was comparable to that of control. This is in consonance with the report of Adesehinwa et al. [2011] who used Farmazyme^R supplementation on processed CPM to feed growing pigs. Also Adesehinwa [2008] reported that high serum urea was an indication of muscular wastage in animals. The higher cholesterol in the maxigrain^R supplemented CPM diet compared to pigs fed only treated cassava peel meal, is in line with the findings of Kilic et al. [2006] who reported that enzymes significantly [$P<0.05$] influenced fat deposition in broilers. This was contradicted by the report of Adesehinwa et al. [2011] who recorded lower cholesterol in pigs given fermented and farmazyme supplemented CPM diet. The blood glucose levels of pigs on CPM based diets though fell within the normal physiologic values, nonetheless, there was a numerical increase in the pigs fed maxigrain^R enzyme supplemented CPM-based feed. This could likely be due to more availability of glucose from enzyme effect on fibres which ordinarily would not be digested by monogastrics. The pigs on control (T_1, maize based diets) showed marginally higher than normal physiologic value of glucose in the blood as reported by Mitruka and Rawnsley [1977]. This could possibly be due to high energy value of maize. However, the normal and slightly higher blood glucose levels obtained for CPM based diets and maize based diet respectively indicated that the pigs were not surviving at the expense of body tissues [Ologhobo et al., 1992].

Conclusion

Fermented and/or enzyme supplemented CPM-based diets do not show negative effect on the haematological and serum biochemical parameters, thus prove good for compounding diets for pigs.

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