Nig. J. Anim. Prod. 2021, 48(5):90-99. https://doi.org/10.51791/njap.v48i5.3189 *Nigerian Journal of Animal Production*

Profile of blood of weaner boars fed *Tetrapleura tetraptera* pod pulp meal

[*]Ezea, J., Ezike, J. C., Nathaniel, J., Ukar, I. A., Oguike, M. A. and Herbert, U.

Department of Animal Breeding and Physiology,
Michael Okpara University of Agriculture, Umudike, Nigeria
[*]**Corresponding author:** jonas96ezea@gmail.com;+234 706 974 5125

Abstract

A study was conducted to determine the effect of Tetrapleura tetraptera pod pulp meal on haematology, red blood cell osmotic fragility and serum chemistry values of weaned boars. A total of 18 weaner boars of Large White x Duroc crossbreeds, aged 6 weeks and weighing 9.4kg on the average, were used for the study, which lasted 56 days. The piglets were divided into 3 equal groups, each of which were assigned 0.0%, 2.5% or 5.0% TPM per kg, respectively, of a basal weaner pig diet, in a completely randomized design. Data sets were collected on haematology, serum chemistry and lipid profile. Red blood cells (6.74, 6.03, 5.57) x 10^{12}/l, packed cell volume (46.33, 39.33, 37.35) %, haemoglobin concentration (13.77, 11.43, 10.37) g/L and the platelet counts (37.90, 33.97, 33.83) x 10^{9}/L were significantly lower (P<0.05) in the sera of boars fed TPM than in those fed zero TPM. Mean cell haemoglobin and mean cell haemoglobin concentration were significantly (P<0.05) lowered by addition of TPM in a dose-dependent fashion. Addition of TPM increased the fragility of the erythrocytes in sodium chloride solution of varying concentrations. Serum glucose increased progressively (P<0.05) with increase in TPM. Albumin was significantly reduced only at 5.0% TPM while globulin and urea were reduced (P<0.05) at both levels of TPM. Total protein and ALT were significantly reduced with increase in TPM. HDL was progressively lowered (P<0.05) with addition of TPM while the reverse was the case with LDL. VLDL and TG were significantly increased only at 5.0% TPM. It is concluded that TPM depressed the haematological indices, compromised the stability of the erythrocytes even in normal saline solution, reduced serum albumin, globulin, total protein, ALT and HDL but increased serum glucose, LDL, VLDL and TG.

Keywords: Blood profile, weaner boars, Tetrapleura tetraptera pod pulp meal

Profil de sang de verrats sevrés nourris de farine de pulpe de gousse de Tetrapleura tetraptera

Résumé

Cet étude a été menée pour déterminer l'effet de la farine de pulpe de gousse de Tetrapleuratetraptera sur l'hématologie, la fragilité osmotique des globules rouges et les valeurs de chimie sérique des verrats sevrés. Au total, 18 verrats sevrés issus de croisements Large White x Duroc, âgés de 6 semaines et pesant en moyenne 9,4 kg, ont été utilisés pour l'étude, qui a duré 56 jours. Les porcelets ont été divisés en 3 groupes égaux, chacun ayant reçu 0,0%, 2,5% ou 5,0% de TPM par kg, respectivement, d'un régime de base pour porcelet sevré, dans un plan complètement randomisé. Des ensembles de données ont été collectés sur l'hématologie, la chimie du sérum et le profil lipidique. Globules rouges (6,74, 6,03, 5,57) x 1012/l, hématocrite (46,33, 39,33, 37,35) %, concentration en hémoglobine (13,77, 11,43, 10,37) g/L et numération plaquettaire (37,90, 33,97, 33,83) x 109/L étaient significativement plus faibles (P<0,05) dans les sérums de verrats nourris au TPM que dans ceux nourris sans TPM. L'hémoglobine cellulaire moyenne et la concentration moyenne d'hémoglobine cellulaire ont été significativement (P < 0,05) abaissées par l'ajout de TPM d'une manière

dose-dépendante. L'ajout de TPM a augmenté la fragilité des érythrocytes dans une solution de chlorure de sodium de concentrations variables. La glycémie a augmenté progressivement (P<0,05) avec l'augmentation de la TPM. L'albumine n'était significativement réduite qu'à 5,0 % de TPM tandis que la globuline et l'urée étaient réduites (P < 0,05) aux deux niveaux de TPM. La protéine totale et l'ALT ont été significativement réduites avec l'augmentation de la TPM. Le HDL a été progressivement abaissé (P<0,05) avec l'ajout de TPM alors que l'inverse était le cas avec le LDL. Les VLDL et les TG n'ont augmenté de manière significative qu'à 5,0 % de TPM. Il est conclu que le TPM a diminué les indices hématologiques, a compromis la stabilité des érythrocytes même dans une solution saline normale, a réduit l'albumine sérique, la globuline, les protéines totales, l'ALT et le HDL mais a augmenté le glucose sérique, le LDL, le VLDL et le TG.

Mots-clés : Profil sanguin, verrats sevrés, farine de pulpe de cabosse de Tetrapleura tetraptera

Introduction

Blood is constituted by cells and the plasma, which is the fluid portion. It functions to transport nutrients, regulate bio-functions, protect the entire animal body as well as exercise homeostatic control (Nasyrova et al., 2006). The usefulness of blood in assessing the quality of foods and feed additives has been underscored by various researchers. Blood is a fast and readily available means of assessing chemical and nutritional health status of animals in feeding trials (Maxwell et al., 1990). Presence of metabolites and other constituents could be investigated through blood examination thus helping to detect condition of stress as could be occasioned by nutrition, environment or disease agents (Aderemi, 2004). Physiologic parameters, when considered in relation to behaviour and morbidity could be used as welfare indicators (Hoy and Verga, 2007); Onasanya *et al.,* 2015). There is growing interest in application of phytogenic feed/water additives in the production of food animals. The reasons are not far-fetched. Phytogenics, phytobiotics or botanicals are potential alternatives to use of pharmaceutical anti-microbial growth promoters (AGPs). The AGPs which are routinely included in feed/water for animals have been found to be limited by harmful residual effects and cross-resistance by pathogens to antibiotics deployed in human medication (Hunters *et al.,* 2010). Increased exploration of herbal feed additives is also linked to consumer pressure to eliminate the use of non-plant xenobiotic agents from diets of animals meant for human consumption (Kumar *et al.,* 2014). *Tetrapleura tetraptera is synonymous with Tetrapleura thonningii Benth* (ICRAF, 2002) and *Adenanthera tetrapleura,* and belongs to the family *Magnoliopsida.* The common name is African Porridge plant. Exploring the ethno-pharmacological significance of the pod pulp, Adesina *et al.* (2016) revealed its inclusion in herbal preparations against febrile convulsions, inflammation, rheumatic pains, flatulence and stomach gripes in infants. Extracts and some isolates of the pod pulp were reported to be hypotensive, hypothermic, anxiolytic, analgesic, antimalarial, and antimicrobial, among other bioactive effects. It is used as a general tonic and flavour agent or spice. Tetrapleura tetraptera pod pulp contains bioactive compounds such as *coumarin, hentriacontane, saponins, naringenin, isoliquiritigenin,* amino acids and toxic constituents. The need to explore the changes in blood cells of post-weaned boars fed *Tetrapleura tetraptera* pod pulp meal informed this work.

Materials and methods

Study location

The research was carried out at the Piggery Unit of the Livestock Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State. Umudike lies on co-ordinates $05^0$29? N and 07^0 33? E, and an altitude of about 122m above sea level. The average annual rainfall ranges from 1700 to 2100 mm. Minimum and maximum temperature are in the ranges18-23^0 C and 26-36^0 C, respectively; while relative humidity is 57-91% (NRCRI, 2017).

Sourcing the pods and preparation of the pulp meal

The pods were bought from New Market, Aba, Abia State. The two soft 'wings' of dry pods were peeled off with a sharp kitchen knife and subsequently crushed with a hammer mill for easy mixing with the other feed ingredients. The resulting meal was packed in air-tight bags until needed for addition to the pigs' basal diets. *Tetrapleura tetraptera* pod pulp meal (TPM) was added as a spice at 0.0% (control), 2.50% and 5.0%, respectively, per kg of basal diet.

Experimental animals and management

The piglets (Large White x Duroc) crossbreeds were about 6 weeks of age and weighing 9.47kg on the average. They were quarantined for 2 weeks; during which they were administered Ivermectin injectable solution 1% via the subcutaneous route at 0.25ml/12.5 kg body weight, against internal and external parasites. Feed was supplied twice daily while they were given access to water ad libitum. They were reared in a house with hard and non-slippery concrete floor. The pens were cleaned daily while the experiment lasted.

Table 1: Diet composition for weaner pigs fed *Tetrapleura tetraptera* pod pulp meal

Ingredient%	0.0% TPM	2.5% TPM	5.0% TPM
Maize	58.90	58.90	58.90
Groundnut cake	27.50	27.50	27.50
Wheat offal	10.00	10.00	10.00
Bone meal	2.00	2.00	2.00
Oyster shell	0.75	0.75	0.75
Vitamin/Mineral premix*	0.20	0.20	0.20
Methionine	0.05	0.05	0.05
Lysine	0.15	0.15	0.15
Salt	0.45	0.45	0.45
Total	**100**	**100**	**100**
TPM (%)	0.00	2.50	0.50
Crude protein (%)	20.17	20.17	20.17
Digestible energy (Kcal/kg)	3361.03	3361.03	3361.03

*To provide per kg of diet: vitamin A (10 000 IU), vitamin D (20 000 IU), vitamin E (5 IU), vitamin K (2.5 mg), choline (350 mg), folic acid (1 mg), Manganese (56 mg), Iodine (1 mg), Iron (20 mg), Copper (10 mg), Zinc (50 mg) TPM = *Tetrapleura tetraptera* pod pulp meal

Blood collection and analyses

Two mililitres each of blood samples were taken from the cephalic vein of the fore limb of the piglets for haematology and serum chemistry studies, respectively. Samples for haematological studies were collected in bottles treated with ethylene diamine tetra-acetic acid (EDTA) to forestall clotting while those for serum chemistry were collected in anticoagulant-free bottles to allow for clotting and harvesting of sera.

Haematological indices were determined according to Jain (1986); while the serum chemistry indices were determined according to Schmidt and Schmidt (1963). Red blood cell osmotic fragility was tested according to Adenkola and Oluremi (2014). Total cholesterol, high-density lipoprotein

(HDL) and triglycerides were determined using Randox commercial kit (Randox Co. UK.), while low-density lipoprotein (LDL) and very-low density lipoprotein (VLDL) were calculated using Friedwald equations. (Friedwald *et al*. 1972) as follows:

$$\text{LDL (mg/dl)} = \text{Total cholesterol (mg/dL)} - \frac{\text{Triglycerides (mg/dL)}}{5} - \text{HDL (mg/dL)}$$

Very low-density lipoprotein (VLDL) (mg/dL) was calculated as:

$$\frac{\text{Triglycerides (mg/dL)}}{5}$$

Data analysis

All data sets generated from the study were subjected to analysis of variance (ANOVA) procedure and significantly different means separated using Fisher's least significant difference (F-LSD) (Fisher),using Statistical Package for Social Sciences (SPSS) version 20.

Results and discussion

Table 2 shows the haematological parameters of weaned boars fed TPM. Red blood cells (RBC), packed cell volume (PCV) and haemoglobin concentration (Hb) were significantly reduced ($P<0.05$) in boars fed TPM. Total white blood cell counts were reduced ($P<0.05$) at 2.5% inclusion of TPM. WBC counts were similar ($P>0.05$) in boars administered control and 5% TPM. Mean cell haemoglobin (MCH) was reduced significantly with addition of 2.5% TPM and even more ($P<0.05$) with 5% TPM. Mean cell haemoglobin concentration (MCHC) was lowered ($P<0.05$) in boars fed 5% TPM, but similar in control and 2.5% TPM-treated counterparts. There was significant reduction in the number of platelets in the TPM-fed weaner boars. Values for RBC and Hb in this study fell within the ranges reported by Friendship *et al*. (1984), for RBC (5.3-8.0 x 10^{12}/L) and Hb (90-140g/L); and Cooper *et al*. (2014), for RBC (5.52-9.11 x 10^{6} µL) and Hb (8.8-12.7g/dl), for Hampshire x Yorkshire pigs weighing 10-20kg. Mean cell haemoglobin and mean cell haemoglobin concentration were also within the ranges reported by Friendship *et al*. (1984). The range of values for packed cell volume was however, superior to those: 26-41% and 28.3-42.7%, documented by the same authors. The result under discussion is in agreement with the findings of Jegede (2013), who observed significant depressions in the haematological parameters of *Clarias gariepinus* juveniles administered TPM. Also, Odesanmi *et al*. (2010), reported significant decrease in the RBC counts of male Dutch White rabbits administered ethanolic extract of *Tetrapleura tetraptera* pod pulp. However, it negates the submissions of Nweze *et al*. (2011) that *Tetrapleura tetraptera* fruits administered to broiler chickens via feed; and as cold and boiled water decoctions, respectively, boosted plasma RBC, Hb concentration and PCV. The comparatively high PCV values obtained in this work could be due to haemo-concentration owing to excitement in the time of blood sampling from the piglets. Epinephrine elaborated in excited state has been known to cause contraction of the spleen, forcing stored erythrocytes into circulating blood, thereby increasing the PCV value (Beitz, 2004). This might well have been exacerbated by the reported anxiolytic effect of *Tetrapleura tetraptera* pod pulp extract in experimental subjects (Adesina *et al*., 2016).

Though the RBC and Hb concentration fell within the reported ranges, the significant reductions in TPM-fed pigs calls for caution, especially in consideration of young pigs, bearing in mind the roles of the indices concerned and the specific implications of their significant reductions, *in vivo*. For instance, it was observed by Togun *et al*. (2007) that a decrease in PCV with marginal reduction in RBC could indicate low efficiency of erythropoiesis,

signifying heightened blood dilution and impaired oxygen transportation at the cellular level (Nwambe and Elechi, 2009). In another dimension, Oyawoye and Ogunkunle (2004) explained that reduced Hb concentration and PCV could be suggestive of presence of a toxic factor like haemagglutinin, which has adverse effect on blood formation. The reduced RBC, Hb and PCV in the piglets fed TPM might equally be reflections of presence of haemolytically active principles in the pods. Akin-Idowu *et al*. (2011) documented presence of 20% saponins, which have been reported to possess haemolytic effect (Okwu, 2005), in Aidan pod.

Table 2: Haematological parameters of weaned boars fed *Tetrapleura tetraptera* pod pulp meal

Parameter	Treatment			SEM
	0.0% TPM	2.5% TPM	5.0% TPM	
Red blood cells ($x10^{12}$/l)	6.74[a]	6.03[b]	5.57[c]	0.17
Packed cell volume (%)	46.33[a]	39.33[b]	37.35[c]	1.37
Haemoglobin (g/l)	13.77[a]	11.43[b]	10.37[c]	0.50
White blood cells($x10^9$/l)	12.90[a]	8.72[c]	10.47[b]	0.61
Platelets($x10^9$/l)	37.90[a]	33.97[b]	33.83[b]	0.67
Mean cell volume(fl)	67.18[b]	65.65[c]	67.61[a]	0.30
Mean cell haemoglobin (pg)	20.24[a]	19.20[b]	18.60[c]	0.24
Mean cell haemoglobin concentration(g/)	29.72[a]	29.04[b]	27.51[c]	0.33

[a-c] Means on the same row with different superscripts are significantly (P<0.05) different.
SEM = standard error of the mean, TPM= *Tetrapleura tetraptera* pod pulp meal

There is a near overlap of the osmotic fragility curves of the TPM-treated pigs, except for a slight shift in the 5% TPM-treated pigs at 0.70% NaCl concentration. Percentage fragility is higher in the TPM-treated pigs. The observed increase in percentage fragility of the red blood cells in the current work negates the observation of Ijioma *et al*. (2017), among rats treated with 200mg/kg and 400mg/kg live weight of pod and leaf extracts of *Tetrapleura tetraptera* and *Gongronema latifolium,* respectively.

The figure however, agrees with the report of Maiworm *et al*. (2014), who observed an increase in percentage red cell osmotic fragility of the blood of Wister rats administered aqueous extracts of *Lantana camara*. Also, Saad and Habib (2013) reported increased percentage osmotic fragility in human erythrocytes exposed to 1.25%, 2.50%, 3.75% and 7.50% of extracts of the popular *Hibiscus sabdariffa* (*Zobo*) and *Nigella sativa* (Black cumin), both used traditionally in folk medicine (Awhin, 2012).

The trend of change in the osmotic fragility curves indicates a disturbance in the membrane permeability and cellular homeostasis as a result of the treatment with *Tetrapleura tetraptera* pod pulp meal compared with the control. This translates to alteration in membrane integrity, especially from 0.30% NaCl concentration up till the physiologic level (0.85% NaCl). Increase in osmotic fragility would result in increased deformability of RBCs; and this is tantamount to shortened lifespan of the cells. (Saad and Habib, 2013). Maiworm *et al*. (2014), explaining the percentage increase in red cell osmotic fragility alluded to some phytochemical constituents of the pod; which might be able to interact with membrane components of erythrocytes, thereby modifying the osmotic transport balance. Recall that TPM depressed the haematological parameters of these weaner pigs (Table 2). Figure 1 shows the percentage fragility in sodium chloride solutions of varying concentrations of the red blood cells of weaner boars fed TPM.

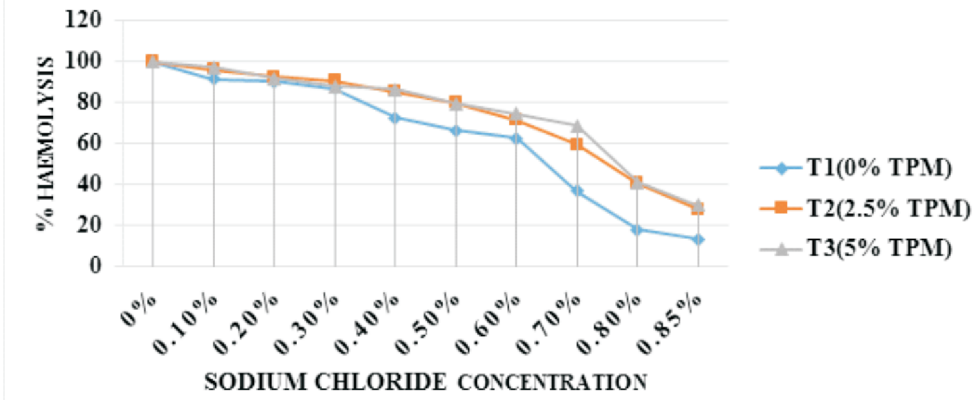

Figure 1: Erythrocyte osmotic fragility of weaner boars fed *Tetrapleura tetraptera* pod pulp meal

Table 3 shows the serum chemistry parameters of weaned boars fed TPM. Glucose increased progressively ($P<0.05$) in the sera of piglets with increase in TPM. Albumin was significantly reduced at 5% addition of TPM. Globulin and urea were significantly lower ($P<0.05$) at 2.5% TPM than in boars treated with zero and 5% TPM, respectively. Total protein and alanine aminotransferase (ALT) were more abundant ($P<0.05$) in the sera of the control group of piglets than in the TPM-fed groups; which differed significantly ($P<0.05$). Aspartate aminotransferase (AST) was significantly reduced at 2.5% TPM, while creatinine was reduced significantly at 0.0% and 2.5% TPM. Increased serum glucose in the TPM-fed boars in the current study is contrary to the report of Kuate *et al*. (2015), who observed reduced plasma glucose in high-carbohydrate, high-fat-diet induced obese and type II diabetic rats, with metabolic syndrome features. It is also a negation of the findings of Adesina*etal*. (2016), who reported hypoglycaemia in normoglycaemic experimental rats administered extracts and isolates of TPM. It could be that at this growth stage of the pigs, glucose metabolism favoured abundance of glucose in the blood to sustain the rapid metabolism taking place in the young animals. Conversion of glucose to and storage as glycogen is not the priority of the animals at this stage of their growth. Increased circulating total protein in the blood reflects an increase in either of albumin and globulin or both; and could manifest in volume contraction, venous stasis or in hypergammaglobulinaemia. Relative increase in albumin may occur in haemo-concentration. On the other hand, decreased albumin could be the result of decreased synthesis occasioned by malnutrition, mal-absorption, liver diseases, loss due to nephrotic syndrome and gastro-intestinal tract conditions and/or increased catabolism. The significant reduction in circulating ALT in the TPM-fed pigs could be indicative of absence of hepatotoxic conditions/ hepatic tissue damage as well as freedom of the experimental boars from oxidative stress, owing to reported abundance of antioxidants in *Tetrapleura tetraptera* pod pulp. Concentration of ALT is known to be higher in the liver than any other tissue in the animal body; and has been identified as a more specific indicator of liver damage than AST (Kamal and Hessah, 2015). Conditions such as necrosis of hepatocytes, myocardial and skeletal muscle cells effect

higher concentration of ALT. Decreased circulation thereof, in the opinion of Uthman (2002), however, is of no known clinical significance. Reduction in serum urea and creatinine of pigs fed 2.5% TPM could be a reflection of more efficient renal function / absence of renal impairment. The increase in serum creatinine in pigs fed 5.0% TPM could be attributed to greater muscle mass in the group so treated.

Table 3: Serum chemistry of weaned boars fed *Tetrapleura tetraptera* pod pulp meal

Parameter	Treatment			SEM
	0.0% TPM	2.5% TPM	5.0% TPM	
Glucose (mg/dL)	66.33[c]	71.00[b]	73.33[a]	1.03
Albumin (mg/dL)	3.70[a]	3.69[a]	3.29[b]	0.07
Globulin (mg/dL)	3.05[a]	2.48[c]	2.64[b]	0.09
Total protein (mg/dL)	6.75[a]	6.17[b]	6.02[c]	0.11
Aspartate amino transferase (u/L)	23.00[a]	19.33[b]	23.33[a]	0.65
Alanine amino transferase (u/L)	19.30[a]	14.67[b]	13.66[c]	0.87
Urea (mg/dL)	19.20[a]	16.73[c]	17.17[b]	0.38
Creatinine (mg/dL)	0.70[b]	0.59[c]	0.71[a]	0.02

[a-c] Means on the same row with different superscripts are significantly ($P<0.05$) different. SEM = standard error of the mean, TPM= *Tetrapleura tetraptera* pod pulp meal

The lipid profile of the sera of weaner boars fed TPM is presented in Table 4. There was significant reduction in high-density lipoprotein (HDL) with increase in TPM. The reverse was the case with low-density lipoprotein (LDL). Very low-density lipoprotein (LDL) and triglycerides (TG) were significantly higher ($P<0.05$) in boars fed 5% TPM than in those fed control and 2.5% TPM, respectively, which differed ($P>0.05$) not. Total cholesterol (TC) showed significant increase ($P<0.05$) in TPM-treated subjects, though not in a dose-dependent fashion. The significantly higher total serum cholesterol and low-density lipoprotein in the experimental weaner boars and the higher value of triglycerides in the sera of those fed 5% TPM are not in agreement with Kuate *et al*., 2015), who reported decreased cholesterol in rats administered a hydro-ethanolic extract of *Tetrapleura tetraptera* pod pulp. Significantly higher total serum cholesterol obtained in the piglets fed TPM could be a pointer to a higher rate of growth and accretion of more body fat. Studies have shown that the intestines, stored lipids in the adipose tissue and anabolic processes constitute sources of blood plasma lipids. It may, therefore be logical to reason that in the TPM-treated piglets, more lipids were mobilized from these sources to the bloodstreams of these piglets for circulation to other body tissues. The significant reduction in HDL with increase in the level of TPM could mean that less of such cholesterol was ferried from extra-hepatic tissues to the liver in piglets so fed. This is in consideration of the role of HDL as the transporter of cholesterol from extra-hepatic tissues to the liver (Beitz, 2004). Low-density lipoprotein is the carrier of cholesterol from the liver to the extra-hepatic tissues. Its significant increase in the sera of weaner pigs fed TPM could imply that the treatment enhanced movement of more cholesterol from the liver to the extra-hepatic tissues. Triglycerides constitute the storage form of fat; and the most significant group of lipids, from the standpoint of energy metabolism (Beitz, 2004). The significant increase of triglycerides in the sera of piglets placed on 5% TPM could be a pointer to faster growth resulting in heavier muscle mass. Higher VLDL in piglets fed 5% TPM could presuppose that more triglycerides were mobilized to extra-hepatic tissues in this group of piglets. Recall that VLDLs function in transporting triglycerides to the extra-hepatic tissues.

Table 4: Lipid profile of weaner boars fed *Tetrapleura tetraptera* pod pulp meal (TPM)

	Treatment			
Parameter	**0.0% TPM**	**2.5% TPM**	**5.0% TPM**	**SEM**
High-density lipoprotein (mg/dL)	66.97[a]	63.83[b]	58.43[c]	1.25
Low-density lipoprotein (mg/dL)	3.77[c]	18.45[b]	18.93[a]	2.49
Very low-density lipoprotein (mg/dL)	29.99[b]	29.84[b]	31.33[a]	0.24
Triglycerides (mg/dL)	149.96[b]	149.19[b]	156.66[a]	1.21
Total cholesterol (mg/dL)	100.72[c]	112.12[a]	108.69[b]	1.69

[a-c] Means on the same row with different superscripts are significantly (P<0.05) different.
SEM = standard error of the mean, TPM= *Tetrapleura tetraptera* pod pulp meal

Conclusions

It is concluded that *Tetrapleura tetraptera* pod pulp meal depressed the haematological indices, compromised the stability of the erythrocytes even in normal saline solution, reduced serum albumin, globulin, total protein, alanine aminotransferase and high-density lipoprotein but increased serum glucose, low-density lipoprotein, very low-density lipoprotein and triglycerides.

References

Adenkola, A. Y. and Oluremi, O. I. A. 2014. Erythrocyte osmotic fragility score in rabbits fed Hibiscus sabdariffa in graded levels. *Nigerian Journal of Physiological Sciences,* 29: 113-117.

Aderemi, F. A. 2004. Effects of replacement of wheat bran with with cassava root sieviate supplemented or unsupplemented with enzyme on the haematology and serum chemistry of pullet chicks. *Tropical Journal of Animal Science*, 7: 147-153.

Adesina, S. K., Iwalewa, E. O. and Imoh, I. J. 2016. *Tetrapleura tetraptera* Taub. Ethnopharmacology, chemistry, medicinal and nutritional values: A review. *British Journal of Pharmaceutical Research, 12(3): 1-22.*

Akin-Idowu, P. E., Ibitoye, D. O., Ademoyegun, O. T. and Adeniyi, O. T. 2011. Chemical composition of the dry fruit of *Tetrapleura tetraptera* and its potential impact on human health. *Journal of Herbs, Spices and Medicinal Plants,* 17:52-61.

Awhin, E. P. 2012. The effect of aqueous extract of *Hibiscus sabdariffa* L. on the activity of alkaline phosphatase and uric acid in the liver of *Rattus novergicus*. *Continental Journal of Medical Research,* 6(1): 12-15.

Beitz, D. C. 2004. Carbohydrate, lipids and protein and amino acid metabolism. In: Goff, J. P. (ed.), Digestion, absorption and metabolism, Duke's Physiology of domestic animals, 12th ed. Comstock Publishing Associates, Cornell University Press, Ithaca and London, pp 501-535.

Cooper, C. A., Moraes, L. E., Murray, J. D. and Owens, S. D. 2014. Hematologic and biochemical reference intervals for specific pathogen free 6-week-old Hampshire-Yorkshire crossbred pigs. *Journal of Animal Science and Biotechnology*, 10, 5(1):5.

Friedwald, W. T., Levy, R. I. and Fredrickson, D. S. 1972. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without the use of the preparative ultracentrifuge. *Clinical Chemistry*, 18:499-502.

Friendship, R. M., Lumsden, J. H., McMillan, I., and Wilson, M. R. 1984. Hematology and biochemistry reference values for

Ontario swine. *Canadian Journal of Complementary Medicine*, 48(4): 390–393.

Hunters, P. A., Dawson, S., French, G. L., Goossens, H., Hawkey, P. M., Kuijper, E. J., Nathwani, D., Taylor, D. J., Teale, C. J., Warren, R. E., Wilcox, M. H., Woodford, N., Wulf, M. W. and Piddock, L. J. V. 2010. Antimicrobial-resistant pathogens in animals and man: prescribing, practices and policies. *JournalofAntimicrobialChemotherapy*, 65: 3-17.

ICRAF. (2002). *Tetrapleura tetraptera*. International Centre for Research in Agroforestry, Kenya, Agroforestry Database.

Ijioma, S. N., Nwankudu, O. N., Ede, N. E., Ibeh, R. C., Ngwu, E. E. 2017. Erythrocyte osmotic fragility and haematological profile of rats administered graded doses of *tetrapleuratetraptera*fruit and *Gongronema latifolium* leaf extracts. https://www.researchgate.net/publication/314749489

Jain, N. C. 1986. Schalm's Veterinary Haematology, 4th edition. Lea and Febiga, Philadelphia.

Jegede, T. 2013. *Haematological reaction of Clarias gariepinus (Burchell 1822) juveniles exposed to Tetrapleura tetraptera leaf powder. The Internet Journal of Toxicology. 10: (1).*

Kamal, A. A. and Hessah, M. A. 2015. Alterations in lipid profile, oxidative stress and hepatic function in rats fed saccharine and methyl salicylate. *International Journal of Clinical Experimental Medicine,* 88 (4): 6133-6144.

Kuate, D., Kengne, A. P. N., Biapa, C. P. N., Azantsa, B. G. K. and Muda, W. A. M. B. W. 2015. *Tetrapleura tetraptera* spice attenuates high-carbohydrate, high-fat diet-induced obese and type 2 diabetes rats with metabolic syndrome features. *Lipids in Health and Disease*, 14:50:1-13.

Kumar, M., Kumar, V., Roy, D., Kushwaha, R. and Vaiswani, S. 2014. Application of Herbal Feed Additives in Animal Nutrition - A Review. *International Journal of Livestock Research,* 4(9):1-8.

Maiworm, A. I., Presta, G. A., Santos-Filho, S. D., de Paoli, S., Giani, T. S., Fonseca, A. S. and Bernardo-Filho, M. 2008. Osmotic and morphological effects on red blood cell membrane:Action of an aqueous extract of *Lantana camara. Brazilian Journal of Pharmacognosy 18(1): 42-46.*

Maxwell, M. H., Robertson, G. W., Spencer and McCongrouodala, C. C. 1990. Composition of haematological values in restricted and *ad libitum* fed domesticated fowls: RBC characteristics. *British Poultry Science*, 60:1474-1484.

Nasyrova, D. I., Ya. Sapronova, A., Nigmatullina, R. R. and Ugrumov, M. V. 2006. Changes in blood plasma volume in rats during ontogenesis. *Russian Journal of Developmental Biology.* **27**:1062-1604.

NRCRI. 2017. National Root Crops Research Institute. *Meteorogical Data*, 2017.

Nwambe, R. N. and Elechi, F. N. 2009. Haematological and serum biochemical indices of broiler finisher birds fed potash boiled bambara groundnut (*Voandzeia subterranea (L*) Thiur) meal as replacement for soybean meal. *Proceedings of the 34th Annual*

Conference of Nigerian Society for Animal Production, 443-445.

Nweze, B. O., Nwankwegu, A. E. and Ekwe, O. O. 2011. Performance of broiler chickens on African Porridge fruit (*Tetrapleura tetraptera*) pod under different feeding regimes. *Asian Journal of Poultry Science,* 5 (4): 144-149.

Odesanmi, S. O., Lawal, R. A. and Ojokuku, S. A. 2010. Haematological effects of ethanolic fruit extract of *Tetrapleura tetraptera* in male Dutch white rabbits. *Research Journal of Medicinal Plants,* 4:213-217.

Okwu, D. E. 2005. Phytochemicals, vitamins and mineral contents of two Nigerian medicinal plants. *International Journal of Molecular Medicine and Advances in Sciences*, 1: 375-381.

Onasanya, G. O., Oke, F. O., Sanni, T. M. and Muhammad, A. I. 2015. Parameters influencing haematological, serum and bio-chemical references in livestock animals under different management systems. *Open Journal of Veterinary Medicine*, **5**: 181-189.

Oyawoye, B. M. and Ogunkunle, H. N. 2004. Biochemical and haematological reference values in normal experimental animals. Masson, New York, 212-218

Saad, E. A. and Habib, S. A. 2013. Effect of crude extracts of some medicinal plants on the osmoticstability of human erythrocytes *in vitro.*The Journal of Free Radicals and Antioxidants. Photon 139: 265-272.

Togun, V. A., Oseni, B. S. A., Ogundipe, J. A., Arewa, T. R., Hameed, A. A., Ajonijebu, D. C., Oyeniran, A., Nwosisi, I. and Mustapha, F. 2007. Effects of chronic lead administration on the haematological parameters of rabbit – a preliminary study. *Proceedins of the 41st Conference of the Agricultural Society of Nig*eria, 341.

Received: 10th April, 2021
Accepted: 15th August, 2021