Haematological and serological indices of crossbred pigs fed different unconventional feeds

[1]Ufuoma Godstime Sorhue, [1]Philip O. Akporhuarho, [2]Adimabua Mike Moemeka, [2]Efe Peterson Irikefe-Ekeke, [1]Ifeanyichukwu Udeh

[1] Department of Animal Science, Faculty of Agriculture, Delta State University, Abraka, Nigeria; [2] Department of Animal Production, Faculty of Agriculture, Dennis Osadebey University, Asaba, Nigeria. Corresponding author: U. G. Sorhue, gtsorhue@yahoo.com

Abstract. This experiment was conducted to investigate the blood parameters of growing pigs fed diet containing different unconventional feed stuffs. A total of 45 growing pigs weighing between 3 - 5 kg were randomly selected from 72 piglets obtained in crossbreeding Duroc and Large White parents. The 45 growing pigs were randomly allotted to 5 dietary treatments. Treatment 1 (Control) contained whole maize, Treatment 2 - Brewers' dried grain, Treatment 3 - Cassava Peel Meal, Treatment 4 - Plantain peel meal, and Treatment 5 - corn husk meal at 35% inclusion level. Parameters evaluated include: red blood cell counts (RBC), parked cell volume (PCV), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin count (MCHC) and total leucocytes (WBC). From the serum, total protein, glucose, urea, and cholesterol were evaluated. In a completely random design, the data were analyzed using the analysis of variance method. Values ranged from 8.87 ± 0.12 (T3) - 12.53 ± 0.22 (T5); 19.20 ± 0.70 (T4) -29.20 (T1) ; 4.67 (T4) ± 0.07 - 6.50 ± 0.21 (T3); 55.27 ± 0.15 (T4) - 87.37 ± 0.43 (T1) ; 26.67 ± 0.33 (T3) - 37.33 ± 0.67 (T5) ; 3.60 ± 0.20 (T1) - 5.20 ± 0.23 (T4) and 33.26 ± 0.37 (T3) - 33.83 ± 0.32 (T4) were obtained for Hb, MCH, WBC, MCV, PCV, RBC and MCHC respectively. Hb, MCH, WBC, PCV, and RBC differed significantly ($p < 0.05$) across treatments while no significant difference ($p > 0.05$) was recorded for MCHC, while values of 5.74 - 7.16, 1.97 - 2.51, 0.90 - 1.05, 12.13 - 13.97 were reported for total protein, cholesterol, glucose, and urea respectively. The serological parameters studied also differed significantly ($p < 0.05$) across treatments for total protein, cholesterol, glucose, and urea. The study shows that plantain peel meal and cassava peel meal negatively affected blood parameters and could pose health challenges to growing pigs when included at higher levels in pig diets.

Key Words: agro-byproducts, blood indices, swine health, unconventional feeds.

Introduction. The physiological statuses of farm animals vary in haematological indices which can be used to assert the pathology of animals when faced with different environmental factors including nutrition. Good haematological and serological indices are indications that the animals are expected to perform well in terms of growth and general performance that is likely to benefit livestock producers (Khan & Zafar 2005; Isaac et al 2013). Most times, stress posed by the environment, pathology of animals, extent of toxicants in feeds, and the status of the animal's health are basically determined using the changes in haematological parameters (Afolabi et al 2010; Oyawoye & Ogunkunle 2004). With the rising awareness on the use of unconventional feeds in pig feeding occasioned by the continuous rise in cost of maize and other grains, scientist have commenced experimenting other alternative feed sources (Moemeka et al 2022; Sorhue et al 2022). It is also worthy to note that farmers use these unconventional feed ingredients without cognizance to the normal physiological and health functions of the pigs (Etim et al 2014). It has therefore become paramount that all the health benefits and/or implications of feeding these agro-industrial by-products be properly understood to proffer solutions that may arise from feed stuffs that may be toxic to pigs by negatively impacting their haematological and serological indices. In this sense, when red blood cell count drops, it is an evidence that the haemoglobin and oxygen level of the blood is low and the more difficult it becomes to convey blood to tissues, in the same way the lungs receives less carbon-dioxide (Ugwuene 2011; Soetan et al 2013; Isaac et al 2013). It is also evident that pigs prone to severe susceptibility to diseases are those reported to have a low level of white blood cells and vice versa, because high white blood cell enables animals to generate more antibodies to fight antigens (Soetan et al 2013; Isaac et al 2013). To our knowledge and from available literatures, blood heath indices of weaned pigs have not been properly compared and reported during different unconventional feeding regime. Hence, this study was designed to examine the blood indices of pigs fed diet containing different unconventional feed ingredients that are used especially by local farmers in pig feeding.

Material and Method

Ethics and approval. This experiment was approved by the Ethics Committee of Department of Animal Science, Delta State University (DELSU - ANS approval number: PhD - 080119).

Experimental site. The experiment was conducted in the teaching and research farm of the Department of Animal Science, Delta State University Asaba Campus, Asaba which is situated in the humid tropical zone of Southern Nigeria. Research took place from February to June 2022.

Experimental animals, diet and design. A total of forty-five (45) growing pigs at ages 3 - 5 months with a body weight range of 9- 14 kg obtained from crosses between Large White and Duroc breeds were used for this study. The animals were raised on a concrete floor. Throughout the course of the experiment, ad-libitum feed and water were given to the animals. The experimental diets and design were followed according to our previous study (Sorhue et al 2022). The 45 growing pigs were randomly allotted to five dietary treatments (Table 1) with each treatment containing 35% of the test ingredients (whole maize, brewer's dried grain, cassava peel meal, plantain peel meal, and corn husk meal), as reported in our previous study (Sorhue et al 2022).

Table 1

Ingredients of experimental diets, (g kg−1) percentage inclusion and calculated composition

Ingredients	*T1*	*T2*	*T3*	*T4*	*T5*
Whole maize	35	0	0	0	0
BDG	0	35	0	0	0
CPM	0	0	35	0	0
PPM	0	0	0	35	0
CHM	0	0	0	0	35
PKC	25	25	25	25	25
Wheat offal	10	21	8	10	9
Fish meal (72%)	2	1	3	2	3
Bone meal	4	4	4	4	4
Salt	0.5	0.5	0.5	0.5	0.5
Premix	0.5	0.5	0.5	0.5	0.5
Soya bean meal	23	13	26	23	23
Calculated Composition					
Crude protein%	20.34	20.47	19.86	20.72	19.29
NFE%	50.68	42.00	50.31	46.61	44.32
Crude fibre%	7.72	13.81	9.79	10.19	16.99
Crude fat%	8.35	9.02	7.65	8.00	8.02
Crude ash%	4.14	5.45	4.06	5.71	4.30

Note: CPM- cassava peal meal, PPM -plantain peel meal, BDG - brewers dried grain, CHM - corn husk meal, PKC - palm kernel cake.

Blood sample collection and analysis. One pig from each replicate was selected at random for blood sampling within the last week of the feeding trial. Water was given on the evening preceding the blood sampling, which was performed in the morning before feeding; 10 ml of blood was drawn from the jugular vein using a sterilized needle and syringe in a sample vial. For this exercise EDTA vials with anticoagulant and another set of normal vials without anticoagulant were used. Approximately 4 ml of the blood sample was placed in the normal sample bottle. The samples in the plain bottle were allowed to clot to obtain the serum that was used in the determination of some serum metabolites as described by Kaneko (1989). Parameters evaluated include: red blood cell counts (RBC), parked cell volume (PCV), haemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin (MCHC) and total leucocytes (WBC). From the blood serum, the following parameters were evaluated: total protein, glucose, urea and cholesterol. The Red Blood Cell (RBC) count was determined with a coulter Electronic counter (Model ZF by coulter Electronics Ltd. London) with values displayed as millions of red blood cells per cubic milliliter of blood (x 106/mm3). The mean corpuscular haemoglobin (MCH) was computed as: MCH = Hb x 10 divided by the red blood cell and expressed in pg. The mean corpuscular haemoglobin concentration (MCHC) was computed as follows: MCHC = Hb x 100 divided by the pack cell volume and expressed in percentages. The white blood cell (WBC) was determined using standard diluting pipettes with an improved Neubauer haemocytometer. The WBC count was expressed in thousands per cubic milliliter (x 103 / mm3). The serological parameters were determined as follows: total serum protein by the Buiret technology, albumin and globulin by the colorimetric technique, urea content by the Berthelot (colorimetric) method, while glucose and cholesterol was analyzed through the enzymatic colorimetric method.

Statistical analysis. All data collected were subjected to analysis of variance (ANOVA) in a complete randomized design using the using the R - Statistical package.

Results

Table 2

Haematological indices and standard errors (SE) of growing pigs fed different unconventional feed sources

	Treatments				
Parameters	*T1*	*T2*	*T3*	*T4*	*T5*
HB	10.47± 0.42^{a}	10.20 0.12^{a}	8.87 ±0.12^{b}	9.70± 0.26^{a}	12.53±0.22^{c}
MCH	29.20± 0.16^{a}	23.60 0.81^{b}	23.97±0.16^{b}	19.20±0.70^{c}	26.10± 0.45^{ab}
WBC	6.03± 0.38^{ab}	5.70± 0.06^{bc}	6.50 ±0.21^{a}	4.67 ±0.07^{d}	5.33± 0.07^{c}
MCV	87.37± 0.43^{a}	70.26± 2.83^{b}	66.53± 0.65^{bc}	55.27±0.15^{c}	77.67± 0.13^{ab}
PCV	31.33± 1.33^{b}	30.33± 0.33^{bc}	26.67± 0.33^{de}	28.67± 1.16^{cd}	37.33± 0.67^{a}
RBC	3.60± 0.20^{d}	4.33± 0.18^{bc}	3.73± 0.24^{cd}	5.20± 0.23^{a}	4.80± 0.00^{ab}
MCHC	33.41± 0.18	33.73± 0.21	33.26± 0.37	33.83± 0.32	33.57± 0.08

Note: HB - hemoglobin content, MCH - mean corpuscular hemoglobin, WBC - white blood count, MCV - mean corpuscular volume, PCV - pack cell volume, RBC - red blood count, MCHC - mean corpuscular hemoglobin content. a, b, c, d - there is a significant difference in the means within a row with different superscripts ($p < 0.05$).

Table 2 shows the haematological indices of growing pigs fed different unconventional feed sources. The mean haemoglobin content values ranged from 8.87 for T3 to 12.53 for T5. Result of analysis of variance showed there were highly significant differences ($p < 0.01$) among the treatments. The values for mean corpuscular haemoglobin ranged from 19.20 for T2 to 29.20 for T1 with highly significant differences ($p < 0.01$) between treatments. The white blood count values ranged from 4.67 for T2 to 6.50. mean corpuscular volume ranged from 55.27 for T2 to 87.37 for T1 with highly significant differences ($p < 0.01$) among the treatment groups. pack cell volume showed highly significant ($p < 0.01$) across treatments with significant differences recorded between T5 and the other groups. red blood count showed highly significant difference ($p < 0.01$)

among the red blood count in the treatment groups. Mean corpuscular haemoglobin content also revealed no significant differences ($p > 0.05$) among treatment groups.

Table 3

Serological indices of growing pigs fed different dietary energy sources

	Treatments				
Parameters	*T1*	*T2*	*T3*	*T4*	*T5*
Total protein	6.48± 0.03^{b}	6.26 ±0.12^{c}	5.74 ±0.03^{d}	6.13 ±0.05^{c}	7.16 ±0.03^{a}
Cholesterol	2.28 ±0.06^{b}	2.07 ±0.15^{c}	2.10 ±0.03^{cd}	1.97 ±0.01^{d}	2.51 ±0.02^{a}
Glucose	0.96± 0.02^{a}	0.96 ±0.04^{a}	1.05± 0.01^{b}	0.90 ±0.01^{c}	0.95± 0.02^{a}
Urea	12.53 ±0.15^{d}	13.43 ±0.12^{bc}	12.13 ±0.07^{d}	13.83 ±0.12^{ab}	13.97 ±0.18^{a}

Note: a, b, c, d - There is a significant difference in the means within a row with different superscripts ($p < 0.05$).

Table 3 shows the serum biochemical properties of growing pigs fed different unconventional diets. The total protein values ranged from 6.13 for T4 to 7.16 for T5 with highly significant differences ($p < 0.01$) among the treatments. The blood cholesterol values revealed a highly significant difference ($p < 0.01$), with values ranging from 1.97 for T4 to 2.51 for T5. The blood glucose levels also revealed that there was highly significant difference ($p < 0.01$) among treatment groups with values ranging from 0.90 for T4 to 1.05 for T3. The urea values ranged from 12.13 for T3 to 13.97 for T5, with significant differences ($p < 0.05$) between treatments.

Discussion

Haematological indices of growing pig fed different unconventional feeds. The haematological indices of pigs in the present study were significantly affected by treatment diet as significant differences ($p < 0.05$) were recorded for treatment groups. The Hb range of 8.87 - 12.53 reported in this study is within ranges reported by Adenkola et al (2009) and Abeni et al (2018), but had lesser values reported by Nsoh (2021), Drews et al (2016) and Olajide et al (2021) in growing pigs respectively. The haemoglobin count of treatment five was similar to 12.20 reported by Ukpabi et al (2015) for pigs fed tiger nut based diet. The mean corpuscular haemoglobin also differed significantly ($p < 0.05$) among treatment groups with range of 19.20 - 29.20 for T4 and T1 respectively. This MCH range is higher than 18.26, 17.50, 16.67 - 17.19, 18.67, 17 - 18, 17.21 in pigs fed 40% cassava peel meal, tiger nut meal, and turmeric powder supplemented diet (Nsoh 2021; Irekhore et al 2015, Ukpabi et al 2015; Alagbe 2017; Jezek et al 2018; Serem et al 2017; Abeni et al 2018), but were within range of 19.98 and 29.30 reported by Abeni et al (2018) and Olajide et al (2021) in growing pigs fed different protein levels and benniseed hull as replacement for maize. The MCH values for benniseed hull are close to the value reported for corn husk meal reported for treatment five in this study. This could be attributable to the similar fibre composition of hull and husk from cereals and legumes. The white blood count from treatment animals were significantly different ($p < 0.05$) with values ranging from 4.67 for T4 to 6.50 for T3. These values are far lower than the range of values reported by other studies (Ukpabi et al 2015; Irekhore et al 2015; Alagbe 2017; Akovbovbo et al 2014; Nsoh 2021; Okah & Ehuriah 2016; Abeni et al 2018) with values of 6.30-16.00, 10.62, 15.09, 16.62, 17.66, 10.20, and 16.62 respectively. The WBC values are low compared to values found in most of the literatures, however, they are close to the baseline values published for pigs as reported by Etim et al (2014). The high differences observed could be attributable to the different feed ingredients used in the diets of the pigs. The mean corpuscular volume was significantly different ($p < 0.05$) among the treatment groups with values ranging from 55.27 for T2 to 87.37 for T1. The values for mean corpuscular volume are all higher than the range of 48.84-51.01 obtained by Ukpabi et al (2015), but are comparable to values of 55.09, 54.4, 54.9, 52.30, 56.58, and 88.15 reported by Alagbe (2017), Nsoh (2021), Jezek et al (2018), Serem et al (2017), Abeni et al (2018) and Olajide et al (2021). The pack cell volume also differed significantly ($p < 0.05$) across treatments groups with values ranging from 26.67-37.33 (T3 - T5) which is within the range of 21.60-36.70, 32, 34.25, 28-37 reported by Ukpabi et al (2015), Adenkola et al (2009), Irekhore et al (2015) and Okah and Ehuriah (2016), though lesser than reports from Alagbe et al (2017), Akovbovbo et al (2014) and Olajide et al (2021) with values of 42, 38.33 and 45.50 in growing pigs fed diet containing turmeric, water hyacinth and benniseed hull respectively. The red blood count values ranging from 3.60 for T1 to 5.20 for T4 are within range of 3.77, 3.80, and 5.00 reported by Ukpabi et al (2015), Irekhore et al (2015), Okah and Ehuriah (2016) and Olajide et al (2021), but were lower than reports from Alagbe et al (2017), Akovbovbo et al (2014), Nsoh (2021), Jezek et al (2018), Serem et al (2017), and Drews et al (2016). The mean corpuscular haemoglobin content did not differ significantly from each other ($p > 0.05$), which is in line with the report of Ukpabi et al (2015), that mean corpuscular haemoglobin content of growing pigs does not differ from each other when fed tiger nut diets at graded level. The range of 33.26 for T3 to 33.83 for T2, is slightly higher than the range of 32.99- 33.16 for MCHC recorded by Ukpabi et al (2015), but were within range of 33.15 - 33.45 reported by Olajide et al (2021). Treatment three and treatment four gave values lower than the baseline values for haemoglobin and pack cell volume, while treatment four alone reported lower baseline values for white blood cell count. The reduced PCV and haemoglobin in treatment three and four may be due to available toxins in the feeds, in addition to the presence of some anti-nutritional factors such as trypsin present in plantain peel and cassava peel diets; this suggest that detoxification of these feed will be necessary towards improving its utilization in pig feeding (Oyawoye & Ogunkunle 1998). The lower RBC counts are indications that the haemoglobin and oxygen level of the blood dropped in the affected treatments, and that could conversely affect blood transport to tissues. PCV, MCH, Hb and MCHC are parameters aiding blood levels, transport of blood, transport of oxygen, and therefore act as major indices for the diagnosis of anaemia (Awodi et al 2005; Chineke et al 2006). Hence the treatment birds with low values for these parameters may be prone to anaemia and vice versa. It is also evident that pigs prone to severe susceptibility to diseases are those reported to have a low level of white blood cells and vice versa, because high white blood cell enables animals to generate more antibodies to fight antigens (Soetan et al 2013; Isaac et al 2013). However, the values obtained in this study are within range of the acceptable baseline values for normal physiological functioning of animals (Etim et al 2014).

Serological indices of growing pigs fed different unconventional feeds. The serological indices of the experimental animals differed significantly ($p < 0.05$) across dietary treatments with values ranging from 5.74 - 7.16, 1.97 - 2.51, 0.90-1.05, and 12.53 - 13.97 for total protein, cholesterol, glucose, and urea respectively. Treatment five recorded the highest values for all the parameters except for glucose value. The values ranging from 5.74-7.16 obtained for total protein are far lesser than 67.62, 91.00, and 67.92 reported by Adenkola et al (2009), Nsoh (2021) and Abeni et al (2018) in growing pigs fed diet containing ascorbic acid, soya bean milk residues, and different protein levels respectively. Interestingly, the values of total protein in this study are in tandem with ranges of 5.0 - 8.7 and 6.66 - 7.08 obtained by Okah and Ehuriah (2016) and Olajide et al (2021). The cholesterol values reported in this study are far lower than the range of 104-124 reported for growing pigs fed benniseed hull based diet (Olajide et al 2021), but were close to the value of 4.14 reported for growing pigs subjected to ascorbic acid treatment (Adenkola et al 2009), however, the report for cholesterol quite agrees with reports of 2.16 - 2.24 and 2.47 - 2.51 reported for growing pigs fed soyabean milk residues and different dietary protein levels respectively (Okah & Ehuriah 2016; Abeni et al 2018). The glucose values reported in the current study is lower than the range of 10.05 - 18.30 and 4.19 reported by (Okah & Ehuriah 2016; Abeni et al 2018). The values reported for cholesterol and glucose in this study are lower than the value reported for growing pigs fed palm kernel cake supplemented with enzyme-based diets. Higher glucose means the carbohydrate present in the feed were readily available for fermentation, but the serum glucose levels in this study were relatively low. The cholesterol values for the treatments is good enough for normal health functioning in

growing pigs, because high cholesterol is detrimental to the arteries, since it inhibits blood flow occasioned by fat deposition in the blood vessels. The range of urea, which is not too high, compared to literatures and baseline values, indicates sufficient, standard and efficient utilization of protein in the diets fed to the pigs, since high urea levels connotes otherwise (Oyawoye & Ogunkunle 1998). However, the urea values of 12.53 - 13.97 are lesser than values of 42.25 - 62.35, but higher than 3.36 - 3.89 reported by (Okah & Ehuriah 2016
; Abeni et al 2018). High urea levels could also be indications of unnecessary muscular expenditures (Adesehinwa 2007). The variations observed in both blood indices with reports from literatures are a confirmation, and pointer to factors such as breed, age, nutrition and climatic differences.

Conclusions. This study concludes that unconventional feeds can be used efficiently in swine feeding provided the level of inclusion does not exceed the range used in our study. Alternatively, by-products such as plantain peels and cassava peels should undergo detoxification before inclusion in swine diets up to 35%, since they both negatively impacted some of the blood indices.

Conflict of interest. The authors declare that there is no conflict of interest.

References

Abeni F., Patrera F., Pra A. D., Rapetti L., Matteo G. C., Galassi G., 2018 Blood parameters in fattening pigs from two genetic types fed diet with three different protein concentrations. Translational Animal Science, 2(4):372-382.

Adenkola A. Y., Ayo J. O., Sackey A. K. B., Adelaiye A. B., 2009 Haematological and serum biochemical changes in pigs administered with ascorbic acid and transported by road for four hours during the harmattan season. Journal of Cell and Animal Biology, 3(2):021-028.

Adesehinwa A. O. K., 2007 Utilization of palm kernel cake as a replacement for maize in diets of growing pigs: Effects on performance, serum metabolites, nutrient digestibility and cost of feed conversion. Bulgarian Journal of Agricultural Science, 13(5):593-600.

Afolabi K. D., Akinsoyinii A. O., Olajide R., Akinleye S. B., 2010 Haematological parameters of the Nigerian local grower chickens fed varying dietary levels of palm kernel cake. In: Proceedings of the 35th Annual Conference of the Nigerian Society for Animal Production; Enugu, Nigeria, pp. 247-251.

Akovbovbo G., Ajuogu P. K., Yahaya M. A., 2014 Haematological response of weaners pigs fed with graded levels of water hyacinths (*Eichornia crassipes*) as feed supplement. International Journal of Advanced Biotechnology Research, 4(2):165-167.

Alagbe J. O., 2017 Growth performance and blood parameters of weaner pigs fed diets supplemented with turmeric powder. Journal of Agricultural Science, 7(2):57-61.

Awodi S., Ayo J. O., Atodo A. D., Dzende T., 2005 Some haematological parameters and the erythrocyte osomotic fragility in the laughing dove (*Streptopella senegalensis*) and the village weaner bird (*Ploceus cucullatus*). In: Proceedings of the 10th Annual Conference of Animal Science Association of Nigeria; Ibadan, Nigeria, pp. 384-387.

Chineke C. A., Ologun A. G., Ikeobi C. O. N., 2006 Haematological parameters in rabbit breeds and crosses in humid tropics. Pakistan Journal of Biological Sciences, 9(11):2102-2106.

Drews J. E., Haese D., João D. H., Lucas L. K., Rafael B. P., Juliano P. M., et al, Saraiva A., Possatti C. D., 2016 Phosphorus on performance, hematological, biochemical, and bone parameters of growing pigs, Ciência Rural, Santa Maria, 46(6):1076-1081.

Etim N. N., Williams M. E., Akpabio U., Offiong E. E., 2014 Haematological parameters and factors affecting their values. Agricultural Science, 2(1):37-47.

Irekhore O. T., Adeyemi O. M., Idowu O. M. O., Akinola O. S., Bello K.O., 2015 Growth performance, haematological indices and cost benefits of growing pigs fed cassava peel meal diets supplemented with Allzyme® SSF. International Journal of Applied Agricultural and Apicultural Research, 11(1&2):51-59.
Isaac L. J., Abah G., Akpan B., Ekaette I. U., 2013 Haematological properties of different breeds and sexes of rabbits. In: Proceeding of the 18th Annual Conference of Animal Science Association of Nigeria; Abuja, Nigeria, pp. 24-27.
Jezek J., Staric J., Nemec M., Plut J., Oven I. G., Kinkon M., Štukelj M., 2018 The influence of age, farm and physiological status on pig haematological profiles. Journal of Swine Health and Production, 26(2):72-78.
Kaneko J. J., 1989 Clinical biochemistry of domestic animals. 4th ed. New York, NY, USA: Academic Press, Inc.
Khan T. A. A., Zafar F., 2005 Haematological study in response to various doses of estrogen in broiler production. International Journal of Poultry Science, 40(10):748-751.
Moemeka A. M., Sorhue U. G., Omeje S. I., Bratte L., Onainor R., Oghenesuvwe O., 2022 Effect of replacing maize with boiled sweet potato on performance characteristics and expression of insulin-like growth factor-1 gene in pigs. Journal of Animal Health and Production, 10(3):293-302.
Nsoh A., 2021 Growth performance, blood profile and carcass characteristics of growing pigs fed diets containing varying levels of soybean milk residue (SBMR). MSc, Kwame Nkrumah University of Science and Technology, Accra, Ghana.
Okah U., Ehuriah S. A., 2016 Haematological and serum biochemical characteristics of weaner pigs fed graded levels of bambara groundnut offal. Nigeria Agricultural Journal, 46(2):138-144.
Olajide R., Asaniyan E. K., Olusegun B. O., Aro S. M., 2021 Haematological and serum biochemical indices of growing pigs fed varying levels of beniseed (*Sesamum indicum* L.) hull in replacement for maize. African Journal of Food Agriculture Nutrition and Development, 21(9):18629-18643. https://doi.org/10.18697/ajfand.104.19245.
Oyawoye E. O., Ogunkunle M., 1998 Physiological and biochemical effect of raw jack bean on broiler. In: Proceedings of 16th Nigeria Society of Animal Production; Abeokuta, Nigeria, pp. 141-142.
Oyawoye B. M., Ogunkunle H. N., 2004 Biochemical and haematological reference values in normal experimental animals. New York, NY, USA: Masson.
Serem J. K., Wahome R. G., Gakuya D. W., Kiama S. G., Gitao G. C., Onyango D. W., 2017 Growth performance, feed conversion efficiency and blood characteristics of growing pigs fed on different levels of Moringa oleifera leaf meal. Journal of Veterinary Medicine & Animal Health, 9(11):327-333.
Soetan K. O., Akinrinde A. S., Ajibade T. O., 2013 Preliminary studies on the haematological parameters of cockerels fed raw and processed guinea corn (*Sorghum bicolor*). In: Proceedings of 38th Annual Conference of Nigerian Society for Animal Production; Makurdi, Nigeria, pp. 49-52.
Sorhue U. G., Israel I. O., Moemeka A. M., Omeje S. I., Udeh I., Idama C. V., Awolowo F., 2022 Effect of unconventional feeds on production cost, growth performance and expression of quantitative genes in growing pigs. Journal of the Indonesian Tropical Animal Agriculture, 47(4):301-317.
Ugwuene M. C., 2011 Effect of dietary palm kernel meal for maize on the haematological and serum chemistry of broiler turkey. Nigerian Journal of Animal Science, (13):93-103.
Ukpabi U. H., Saulawa L. A., Mbachu C. L., Oguike B. C., 2015 Haematological responses of weaner pigs fed raw tiger nut (*Cyperus esculentus*) based diets. In: Proceedings of 20th Annual Conference of Animal Science Association of Nigeria; Ibadan, Nigeria, pp. 837-841.

Received: 27 November 2022. Accepted: 22 December 2022. Published online: 30 December 2022.
Authors:
Ufuoma Godstime Sorhue, Department of Animal Science, Faculty of Agriculture, Delta State University, Abraka, Nigeria, e-mail: gtsorhue@yahoo.com
Philip O. Akporhuarho, Department of Animal Science, Faculty of Agriculture, Delta State University, Abraka, Nigeria, e-mail: okpakophilip@gmail.com
Adimabua Mike Moemeka, Department of Animal Production, Faculty of Agriculture, Dennis Osadebey University, Asaba, Nigeria, e-mail: mikeadison1@gmail.com
Efe Peterson Irikefe-Ekeke, Department of Animal Production, Faculty of Agriculture, Dennis Osadebey University, Asaba, Nigeria, e-mail: efepeterson@gmail.com
Ifeanyichukwu Udeh, Department of Animal Science, Faculty of Agriculture, Delta State University, Abraka, e-mail: drudeh2005@yahoo.com

How to cite this article:
Sorhue U. G., Akporhuarho P. O., Moemeka A. M., Irikefe-Ekeke E. P., Udeh I., 2022 Haematological and serological indices of crossbred pigs fed different unconventional feeds. Porc Res 12(1):25-32.