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Growth, Haematological and Apparent Nutrient Digestibility of Finisher Pigs Fed Toasted Roselle (*Hibiscis sabdariffa L*) Seed Meal Supplemented With Varying Levels of Lysine

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Abstract
A Feeding trial experiment was carried out to evaluate the growth, haematological indices and apparent nutrient digestibility of mixed bred finisher pigs fed diets with toasted roselle seed meal supplemented with lysine. Proximate and energy composition was done to determine the nutrient content of the toasted roselle seed meal (RSM) and the experimental diets. Five diets were formulated and fed to forty finisher pigs in a groups of eight each, each group was divided four times with two pigs per replicate in a completely randomized design (CRD). The diets consisted of control and four other diets in which part of soybean meal were replaced with toasted roselle seed meal at 30% each and were supplemented with 0.25, 0.30, 0.35, 0.40 and 0.45% lysine levels designated as T1, T2, T3, T4 and T5, respectively. Data were collected on the growth performance, haematological indices and apparent nutrient digestibility. The result of growth performance revealed that pigs on diet with 0.30% (T2) lysine level had better final body weight, feed intake and feed conversion ratio. The haematological indices of the pigs showed significant (P<0.05) difference in packed cell volume (PCV) and the red blood cell while other were not. There were no significant (P>0.05) difference in all the parameters of apparent nutrient digested. In conclusion, roselle seed meal up to 30% supplemented with 0.30% lysine level could be incorporated in the diets of finisher pigs without deleterious effects on these production functions.

Key Words*: Growth, Pigs, Supplementation, Toasted, Roselle*

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I. Introduction

Malnutrition has been known to be prevalent in the under-developed countries. Majority of malnourished people live in Asia and Africa and is having a negative impact on their physical and health condition .The problem of malnourishment can be solved through adequate animal protein intake because it is a protein source that is well tolerated and assimilated (Sola-Ojo *et al*., 2013). Ali-Balogun *et al.* (2003) Stated that poor animal protein intake by man has been associated with dwindling livestock productivity.

A significant percentage of animal protein supply in Nigeria had in the past depended on ruminant (cattle, sheep and goats) and to a lesser extent on bush game such as antelopes, deer, hares and other rodents (Vietmeyer, 2005).With a population of over 165 million people and an estimated national population growth rate of 5.7% per annum in Nigeria USAID (2013), a lot of pressure has been put on these meat sources and as such; as it has become clear that these aforementioned animals alone could no longer sustain the growing demand of animals protein. In Nigeria as in most developing countries, the daily dietary intake of animal protein (3.24g) falls grossly short of the recommended 27g animal protein per person per day (FAO, 1993). The daily animal protein intake of individuals in an average of 60kg healthy adult female, and 56g for an average of 75kg male by the (FAO, 2002). Oyawoye, (2002) recommended that Nigeria adopts the production of pigs, poultry and rabbits because of their high productive potential and short generational intervals. However, pigs have economics importance of production over other domestic livestock (like sheep, goats, horses, cattle, rabbits etcetera) in areas like prolificacy, efficiency of conversion to useful products (pork , skin, hair and manure) (Emmanuel, 2011). Pigs have the following attributes which could meet this recommendation, fast growth rate, good feed conversion ratio and high dressing percentage of between 60-80% and is highly prolific, with a high fecundity, farrowing up to 10-15 piglets per litter and two and a half litters a year. They mature early and are

efficient converters of even poor quality feeds to meat for human consumption (Charles, 2009). However, the potential of pig production in alleviating the problem of protein inadequacies in human nutrition in the developing countries of the world is becoming less realizable (Ari, 2012). This has been attributed to high cost, scarcity and insufficient supply of plant and animals protein ingredients such as groundnuts cake, fish meal among others, because of the high level of competition between livestock and man for the same ingredients (Mahadi, 2002 and Admorson,2000).

Intensive approach to pig production would therefore entails the use of alternative plant protein sources other than the conventional ones, which should be cheaper and yet capable of supplying the nutrients required by the animal for optimum growth and production. Roselle (*Hibisus sabdariffa L.*) seed meal could be one of such alternative plant protein, it is the seeds obtained after maturity of the roselle plant meant for making zoboo drink or local soup. It is currently considered as a non-conventional feedstuff in pig feeding and as a valuable protein feed resource *(*Anhwange *et al.,* 2006*). Also* roselle seed (*Hibiscus sabdariffa* L.) is relatively low human preference and demand in Nigeria. The roselle seed contains three times more vitamins C than black – currant (*Ribes nigrum*) and nine times more than citrus (*Citrus sinensis*) fruits. In Sudan, the leaves are eaten green or dried, cooked with onions and groundnuts. In Malaysia, the leaves are also used as tea and as a base for jam (Mat Isa *et al*. 1985; Emmanuel, 2011). The roselle seed is presently sold in Jalingo, Nigeria at one third (₦9000 per bag) of the cost of soyabean seed (₦32,000 per bag) and hence justifies investigation of its use in pig feeding. From the standpoint of economics, availability and nutritional value, roselle seed meal represents an attractive replacement for soyabean meal in the diet of animal (Fagbenro *et al*., 2005). Therefore, the study is aimed at evaluating roselle seed meal in diets of finisher pig

II. Materials And Methods

Study Area

The research was conducted at the Teaching and Research Farm, Department of Animal Production and Health, Taraba State Polytechnic, Jalingo. Jalingo lies between latitude $8^0 11$ to $8^0 5^0$ N and longitude $11^0 05^1$ to $11^0 25^1$E. It has a total area of about 130 km^2 with estimated population of 139,845 (NPC, 2006). And is situated in the northern Guinea Savannah Zone. The state is characterized by tropical climate marked by dry and rainy season, the rainy season usually commences in the month of March and ends up in October, and they dry season then start in late October and ends in March. The annual rainfall is between 1000- 1500mm with an average minimum temperature of 30^0c and maximum temperature of 38^0c depending on the season (Taraba State Diary, 2008

Sources and Processing of Roselle Seed

Roselle seeds were purchased from Hausa trader in Jalingo Central Market. The seeds were cleaned by winnowing and hand picking of stones and debris. The cleaned seeds were subjected to toasting:

Toasted: Raw roselle seeds shared in 30 kg batches were toasted in a local oven like construction of 1.20m high, 2.00 m long and 0.90m wide, with firmly placed frying pan on top; one person on either side toasting at a time, using fire wood as source of energy. The seeds were stirred constantly in the frying pan to ensure the toasting of the seeds uniformly. The toasting continued until a changed in the colour from red to a dark brown with a pleasant aroma was achieved. Seeds were poured on the cement floor to cool before being crushed (0.3-0.7mm) as described by Amaefule and Nwagbara (2004) and incorporated in the diet of pigs. The milled seeds were tagged as toasted roselle seeds meal (TRSM)

Experimental Design and Diets

Five dietary treatments were formulated for finisher pigs. (Table 1). The diets contained 30% toasted roselle seed meal each and supplemented with 0.25, 0.30, 0.35, 0.40 and 0.45% lysine levels respectively, designated as T1, T2, T3, T4 and T5. The pigs were allotted to the five groups of diet with eight pigs each and divided four times with two pigs per replicate in a completely randomized design (CRD).

Experimental Animals and Management

A total of forty mixed bred finisher pigs weighing on the average body weight of 45kg were purchased from the local farmers in Jalingo, Taraba State. The pigs were fed the experimental diet twice daily, in the morning (8:00 am) and afternoon (4:00pm), the wallowing trough contained water at all time while drinking water were provided *at libitum*. The pigs were treated against ecto and endo parasites with ivomectin injection prior to the start of the study. They were prophylactically administered antibiotic (tertracycline LA) injection to ensure good health. Before the start of the experiment, one week adjustment period (adaptation period) was observed, using a common diet.

Table 1: Composition of Finisher Pigs Diets Containing Toasted Roselle Seed Meal Supplemented with Lysine

	Lysine inclusion levels				
	T1	T2	T3	T4	T5
Ingredient (%)	0.25	0.30	0.35	0.40	0.45
Maize	38.50	38.50	38.50	38.50	38.50
Soybean	16.00	16.00	16.00	16.00	16.00
Toasted roselle seed meal	30.00	30.00	30.00	30.00	30.00
Rice offal	10.00	10.00	10.00	10.00	10.00
Bone meal	4.50	4.50	4.50	4.50	4.50
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25	0.25
Calculated Analysis					
Metabolizable energy (Kcal/kg)	2732.01	2732.01	2732.01	2732.01	2732.01
Crude protein	19.71	19.71	19.71	19.71	19.71

*Vitamin/mineral premix from agricare-mix® supplied per kg of died; vitamin A20,000 I4; vitamin D 4,000 I4 vitamin E 39.96I4; vitamin k 5.99mg;Ribofeorin 12mg; vitamin B12 0.1mg; pyridoxine HCL7mg; cal.D. potassium 0.30%; copper 24mg; manganes 110g; Folic acid 2mg; Zing 100mg;selienium 0.3mg; calcium 0.22mg; Iodine 3mg; choline 1000mg; Butylatedhydroxytoleine (BHT) 140Mg and Zeolex 50mg.

Data Collected

Data were collected on the growth performance, (feed intake, final body weight gain and feed conversion ratio), haematological indices and the apparent nutrient digestibility. The feed allowance were split into two with one-half fed in the morning (8:00am) and the other half fed in the afternoon (4:00pm), to avoid feed wastage. Each morning, the left over feed were subtracted from quantity supplied to obtain the daily feed intake. The pigs were weighed to obtain initial weight using an Avery weighing balance (Avery ® England). Weekly gain were determined as the difference between the end of week weight and the initial weight at the beginning of the week; while the daily weight gain were obtained by dividing the weekly total weight gain per treatment by the number of pigs per treatments. Feed conversion ratio were measured as an index of feed utilization for each treatments group and calculated as the ratio of intake to weight gain.

FCR= feed intake/ Body weight gain

At the end of the experiment blood samples were collected from 4 pigs per treatment for the determination of haematological indices. The pigs were randomly selected and fasted overnight before they were bled early in the morning to avoid temporary elevation of blood metabolites by feeding (Bush, 1975).

In order to dilate the ear vein, the ear were gently stroked and soaked alcohol swab was used to clean the ear. The veins were then be occluded at the base of the lateral surface of the ear after which the needle were slid towards the ear for blood collection. Sample for hematology analysis were collected into properly labeled sterile bottles containing 0.2g of EDTA (ethylene diamine tetra-acetate acid) as anticoagulant using 5ml sterile disposable and needles (21guage). The sample tubes were three-quarter filled and inverted repeated after replacing the cap to avoid clotting. The blood samples were analyzed for the following parameters: The pack cell volume, red blood cells, haemoglobin, white blood cells and its differentials, (lymphocytes, neutrophils', eosinophil, basophils, and monocytes) (Baker *et al*., 2000).

The digestibility trial were carried out in the metabolism house, equipped with metabolism metal crates. Each crate measuring 71.5cm x 131cm x 90cm with slated metal floor and was provide with feed and water trough. Directly below the crates was a metal sheet perforations to catch faeces. At the end of the feeding trial, twenty (20) finisher pigs (four per treatment) were randomly selected for the digestibility trial. The pigs were separately kept in the metabolism crates for seven (7) days to acclimatize before data collection began. The pigs were starved for 12 hours prior to the experiment feeding to clear the gut of the previous meals. They were starved for another 12 hours at the end of feeding period to ensure total collection of faeces arising from the diets offered. Faeces were collected separately on a daily basis every morning (7:30am-8:30am). At the end of 7 days collection period, faeces from each replicate were mixed together and representative sample taken for nutrientss determination.

Dry Matter Digestibility (DM) were calculated from the differences between DM intake and faecal DM output expressed as percentage of DM intake. Digestibility of other nutrients were calculated from the differences between the nutrients intake and the nutrients output in the faeces. The percentage of the nutrients (DM, crude protein, crude fibre, ash and either extracts) were estimated according to McDonal and Low. (2002) method as seen below.

Chemical Analysis.
The toasted roselle seeds meal were analyzed for proximate and energy composition (AOAC, 2006).The proximate composition analysis in the laboratory were used to separate the diets into six fractions which are: moisture, dry matter, ash (inorganic matter), crude protein, ether extract, crude fibre and nitrogen extract according to AOAC, (2006) method.

Statistical Analysis
Data generated were subjected to analysis of variance (Steel and Torrie, 1980) using statistix (2003) software means were separated using Tukey option of same software

III. RESULTS A

The results of proximate and energy composition of toasted roselle seed meal revealed that, there was no effect of the processing on the dry matter and the crude protein of the roselle seed, the crude fibre, Metabolizable energy was equally not affected by the processing method.

Table 2: Proximate and Energy Composition of toasted Roselle Seed Meal (on dry matter basis)

	Processed Method
Parameter (%)	TRSM
Dry matter	92.43
Crude protein	29.67
Crude fibre	13.78
Ash	7.43
Ether extract	18.78
Nitrogen free extract	22.77
Metabolizable energy Kcal/kg	3,427.31

TRSM= toasted roselle seed meal.
ME= Metabolizable energy calculated using Pauzenga (1985)
ME= $37^{x}CP+81^{x}EE+35.5^{x}NFE$

The growth performance data (Table 3) showed significant (P<0.05) difference in the final body weight, similarly, the total body weight gain similarly showed significantly (P<0.05) difference across the treatment groups, the average daily weight gain by the pigs followed the same pattern as the final weight gain and the total body weight gain. The total feed intake and the feed conversion ratio of the pigs showed no (P>0.05) variation across the treatment groups.

Table 3: Growth Performance of Finisher Pigs Fed Diets Containing Toasted Roselle Seed Meal Supplemented with Lysine

	Lysine inclusion levels (%)					
Parameter	T1(0.25)	T2(0.30)	T3(0.35)	T4(0.40)	T5(0.45)	SEM
Initial weight (kg)	41.31	41.63	40.94	40.93	41.75	
Final weight (kg)	75.22^{ab}	75.78^{a}	72.85^{ab}	72.43^{ab}	71.78^{b}	0.89*
TBWG (kg)	33.91^{a}	34.15^{a}	32.91^{ab}	31.50^{ab}	30.03^{ab}	0.84*
ADWG(kg)	0.61^{a}	0.61^{a}	0.59^{ab}	0.56^{ab}	0.54^{b}	0.03*
Total feed intake (kg)	123.29	124.68	124.30	116.85	113.40	5.04^{ns}
Feed conversion ratio	3.65	3.65	3.79	3.72	3.79	0.18^{ns}

ab = Means on the same row with different superscript are significantly (P<0.05) different.
*= (P<0.05), NS= not significant (P>0.05), TBWD = Total body weight gain, ADWG = Average daily weight gain.

Table 4: shows the haematological indices, it revealed significant (P<0.05) differences in the packed cell volume, haemoglubin and the lymphocyte, monocyte, eosinophil and the basophil differential. The white blood cell and neutrophils did no differ (P>0.05) across the treatment groups.

Table 4: Haematological Indices of Finisher Pigs Fed Diets Containing Toasted Roselle Seed Meal Supplemented with Lysine

	Lysine inclusion levels (%)					
Parameter	T1(0.25	T2(0.30)	T3(0.35)	T4(0.40)	T5(0.45)	SEM
Packed cell volume (%)	39.99^{a}	42.02^{ab}	42.15^{ab}	45.21^{a}	44.67^{a}	1.31*
Haemoglubin g/dl	14.01^{ab}	14.32^{ab}	13.29^{b}	15.24^{a}	15.13^{a}	0.56*
Red blood cell ($^{x}10^{6}$/µl)	7.09	7.33	7.13	7.41	7.38	0.49ns
White blood cell ($^{x}10^{3}$/µl)	20.49	21.01	20.54	19.81	21.74	0.50ns
Neutrophil($^{x}10^{3}$/µl)	9.33	9.48	10.35	9.61	9.83	0.87ns

Lymphocyte($\times10^3$/µl)	11.31^{ab}	10.56^{b}	11.36^{ab}	12.46^{a}	11.86^{ab}	0.47*
Monocyte ($\times10^3$/µl)	0.49^{b}	0.80^{a}	0.81^{a}	0.71^{ab}	0.77^{a}	0.08*
Eosinophil ($\times10^3$/µl)	0.27^{b}	0.39^{a}	0.36^{ab}	0.31^{ab}	0.35^{ab}	0.04*
Basophil ($\times10^3$/µl)	0.09^{b}	0.19^{ab}	0.26^{a}	0.16^{ab}	0.11^{ab}	0.06*

ab= Means on the same row with different superscript are significantly different, (P<0.05), SEM= Standard error of means, NS =(P>0.05).

The apparent dry matter, crude protein , ash, ether extracts and the nitrogen free extracts digestibility revealed no (P>0.05) variation across the treatment groups except the crude fibre that indicated significant (P<0.05) difference between the control and the other treatment groups.

Table 5: Apparent Nutrient Digestibility of Finisher Pigs Diets Containing Toasted Roselle Seed Meal Supplemented with Lysine

	Lysine inclusion levels (%)					
Parameter (%)	T1(0.25)	T2(0.30)	T3(0.35)	T4(0.40)	T5(0.45)	SEM
Dry matter	81.21	82.12	82.94	83.52	83.72	2.15^{ns}
Crude protein	86.32	86.47	86.92	87.82	87.43	3.74^{ns}
Crude fibre	72.13^{c}	75.14^{bc}	75.89^{abc}	80.02^{ab}	81.79^{a}	2.04*
Ash	74.15	74.32	74.92	75.22	75.62	2.29^{ns}
Ether extract	70.32	71.02	71.92	72.00	72.13	1.44^{ns}
NFE	76.4	76.13	76.92	77.82	80.12	3.07^{ns}

NFE = Nitrogen free extract

abc= Mean on the same row with different superscripts are significantly different (P<0.05)

NS = Not significant (P>0.05)

IV. Discussion

The dry matter (DM) content value of 92.43% recorded was higher than the values (88.37 and 91.32%) reported by Wafar *et a*l (2020) who worked on raw and fermented roselle seed meal but similar to the value 95.17% reported by Onunkwo *et al*. (2019) who used roselle seed cake as replacement for soybean meal in the diet of weaner pigs. However, the result of dry matter (DM) in this study fell below the recommended value (96.76%) for pigs (Abdulrahaman *et al*., 2021). The variation could be as a result of differences in their harvesting period and the processed method used.

The value (29.67%) of Crude protein (CP) content recorded in toasted roselle seed meal was lower than 30.23 and 36.95% for raw and fermented roselle seed meal reported by Wafar *et al.* (2020) and also lower than values of 37% reported by Kwari *et al.* (2011), however, it could be argued that the decreased in crude protein content value of the roselle seed meal in this study compared to other reports may be due to the processed method used and the age at which the plants were harvested (Ukpabi *et al.,* 2019).

The value (13.78%) of crude fibre (CF) recorded in the toasted roselle seed meal were higher than 4.20% reported by Maria (2007) who replaced two conventional protein sources with roselle seed cake in broiler chicken diets. However, the obtained was similar the values of 12.01-14.32% reported by Maffo *et al*.(2014) who worked on the proximate, mineral composition and protein quality of roselle seed cultivated in two different agro ecological areas in Cameroom. The differences between the crude fibre content value of the roselle seed meal in this study and other reports could be attributed to the variation in their age of harvest, soil and climate and the different processed method used.

The ash content value (7.43%) obtained was similar with the ranged values of 5.55-7.03% reported by Anhwange *et al*. (2006) who determined the effects of different processed methods on the minerals value of *Hibiscus sabdariffa* seed but higher than the ranged values of 5.80-6.89% reported by Amin-Ismail *et al*. (2008) who reported on the effects of differently processed method of roselle seed meal on growth and calcium supply needed by monogastric animals. The variation could be attributed to the age and harvesting period of roselle seed (Wantana *et al*., 2008)

The highest ether extracts (EE) value (18.78%) value recorded was higher than the ranged values of 1.84-1.98% reported by Wantana *et al.* (2008) who determined the effect of roselle seed meal on growth performance in post weaning pigs. However, the variation in this study compared to the other reports may be due the differences in the cultivated region of the plants and the method of processing employed.

Nitrogen free extracts (NFE) value of 22.77% recorded was lower than the ranged 37.50-48.10% earlier reported by Owosibo *et al*. (2018) who worked on the effect of graded levels of differently processed roselle seed meal in diets of fingerlings but similarly to the value of 29.33% reported by Amin-Ismail *et al.* (2008) who worked on the nutritional composition, protein quality and health benefits of roselle seed. However, it can be argued that, the nitrogen free extracts value of the toasted roselle seed meal obtained in this study agreed with the recommended value (29.76%) for proper utilization by the monogastric animals especially pig (Ukpabi *et al*., 2019). The variation in this work and other report could due to the processed method used

The metabolizable energy value recorded was similar to the value of 3,311.43 reported by Ebuka and Eke (1990) who stated that higher energy diet support growth rate in pig than the low energy diets. The higher levels of metabolizable energy of rosselle seed meal in this study could be attributed to moderate fibre content of the seed, thus agreed with earlier report of Fatufe *et al.* (2007) who stated that feed intake of non-ruminant is influenced greatly by dietary fibre characteristics.

There tended to be an increase in the final body weight (FBW) of the pigs on T1 and T2 whereas a sloping decrease in those on other treatment groups as the levels of lysine increased from 0.35 to 0.45%. The improved in FBW of those pigs in T1 and T2 shows better utilization of the nutrient in the diets (Shikata *et al*., 2007). The results of FBW recorded showed that all the lysine inclusion levels across the treatment groups improved the FBW of the pigs. The results obtained agreeds with the report of Taiji *et al.* (2015) who stated that both lysine adequacy and excess can increase the weight of pigs compare with the lysine deficiency diet. Also, the results agreed with the report by Civitelli *et al*. (1992) who stated that dietary lysine supplementation of 0.11-0.25% could regulate Ca metabolism, specifically enhancing intestinal Ca absorption thereby improve cells development. The total body weight (TBW) gain by the pigs followed similar pattern as the final body weight.

The average daily weight (ADW) gain showed an increased in those pigs on diets with 0.25 and 0.30% lysine supplementation respectively than those on other treatment groups. The results of the ADW obtained showed that pig's plasma concentration of all the amino acids (AAs) were not affected, however, this finding could be compare with the ealier report of Roy et al. (2000) who discovered that pigs fed diets deficient in lysine hampered cells development.

Reduction in feed consumption were observed when lysine levels exceeded 0.35% but the overall intake by the pigs across the treatment groups were still within the recommended range of 1.10 to 1.98kg/day (Kumar *et al*., 2012). The results obtained is consistent with the assertion by Gary (2016) who stated that improper lysine in the diet could depress intake consequently affecting performance as a result of antagonism with other amino acids (AAs).

Feed conversion ratio (FCR) obtained in all the treatment groups showed adequate balanced and utilization of diets by the pigs, the values of FCR recorded in this study indicated that feed per gain ratio were not hampered by the inclusion levels of lysine. This finding is agrees with the report of Taiji *et al.* (2015) who asserted that unbalanced amino acid (AA) ratio of a diet may cause lack of lysine for body protein synthesis.

The blood packed cell volume (PCV) of the pigs on T4 and T5 showed higher percentage (45.21 and 44.67% respectively) than those on other treatment groups. The PCV percentage values recorded in this study were higher than the ranged of 33.00-39.25% reported by Irekhore *et al.* (2015) for pigs on cassava peel meal supplemented with lysine but, lower when compared with the value (46.38%) reported for pigs on soybean products (Stein *et al*., 2004). The variation between the blood PCV of the pigs in this study and other reports could be attributed to the genetic make-up and breeds pigs used.

The blood haemoglubin (Hb) of the pigs across the treatment groups were statistically different, higher values (15.24 and 15.33g/dl) were recorded in those pigs on T4 and T5 respectively. The values of Hb obtained were higher when compared to the values of 10.25-11.75g/dl for pigs fed cassava peel meal supplemented with lysine at 0.45 and 0.50% (Irekhore *et al*., 2015). The higher values of Hb recorded showed the supplementation of lysine properly balance the amount of other amino acids in the diets (Shangfa *et al*.,2015).

Red blood cell (RBC) Showed that all the pigs across the treatment groups had similar volume, RBC values recorded in this present study were slightly lower than those values (8.07-9.23$^{x}10^{6/}$µl) reported by Amoikon *et al.* (2006) who determined the effect of dietary Chromium tripicolite and lysine on plasma metabolite levels in pigs. However, the values were still within the ranged values of 8.55-8.87 $^{x}10^{6/}$µl suggested by NRC (1998) for pigs.

The values of white blood cell (WBC) were not different across the treatment groups. The results of WBC obtained showed that the similarity could be related to nutritional adequacy and the safety of the test-ingredient with lysine supplementation.

Higher values of dry matter (DM) apparent digestibility percentage by the pigs were recorded across the treatment groups compared to the reports of Zeng *et al*. (2013) and Jose et al.(2019) on diets supplemented with lysine. Excess lysine levels was previously reported to not affect the nutrient apparent digestibility by pigs Yen *et al*.(2005), which is consistent with the results of the present study and thus implied that all the pigs across the treatment groups made better and efficient utilization of the feed nutrients. The better and efficient utilization of the DM by the pig shows that all the lysine inclusion levels supplemented were adequate and enhance utilization by the pigs.

There were statistically no difference in crude protein (CP) digestibility percentage by the pigs on diet with 0.25% lysine supplementation compared to those on higher levels. In previous report by Jin *et al*. (2010), crude protein digestibility decreased as dietary lysine was restricted, it was also found that different dietary lysine levels can affect the apparent nutrient digestibility in finishing pigs (Wang *et al*., 2012). These present results suggested that the dietary lysine levels could enhences the apparent CP digestibility in pigs thus reduced the impact of animal production on the environment.

The results of this study had showed that the ash apparent digestibility percentage by those pigs on diet with 0.25% lysine supplementation were statistically similar with those on higher lysine levels. The results obtained is consistent with the report by Zeng *et al*. (2013) who stated that a reasonable lysine level facilitate the digestion and utilization of feed nutrients by animals. Therefore, the high ash apparent digestibility percentage values recorded shows that all the levels of lysine supplemented were adequate to support metabolic function of the pigs.

The results of ether extract (EE) apparent digestibility percentage by the pigs across the treatment groups showed no differences. The values recorded for EE apparent digestibility percentage were all lower than the ranged of 76.32-80.09% reported by Moon *et al*. (1994), although, no symptom of lysine deficiency were observed in all the pigs and it appears all the diets have no negative on them.

Nitrogen free extract (NFE) apparent digestibility by the pigs showed statistically lower values across the treatment groups when compared to the values 80.09% reported by Zeng *et al*. (2013), the lower NFE values obtained in this study when compared with other reports could be attributed to the breed, genetic capacity, immune stress and differences in AA digestibility between pigs (Kandell *et al*., 2008).

V. Conclusion

It was concluded that roselle seed meal up to 30% supplemented with 0.30% lysine could be incorporated in the diet of finisher pigs without adverse effect on the growth performance, blood indices. Further investigation into higher levels of replacement and supplementation needs to be carried out so as to reduce the cost of pig production.

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