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ORIGINAL ARTICLE

Evaluation and Utilization of Blood Meal Diets by Weaner Pigs Reared under Tropical Environment

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SUMMARY

This study evaluated the effects on growth and cost benefits of substituting soybean meal (SBM) with blood meal (BM) in diets of weaner pigs. Possible pathogenic bacteria contamination and nutritional contents of the BM were determined prior to feed formulation. Four weaner diets (A, B, C, and D) were formulated such that BM replaced SBM at 0.0 (control), 50.0, 75.0, and 100.0%, and fed to 32 Landrace x Large White weaner pigs at 5 % of their body weight. Feed intake, growth rate, feed conversion ratio (FCR), gain: feed and cost benefit of the diets were determined weekly for 20 weeks. Proximate analysis of the BM was determined after 20 - week study. *Bacillus* and *Staphylococcus* species which ranged from 0.00 to 6.70 ± 0.12 x 10^3cfu/g (*Bacillus)* and 0.00 to 4.10 ± 0.34 x 10^3 cfu/g (*Staphylococcus)* were recovered from the BM. Proximate analysis showed that crude protein increased linearly as BM inclusion increased. Energy, ether extract, phosphorus and calcium contents of diets B, C, and D were not affected by the substitution. There was no significant ($P > 0.05$) difference in FCR, daily feed intake and gain: feed among the groups. Diet C significantly ($P < 0.05$) reduced costs per kg diet, improved weight gain and gross margin more than the control. Proximate analysis of the BM after the 20 weeks showed no significant ($P > 0.05$) difference in its initial nutrient composition. Authors recommend replacement of SBM with 75% BM when formulating weaner pig diet in the tropics.

Key words: Swine, bacteria contaminant, pig performance, cost benefits, Nigeria.

INTRODUCTION

Animal studies were carried out following the guidelines of the ethical procedure of the Animal Use and Care Committee of Faculty of Veterinary Medicine, University of Nigeria Nsukka. The research was carried out in 2 studies. Study 1 demonstrated how the BM used was evaluated for possible pathogenic microbial and nutritive contents. Study 2 involved testing the effects of replacing SBM with BM on growth performance of weaner pigs and the cost benefits of this substitution.

Study 1: Processing, microbial evaluation and proximate analysis of the BM.

The blood used in this study was sourced from cattle slaughtered within two months

(January to February) at Nsukka Municipal Abattoir, Nsukka, Nigeria. It was collected with a clean container directly from bleeding animals that were considered healthy after ante-mortem inspection by veterinary personnel. The harvested blood was then immediately processed into meal by boiling in a clean metal drum for about 30 min and thereafter sun-dried and milled. The processed BM was then stored under room temperature in clean air tight plastic containers from where it was collected and used for the evaluations and formulation of test diets.

Microbial evaluation of the BM was carried out at the Department of Veterinary Microbiology and Pathology, University of Nigeria, Nsukka using standard method of counting bacteria (Singleton, 2004). The proximate content of the processed BM was determined at the Nutrition Laboratory of the Department of Animal Science and at Energy Research and Development Centre both at the University of Nigeria Nsukka, Nigeria using standard procedures (AOAC, 1990). Thus, crude protein was determined by Micro Kjaldahl technique (Micro Kjaldahl apparatus, Fibre Technology, Germany); ether extract (fat) was by Soxhlet fat extraction method; crude fibre by the Weede method (Micro Kjaldahl apparatus, Fibre Technology, Germany); net energy was determined by multiplying the carbohydrate content of the BM by a factor of 3.75 as described by Pearson (1976). Calcium and phosphorus were determined by atomic absorption spectrophotometer (Spectronic 20, Bosh and Lomb, England).

Although 10 bags of BM were obtained which weighed 20 kg each, samples were randomly selected and evaluated from 5 bags (n=5) for the microbial and proximate contents indicated. However, only proximate analysis was repeated on the 5 samples previously evaluated at the end of 20 weeks study period. This was done with a view to determining the shelf-life or keeping quality of the BM.

Study 2: Evaluating the effects of replacing SBM with BM on growth performance of grower pigs

Thirty-two weaner pigs of mixed sexes (Landrace x Large White); 17 males and 15 females were selected and used in this study. They were progeny of 4 sows and 1 boar, between the ages of 6.0 to 6.5 weeks and weighing an average of 11.15 kg (range, 11.18 to 12.11 kg). They were acclimatized for 2 weeks prior to the commencement of the study. During this period, the animals were fed same weaner diet and identified by ear notching. Some prophylactic measures were also carried out on them. These measures included deworming using Ivomec Super® (Merial, France); anti-trypanosomal treatment with Trypamiduim-Samorin® (Merial France), and antibiotic cover with Oxytetra® (Pantex, Holland BV). All the drugs were administered once and at the recommended prophylactic doses.

After two weeks of acclimatization, the 32 pigs were taken to grower unit that is fly proof, well ventilated house with concrete floor. The pigs were then randomly divided into 4 treatment groups and assigned to 4 pens with 8 pigs in each group. Each pen measured 4.38 m^2, and was fitted with feeding and watering troughs. Each group was then fed one of the four grower diets A, B, C and D formulated such that the processed BM replaced SBM at 0.0% (Diet A) (control), 50.0 (Diet B), 75.0 (Diet C), and 100.0 (Diet D), respectively (Table I).

Experimental diets were analysed for their nutrient contents including crude protein, ether extract, net energy, calcium and phosphorous using standard procedure as described above for proximate analysis of the processed BM. Diets generally met the NRC nutrient requirements of grower pigs (Kahn and Line 2010b) except in energy which was slightly lower. They were given

feed that was equivalent to 5% of their average body weight, fed twice daily at 0900 and 1600 h

TABLE I: Gross and proximate composition of weaner pig diets formulated by replacing soybean meal with blood meal (as-fed basis)

	Treatments			
Ingredients	T1 (0.0% BM, control)	T2 (50.0% BM)	T3 (75.0% BM)	T4 (100.0% BM)
Dry cassava	31.40	31.40	31.40	31.40
Maize offal	15.20	15.20	15.20	15.20
Rice husk	10.10	10.10	10.10	10.10
Palm kernel cake	30.60	30.60	30.60	30.60
Soya bean cake	10.00	5.00	2.50	----
Blood meal	----	5.00	7.50	10.00
Bone meal	1.00	1.00	1.00	1.00
Calcium carbonate	1.10	1.10	1.10	1.10
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Salt	0.10	0.10	0.10	0.10
Vitamin premix	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Proximate				
Crude protein (%)	19.18	20.14	21.56	23.35
Net. energy (Kcal/kg)	2945	2965	2884	2894
Crude fibre (%)	5.68	5.03	5.00	5.01
Ash (%)	4.08	4.02	4.15	5.00
Ether extract (%)	4.01	5.14	4.42	5.00
Calcium (%)	1.02	1.00	0.99	0.98
Phosphorus (%)	0.74	0.57	0.63	0.65

[a] (Mineral/vitamin premix) supplied the following per kg of the diets: vitamin A, 10,000 iμ; vitamin D3, 15,00 iμ; vitamin E,3g; B1,2.0 mg; B_6, 1.2 mg; Vitamin K,3.2 g; Vitamin B_{12},0.12 μg; Pantothenic acid, 7.0 mg; Nicotinic acid, 8.0 mg; Folic acid, 0.06 mg; Sodium chloride, 500 mg; Fe, 60 mg; Mn, 80 mg; Mg. 100 mg; Cu, 8.0 mg, Zn, 50 mg; Co, 0.45 μg, I, 2.0 mg and Sc, 0.1m

(Onyimonyi, 2002), respectively for 20 weeks, and had free access to clean drinking water. Data on the effects of the test diets on their feed intake, feed conversion ratio (FCR), growth rate, gain: feed, and cost benefits were collected at 2- week interval.

The weight gain of pigs and feed intake were determined using a hoist scale (Diamond, Taiwan) by subtracting respective weights (kg) at the previous 2 weeks from the weights (kg) at the following weeks. Daily feed intake and weight gain were then determined by dividing the 2 weeks weight and feed intake by 14. Food conversion ratio was determined on as-fed basis by dividing the feed consumed in 2 weeks in kg by live weight gained (kg) within the same period. Similarly, gain: feed were the inverse of FCR.

To determine the cost benefits of the experimental diets, the method as described by Amaefule *et al. (*2006) was used. Thus, cost per kg of the diet was calculated by multiplying the percentage of the feedstuff with the price per kg of each feedstuff and summing up all. The total feed cost was determined by multiplying the cost per kg weight of feed by the feed intake. Feed cost per kg weight gain was also determined by

progressed and its location also differs from other domestic animals investigated including camel, cattle, pig and sheep (Venzke 1975; Hajovska, 2002; Dyce *et al*., 2002). It was attached dorsolaterally to the larynx in all age groups studied. Its position varied between cricoid cartilage of larynx and 12th tracheal rings during the developmental period. The two lobes were multiplying FCR by cost per kg of each diet. Similarly, cost of feed was assumed to be 80% of total cost of production; profit or gross margin was therefore calculated as price per kg of pork minus total cost of producing 1 kg life weight of pork.

Statistical Analysis

Data recorded including feed intake, FCR, weight gain, gain: feed and cost benefits were analyzed by one-way analysis of variance (ANOVA) in a completely randomised design (CRD) using SPSS data editor version 17. Each pen was considered as the experimental unit while the effect of blood meal diets (treatments) was considered as the experimental model. Significant differences in means were separated by Duncan's multiple range tests as found in the computer package and significance was accepted at $P < 0.05$.

RESULTS

Bacillus and *Staphylococcus* bacteria contaminants were recovered from the BM after incubation. These bacteria species ranged between (mean ± SD) 0.0 to 6.70 ± 01 x 10^3cfu/g and 0.0 to 4.10 ± 0.34 x 10^3cfu/g for *Bacillus* and *Staphylococcus species*, respectively.

The results of the proximate analysis of the BM showed that its protein and energy contents were 65.10% and 2, 932.04 kcal/kg, respectively. Similarly, values of 95.45, 2.00, 0.49 and 0.59% were noted for dry matter, ether extract, calcium and phosphorus, respectively (Table I).

Analysis of the processed BM used at the beginning (week 0) and end (week 20) of study period showed no significant ($P > 0.05$) difference in their nutrient compositions (Table II). The mean 2 - week gain: feed of the experimental animal groups showed that it was low at the beginning (weeks 2 to 4) and end of the observation period (weeks 18 to 20). Subsequently, a gain: feed range of 0.140 ± 0.02 to 0.670 ± 0.01, 0.140 ± 0.04 to 0.510 ± 0.02, 0.150 ± 0.02 to 0.570 ± 0.03 and 0.160 ± 0.02 to 0.560 ± 0.01 were obtained for groups A, B. C and D, respectively. Generally, gain: feed did not show much variation among the four treatment groups within the trial period (Table III). There was a linear reduction in cost per kg feed produced as the level of SBM replacement with BM increased (Table IV). Total cost of feed was lowest at 100.0 % level of BM inclusion, diet C (75.0%

TABLE II: Analytical composition of blood meal used (n=5) $^{\beta}$ to substitute soybean meal in formulating weaner pig diets at onset and end of the study 20 weeks period (mean ± SD)

Nutrients	Composition at week 0	Composition at week 20
Crude protein (%)	65.10 ± 2.40 ^{a}	66.58 ± 1.25 ^{a}
Net energy (kcal/kg)	2,932.04 ± 12.0 ^{a}	2,899.01 ± 10.1 ^{a}
Crude fiber (%)	1.40 ± 0.01 ^{a}	1.40 ± 0.00 ^{a}
Ash (%)	4.00 ± 0.00 ^{a}	3.78 ± 0.05 ^{a}
Ether extract (%)	2.00 ± 0.01 ^{a}	2.17 ± 0.03 ^{a}
Dry matter (%)	95.45 ± 0.05 ^{a}	93.00 ± 0.04 ^{a}
Calcium (%)	0.49 ± 0.01 ^{a}	0.49 ± 0.00 ^{a}
Phosphorus (%)	0.59 ± 0.00 ^{a}	0.58 ± 0.02 ^{a}

^{a} Values with same superscripts are similar ($P < 0.05$; ANOVA)

$^{\beta}$ Number of samples analysed out of 10 bags of BM processed

TABLE III: 2 - week gain - feed ratio of grower pigs [Þ] (n=32) fed soybean replaced blood meal diets

Experimental Period (Weeks)	Dietary treatment A (0.0 %BM)	B (50.0 % BM)	C (75.0 % BM)	D (100.0 %BM)
2	0.230 ± 0.15 [a]	0.330 ± 0.01 [a]	0.300 ± 0.02 [a]	0.300 ± 0.01 [a]
4	0.270 ± 0.07[a]	0.220 ± 0.00[b]	0.210 ± 0.03[a]	0.240 ± 0.01[b]
6	0.450 ± 0.00[b]	0.460 ± 0.01[b]	0.570 ± 0.03[a]	0.400 ± 0.05[b]
8	0.670 ± 0.01[a]	0.510 ± 0.02[b]	0.450 ± 0.01[a]	0.560 ± 0.01[b]
10	0.560 ± 0.01[a]	0.450 ± 0.04[b]	0.530 ± 0.01[a]	0.450 ± 0.01[b]
12	0.450 ± 0.01[a]	0.350 ± 0.01[a]	0.300 ± 0.02[b]	0.390 ± 0.02[a]
14	0.310 ± 0.01 [a]	0.350 ± 0.00 [a]	0.300 ± 0.03 [a]	0.390 ± 0.01 [a]
16	0.390 ± 0.01 [a]	0.350 ± 0.01 [a]	0.300 ± 0.01 [a]	0.390 ± 0.03 [a]
18	0.180 ± 0.01 [a]	0.140 ± 0.04 [a]	0.200 ± 0.01 [a]	0.210 ± 0.02 [a]
20	0.140 ± 0.02 [a]	0.160 ± 0.04 [a]	0.150 ± 0.02 [a]	0.160 ± 0.02 [a]

[ab] Values with different superscripts differ (P < 0.05; ANOVA)
Þ 8 pigs per treatment/pen

TABLE IV: Growth performance and economy of replacing soybean meal with blood meal in formulating grower pig (n=32) diets (mean ± SD)

Parameters	Treatment A (0.0 %BM)	B (50.0 % BM)	C (75.0% BM)	D (100.0 % BM)
Initial weight of pigs (kg)	11.88 ± 0.00 [a]	12.11 ± 0.13 [a]	11.18 ± 0.04 [a]	11.58 ± 0.09 [a]
Total feed intake (Kg)	1250.00 ± 15.14[b]	1096.90 ± 21.22[c]	1319.80 ± 31.20[a]	1068.20 ± 25.00[c]
Daily feed intake (kg)	8.92 ± 1,23 [a]	7.84 ± 0.14 [a]	9.42 ± 2.01 [a]	7.63 ± 4.21 [a]
Mean FCR	3.98 ± 0.52[a]	4.59 ± 0.31[b]	3.40 ± 0.24[a]	4.12 ± 0.26[b]
Av. daily weight gain (g)	490 ± 21.98[b]	420 ± 13.88[b]	530 ± 17.36[a]	410 ± 22.90[b]
Av. gain: feed	0.357 ± 0.04[a]	0.362 ± 0.02[a]	0.321 ± 0.01[a]	0.347 ± 0.08[a]
Final weight of pigs (kg)	68.57 ± 4.80[b]	59.95 ± 1.27[c]	73.64 ± 2.01[a]	57.92 ± 3.11[c]
Cost per kg feed (₦)	24.49 ± 1.20[a]	23.33 ± 1.00[a]	21.24 ± 6.23[b]	19.16 ± 2.12[b]
Cost of feed / kg weight gain (₦)	108.04 ± 2.13[a]	107.08 ± 5.10[a]	72.22 ± 4.00[c]	78.94 ± 3.41[b]
Total cost of feed (₦)	34,362.50 ± 58.28[a]	23,590.68 ± 51.12[c]	28,032.55 ± 73.00[b]	20.466.71 ± 42.11[c]
Total cost of prod. 1 Kg pork (₦)	135.05 ± 9.00[a]	133.85 ± 9.47[a]	90.28 ± 8.20[c]	98.68 ± 8.00[b]
Price per kg pork [€] (₦)	400.00	400.00	400.00	400.00
Gross margin (₦)	264.95 ± 5.12[b]	266.15 ± 6.41[b]	309.72 ± 8.40[a]	301.32 ± 9.11[a]

[abc] Values with different superscripts differ (P < 0.05; ANOVA)
[χ] Feed conversion ratio = feed consumption (kg) / live weight gain (kg)
¥Gain: feed = weight gain (kg)/live weight gain (kg)
[€] Price per kg was the prevailing market price for 1 kg of pork at the time of this study

BM) significantly (P < 0.05) reduced total cost per live weight gain, total cost of producing 1 kg pork and increased financial return or gross margin more than any other treatment group (Table IV).

DISCUSSION

The results obtained from this study indicate that the method used for the processing of the BM before it utilisation in the formulating the weaner pig diet had the advantage of reducing possible pathogenic bacteria build up. The fact that *Salmonella* and other pathogenic bacteria species which are generally ubiquitous in nature were absent in the samples screened in spite of the fact that blood is a good medium for their growth may be attributable to this boiling process. The two bacteria identified (*Bacillus* and *Staphylococcus)* could be free living and not the pathogenic species. This is in view of the fact that they did not pose any recognizable health hazard as all the experimental animals used remained healthy throughout the study period. This observation supports an earlier report that *Salmonella* organisms in organic feedstuffs are damaged by heating at 80^{o}C for 15 min (Radostits *et al.,* 2003).

Comparing the proximate analysis of the processed BM used at the beginning (week 0) and end (week 20) of study period showed no significant difference in their nutrient compositions (Table II). The present processing and storage methods which was able to keep the BM stable for a period of five months lays credence to the earlier claim of Mann (1984), that boiling for 20 to 30 min and sun drying reduces bacteria load in BM and helps to preserve it.

It is important to note that the BM used in this study was processed during the months of January and February (dry season), and feed trial conducted within the months of March to July (mainly rainy season). The stability in the nutrient composition of the BM is an indication that BM processed and stored using the present methods could be used for a period of five months. This could also imply that during the dry season in the tropics when there is abundant sun shine, blood could be harvested from the abattoirs, processed and stored using the present methods and thereafter used during the rainy season. During this period of the year, the weather will no longer be favourable to this method of processing in many tropical countries except with the use of all weather solar drying machine (Mann, 1984). This equipment may however be beyond the reach of many pig farmers due to non availability, high cost or both.

The results of the proximate analysis of the BM showed that its dry matter of 95.45%, ether extract of 2.00% and energy content of 2,932.04 kcal/kg were respectively comparable to values of 93.00%, 1.5% and 2,900 kcal/kg noted for the same parameters in BM by other researchers (Pearsons *et al.*, 1985). Similarly, values of 0.49 and 0.59% noted for calcium and phosphorus in this study were close to 0.48 and 0.61% earlier reported in locally processed BM (Mann, 1984). However, crude protein content of 65.10% we obtained was lower than the crude protein range of 84.90 to 94.10% obtained respectively from flash and spray BM through other advanced methods (Cromwell, 2009). These variations may be attributed to the differences in processing methods which some authors have acknowledged could cause variations in nutrient quality of BM (Pearsons *et al.*, 1985; Cromwell, 2009). The variations notwithstanding, the present method could still be recommended for pig farmers particularly those in the tropics in view of the fact that it is simple and can easily be applied. The proximate composition of the formulated diets showed that their crude protein content increased with increasing percentage replacement of SMB with BM (Table I). The crude protein and energy range values of 20.14 to 23.35%; 2884 to 2965 Kcal/kg obtained for BM included diets (B,C and D) in present study were within the limits of 20 to 23% and 2800 to 3000 Kcal/kg previously recommended for growing/fattening pigs in the tropics

(Onyimonyi, 2002). Similarly, macro elements present in the diets were comparable with the values recommended for grower pigs thus; calcium content range of 0.98 to 1.00% and phosphorus range of 0.57 to 0.65% compared favourably with 0.45 to 0.90% and 0.40 to 0.70% calcium and phosphorous requirements for growing pigs (Kahn and Line, 2010a).

There is no doubt from these findings that inclusion of BM in the formulation of swine diet potentiates its quality. Although the energy values were below the NRC recommended standard (Kahn and Line, 2010a) and differences in the values of ether extract and ash appear negligible, many authors recommend that livestock diets based on BM as sole source of protein should be further fortified so as to enhance their quality (Fombad and Bryant, 2004; Seifdavati *et al.,* 2008).

The low gain: feed noted among the four experimental groups at the beginning and end of study period (Table III), was probably due to low feed intake we observed within these periods. Since the introduction of the experimental diets was abrupt, the reduced feed intake could probably be as a result of gradual adaptation to the new diets or period required by the animals to get used to eating BM diets (Seifdavati *et al.*, 2008). Again, some of the pigs attained puberty towards the end of the study and were observed to manifest symptoms of oestrus or heat such as swelling and reddening of the vulva, mounting of pen mates, fence walking, i.e. restlessness (Kahn and Line, 2010b). The second phase of low gain: feed recorded could be attributed to the fact that, while the pigs were exhibiting these symptoms, they become less interested in their feed. Notwithstanding, average daily weight gain range of 410 to 530g recorded in the present study is close to 509 to 524g reported among Duroc x Yorkshire/Large White) x Landrace breed (Chen *et al.*, 2005), and greater than 290 to 347g reported in piglets fed yeast (*Saccharomyces cerevisiae*) incorporated diets (Mathew *et al.,* 1998).

Animals in group C significantly ($P < 0.05$) consumed higher total amount of feed, gained higher average daily weight and subsequently attained higher final weight than other 3 groups (Table IV). No significant dietary treatment effects were observed in their average daily feed intake and overall gain: feed, although these parameters tended to have favoured those on diet C (Table IV). Generally pigs fed with BM included diets (B, C, and D) compared favourably with those in the control group (diet A). Similarly, there was no significant ($P > 0.05$) difference in overall FCR of animals in groups B (50.0% BM) and D (100.0% BN) when compared to those fed the control diet A (0.0%BM).

Replacement of SBM (10% of total feed) with 75.0% BM is equivalent to BM comprising 7.5% of total feed. This value is fairly higher than the 6.0% inclusion level recommended for grower pigs (Ilori *et al.,* 1984). Similarly, the performance of pigs fed diet C in the present study also contradicts the former recommendation that to improve performance, replacing SBM with BM should not go beyond 3.0 to 4.0% of the total feed during the growing period in pigs (Fombad and Bryant, 2004). From this study, it is possible that replacement of SBM with 75.0% of BM in the diet provided a better amino acid balance, improved quality and palatability more than the other two levels of substitution and the control. This is in view of the fact that the animals in this group relished and consumed more feed than others. This observation contradicts the reports of other studies (Owen *et al.,* 1995; Caffey *et al.,* 2001) that palatability is a major impediment to the use of BM beyond 4.0% in formulating pig diets. Therefore, under tropical environment, it may be argued that processing methods used and environmental factors could determine suitability and level of BM that need to

be used to replace SMB, when formulating grower pig diets.

The general lower cost of diets B, C, and D than the control diet A could be as a result of the high cost of SBM compared with negligible cost of processing and availing replacement BM. The cost per kg of SBM which was ₦110.00 appears to be very high when compared with ₦26.62 for the BM in this study. This supports previous observations that inclusion of unconventional feed ingredients in formulating livestock diets significantly reduces cost of feed (Amaefule *et al.,* 2006; Tyus *et al.,* 2008; Aka *et al.,* 2009). The findings of this study tend to suggest that, when SBM is substituted with BM in diets of grower pigs, a threshold is reached beyond which performance no longer can be noticed. The superiority in performance of pigs fed diet C over the other two groups (B and D) appears to support this and suggests that replacement at 75.0% is the optimal level of replacement.

CONCLUSION

This study highlighted the conversion of food animal blood which is wasted in many tropical countries to useful component of swine feed. Authors believe that proper harnessing of blood of food animals using the present method will add value to it. This could be a source of job creation if many jobless people get involved in its processing and sale to potential pig farmers. Under the conditions of this study, blood of slaughtered food animals can be processed at the dry season (November to March), used immediately by pig farmers or stored and utilised during the wet season (April to October). Diet C significantly improved growth performance, reduced cost of pig production and increased gross margin more than the other three diets. Authors therefore recommend that under tropical environment, BM could be used to replace 75% SBM when formulating grower pigs' diet.

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REFERENCES

ABONYI, F.O. and OMEKE, B.C.O. (2013): Effects of feeding locally processed blood meal diets on reproductive performance of pigs. *Indian Journal of Animal Research,* **47** (4): 367-370.

AKA, L.O. OBIDIKE, R. I., IGBOKWE, C.O. and EZEMA, W.S. (2009): The effect of feeding different prepared breadfruit (*Artocarpus altilis*) on the haematology, serum biochemistry, liver and relative organ weights in albino rats. *Nigerian Veterinary Journal*. **30**: 26-34.

AMAEFULE, K.U., ONWUDIKE, O.C., IBE, S.N. and ABASIEKONG, S.F. (2006): Performance, cost benefit, carcass quality and organ characteristics of pigs fed high graded levels of brewers dried grain in humid tropics. *Pakistan Journal of Nutrition*. **5**: 242-247.

AOAC (1990): Official methods of analysis, 15th edition. Association of Analytical Chemists, Washington D C.

AYINDE, I.A. and AROMOLARAN, A.B. (1998): Economics of rabbit production in Abeokuta South Local Government Area of Ogun State Nigeria. *Nigerian Journal of Animal. Prouction,* **25**: 100-105.

CAFFEY, R.D. and CROMWELL, G.L. (2001): Use of spray–dried plasma in diets for weanling pigs. Pig News and Information. **22**: 39 – 48.

CHEN, Y.J. SON, K.S., MIN, B.J., CHO, J.H., KWON, O.J. and KIN, I.H. (2005): Effects of dietary probiotics of growth performance, nutrient

digestibility and feed noxious gas content in growing pigs. *Asian-Australian Journal of Animal Science*. 18: 1464-1468.

CROMWELL, G.L. (2009): National Renderers Association. In: Rendered products in swine nutrition. Available at http://nationalrenderers.org/nutrition/swine.pdf Accessed 26 November 2012.

FOOD AND AGRICULTURAL ORGANIZATION [FAO] (1990): The Nutrition profile: Nigeria, FAO, Rome.

FOMBAD, R.B. and BRYANT, M. (2004): Effects of cotton seed based diets supplemented with blood meal alone or with lysine on growth of pigs. *Tropical Animal Health and Production*. 36: 385-395.

ILORI, J.O. MILLER, E.R., ULLREY, D.E., KU, P.K. and HOGBERG, M.G. (1984): Combination of peanut meal and blood meal as substitution for soya bean in corn based growing finishing pig diets. *Journal of Animal Science*. 59: 394-399.

INYANG, C.O. and OREWA, S.I. (2009): Determination of daily protein intake among rural and low-income urban households in Nigeria. *Journal Sci. Resources*. 4 (4): 290-310.

KAHN, C.M. and LINE, S. (2010a): Management of reproduction: pigs. In: The Merck Veterinary Manual. Kahn C.M and Line S. (Ed), 10th edition. Merck and Co. Inc, Whitehouse Station N.J., USA: 1939-1948.

KAHN, C.M. and LINE, S. (2010b): Nutritional requirements of the pig. In: The Merck Veterinary Manual. Kahn C.M and Line S. (Ed), 10th edition. Merck and Co. Inc, Whitehouse Station N.J., USA: 2066.

MANN, I. (1984): High-protein feed from blood and ruminal contents using a solar drier. *World Animal Review*. 50: 24–28.

MATHEW, A.G., CHATTIN, S.E., ROBBINS, C.M. and GOLDEN, D.A. (1998): Effect of direct-fed yeast culture on enteric microbial populations, fermentation acids, and performance of weanling pigs. *Journal of Animal Science.* 76: 2138-2145.

ONYIMONYI, A.E. (2002): Nutritional evaluation of cassava peels and Bambara waste in pig diet. PhD Thesis, University of Nigeria Nsukka, Nigeria.

ONYIMONYI, A.E. and UGWU, S.O.C. (2007): Bio-economics of broiler chicks fed varying rations of cassava peels/bovine blood meal. *International Journal of Poultry Science.* 6: 318-321.

OWEN, K.O., NELSSEN, J.I., GOODBAND, R.D., TOKACH, M.D., KATS, L.J. and FRIESEN, K.G. (1995): Added dietary methionine in starter pig diets containing spray dried blood products. *Journal of Animal Science.* 73: 2647 – 2654.

PARR, T.M., KERR, B.J. and BARKER, D. (2004): Isoleucine requirements for late-finishing (87 – 100kg) pigs. *Journal of Animal Science*. 82: 1334 – 1338.

PEARSON, D. (1976): Legal requirements; the chemical analysis of foods. 7th edition, Medical Division of Longman Group Limited, Edinburgh, London: 185.

PEARSONS, M.J. and MILLER, E.R. (1985): Lysine availability in flash dried blood meals for swine. *Journal of Animal Science.* 60: 1447 – 1453.

RADOSTITS, O.M., GAY, C.C., BLOOD, D.C. and HINCHCLIFF, K.W. (2003): Diseases caused by Salmonella spp. In: Veterinary Medicine a textbook of the diseases of cattle, sheep, pigs, goats and horses. Radostits, O.M., Gay, C.C., Blood, D.C and Hinchcliff, K.W. (Eds), 9th edition. WB Saunders, an imprint of Elsevier Science Limited, 90 Tottenham Court Road London: 829-890.

SEIFDAVATI, J., NAVIDSHAD, B., SEYEDSHARIFI, R. and SOBHANI, A. (2008): Effects of locally produced blood meal on performance, carcass traits and nitrogen retention of broiler chickens. *Pakistan Journal of Biological Sciences*. **11**: 1625-1629.

SINGLETON, P. (2004): Bacteria in biology, biotechnology and medicine. Biotechnology and Medicine. Singleton P. Southgate (Ed), 6th edition. Wiley and Sons Limited, Chichester, West Sussex, England: 42-43.

TYUS, J. I. MAHASHONI, S. N. ADELOPE, N. and WRIGHT, D. (2008): Growth performance of single comb White Leghorn chicks fed diets containing blood meal supplemented with isoleucine. *Journal of Poultry Science.* **45**: 31-33.