Processing, Chemical, and Amino Acid Determination of Rumen Epithelial Scrappngs as Potential Protein Feedstuff for Poultry.

Philip C.N. Alikwe, Ph.D.

Livestock Production Technology Department, Niger Delta University, Wilberforce Island, PMB 071, Yenagoa, Bayelsa State, Nigeria.

E-mail: agricbiochem2011@gmail.com
Telephone: +234-813-425-3682

ABSTRACT

A chemical trial was conducted to assess the proximate, mineral and amino acid composition of Rumen Epithelial Scrappings Meal (RESM) as a novel unconventional feed ingredient so as to enhance livestock development. Rumen Epithelial Scrappings were harvested at the abattoir processed and analyzed for its nutrient constituents using internationally established procedures. The results showed that the sun and oven dried RESM had 53% and 64.03% CP which was comparable to meat meal (55%CP) and Ca (3.89%), P (0.92%), Zn (44.39ppm), Iron (145ppm), and Cu (6.85ppm) which were lower than that of meat meal. Quantitative chromatic analysis of RESM hydrosylates revealed 17amino acid which meets the minimum requirement (NRC) for broiler birds and in comparing its amino acid with those of hen's eggs shows a higher superiority in Threonine, Valine, Phenylalanine, Histidine, and Tryptophan but a deficiency in Lysine, Methionine, Arginine, and Leucine. The results of this study showed that RESM possess an appreciable quantities of all the dietary elements tested for, which could make them partial or complete substitutes for the conventional feed sources.

(Keywords: nutrient composition, unconventional animal protein, livestock industry, animal feed)

INTRODUCTION

In poultry production, feed constitutes 70-80% of the total cost of production (McNab and Shannon, 1972) and the growth of the industry in Nigeria has been militated against by scarcity and high cost of conventional feed ingredients most especially the (protein sources such as fish meal, meat meal, casein, milk by-products, groundnut cake, soybean cake, etc.) and of finished feeds. Therefore, with ever increasing demand for protein sources coupled with high cost of imported fish meal, attention is been shifted to non-conventional feed stuffs.

The non- conventional feedstuffs are of considerable variable materials emanating from agricultural and industrial processing as by-products such as food and non- food industrial wastes. The processing (rendering) method must be economically feasible and adaptable to low technological inputs; it must also be safe for both man and livestock. Karzimerz *et al*. (2003) indicated that processing techniques of NCF's can be done by autoclaving under pressure, mechanical or thermal condensation and drying, hydrothermal, acid and alkali hydrolysis or by microbiological and chemical souring. Microbiological and Chemical souring techniques are used to prepare most agricultural by-products and are effective methods of removing harmful substances, for example, isothiocyanates from rape, souring of skim milk and whey, preserving by-products of animal origin such as blood, rumen content, animal and poultry excrements which are now used as feed ingredients (Karzimerz *et al*., 2003) but Olomu (2011) indicated that most meat by-products are processed by wet or dry rendering or drying before grinding. In livestock production, agro-industrial by-products can be used as either major or subsidiary protein or energy sources in animal ration. Gomez (1983) observed that research into utilization of NCF's in poultry feeds requires the development of a general scheme, whereby promising NCF's are assayed and processed for nutritional composition and tested in acceptability trials. He also stated that anti-nutritional or restrictive factors should be identified and supplementation of amino acids and mineral deficiencies to improve the utility value and then the biological evaluation, to ascertain the replacement value in practical rations.

Although by-products (Gomez, 1983) could attain new status as feedstuffs to meet nutrient deficits in the expanding livestock and feed industries, their usage is an avenue for addressing disposal and environmental pollution. While it is a laudable objective to utilize locally produced NCF's resources in livestock feeds, quality assurance of the finished feeds should not be compromised. Therefore when contemplating the substitution of an ingredient, it will be such that the substituting ingredient will furnish nutrients of almost equivalent quality.

The rumen epithelial scrappings are obtained from the papillae layer of rumens of cattle slaughtered in abattoirs in Nigeria. They are readily available since about 11.873 million heads of cattle are slaughtered annually (Adeniji, 2001). A similar by-product is generated through slaughter of other ruminants such as donkeys in Ebonyi Sate, goats, sheep, camels, etc. Consequent upon the above, the exploitation of the potentials of recycling Cattle rumen epithelial scrapping appears rational and more economical than their disposal problems. Currently they are piled mixed with hairs from cattle skin processing and feed remnants from the rumen and dumped as wastes at abattoirs where it constitutes a pollutant to the environment by the local by product processors.

Researchers have indicated that some nutrient rich abattoir wastes such as meat meal, blood meal, rumen digesta, and RES can, replace the conventional protein sources (Bawala and Akinsoyinu, 2006; Abubakarm 1998; Howie *et al.,* 1996; Skrede and Nes, 1988). Nutritive values of abattoir wastes such as blood meal, bone meal, meat and bone meal, rumen content meal, hoof and meat meal had been documented (Adewoye, 1982; Alhassan *et al.,* 1985; Odukwe and Njoku, 1987; and Abubakar and Mohammed, 1992). However, there is a paucity of information on the production potential, processing (rendering) technology and nutritive value of cattle rumen epithelial scrapping as sole or supplementary dietary protein source in monogastric diets.

In recent times rumen epithelial scrapping meals had been given some attention in the feeding of ruminant animals (Isah, 2001; Fajemisin *et al.,* 2003; Bawala *et al.,* 2003) but none in monogastric nutrition such as pigs, poultry, rabbits, snails, grasscutters, or guinea pigs has been reported. Being high in protein and mineral contents (Bawala and Akinsoyinu, 2006), a limited quantity of RES may be strategically supplied to replace fishmeal in monogastric diets. The work reported here was carried out to ascertain simple and least cost processing (rendering) techniques of RES that can be used by rural livestock farmers. Proximate, Mineral composition and Amino acid assay of RES was done to estimate their nutritive values.

MATERIALS AND METHODS

Cattle Rumen Epithelial Processing at the Abattoir

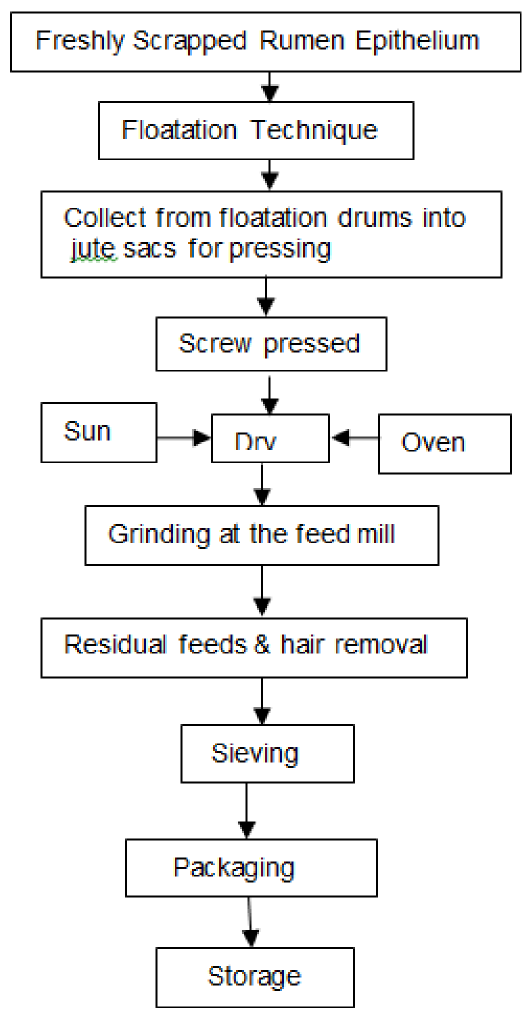

Figure 1: Flow Chart on the Processing of Rumen Epithelial Scrappings Meal.

Collection of Samples

The fore stomach of a slaughtered ruminant particularly cattle was sliced open with a sharp knife, undigested feed emptied, washed partially in water to remove undigested feeds remnants attached to the epithelium. The emptied rumen is later dropped into a drum of boiling water and par-boiled for about 30 minutes with constant rigorous stirring. The fore stomach was later removed from the boiling water placed on a table where a blunt knife was used to scrape the fore stomach. The scrapped layer is the RES owing to the undigested food remnant contamination; a further processing of RES is required. The flow chart is as indicated in Figure 1.

Proximate Analysis

Fresh, Sundried and Oven dried sample at 105^{o}C overnight were grounded to a powdered form using mortar and pestle and allowed to pass through a 0.2 mm sieve. The three samples fresh, sun and oven dried were analyzed in triplicates. The moisture and ash contents were determined using the air oven and dry ashing methods of Pearson (1976). The ash was digested with 3M HCl Crude proteins were determined by the micro-kjeldahl method as described by Pearson (1976). Samples were analyzed for crude fiber, fat and soluble carbohydrate according to the methods of the Association of Official Analytical Chemists (AOAC, 1990), Joslyn (1990), and Pearson (1976).

Minerals Analysis

The moisture and ash contents were determined using the air oven and dry ashing methods of Pearson (1976). The ash was digested with 3M HCl and mineral contents of the sample were determined using atomic absorption spectrophotometer Buck 210 model (Oshodi,1992); Phosphorus was determined by the colorimetric technique using vanado-molybdate yellow method (Pearson, 1976) The sodium and potassium contents were determined by flame photometry. The other mineral elements were determined after wet digestion with a mixture of nitric, sulphuric and hydrochloric acid using Atomic Absorption Spectrophotometer (AAS Model SP9). Elements such as Manganese(Mn++) and Zinc (Zn++) magnesium (Mg++), copper (Cu++) levels where determined by absorption spectrophotometry (AAS) using the perking Elmer (Model No. 403, Norwalk, Connecticut, USA) as described by Tsalev and Zaprianov (1983) and Ogunsanmi *et al*. (1994).

Amino Acid Analytical Procedure

Ten grams of the ground sun dried sample were analyzed for amino acid using modified Ninhydrin colorimetric analysis method Rosen (1957) Mereck (1976) Lewis *et al.* (1995) and thin layer chromatographic quantification at Federal Institute of Industrial Research Laboratory Oshodi, Lagos, Nigeria.

Data Analysis

All the data generated in the study were analyzed (Steel and Torrie 1980). Significant means were separated (Duncan 1955).

RESULTS AND DISCUSSIONS

Table1 Proximate Chemical Composition of Rumen Epithelial Scrapping Meal

Constituent (%)	Fresh	Sun Dried	Oven Dried
Moisture	61.26	10.48	10.57
Dry matter	38.74	89.52	89.43
Crude protein	29.25	53.00	64.03
Ether extract	3.37	5.08	7.45
Ash	5.45	15.98	12.34
Crude fibre	1.72	2.33	1.72
NFE	59.83	13.13	3.89
Gross Energy	1.75	4.09	3.89

Table2: Major mineral constituents of rumen epithelial scrapings

Constituent	Concentration
Calcium (%)	3.89±0.01
Magnesium (%)	0.67 ±0.01
Potassium (%)	0.51 ±0.02
Phosphorus (%)	0.92 ±0.02
Sodium(%)	0.43 ±0.01
Manganese (ppm)	764±4.44
Zinc (ppm)	44.39 ±0.06
Copper (ppm)	6.85±0.15
Iron (ppm)	145 ±4.22

Table 3a: Amino Acids Composition of sun dried RESM

Name	%
Lysine	0.08
Methionine	0.14
Threonine	2.85
Leucine	0.79
Valine	0.38
Arginine	0.71
Phenylalanine	2.55
Histidine	2.45
Tryptophan	0.33
Alanine	0.05
Aspartic acid	0.75
Glutamine	2.85
Serine	0.33
Proline	0.06
Tyrosine	2.55
Cysteine	0.35
Glycine	0.44

Table 3b: Amino Acids Composition (mg/g) of RESM compared with hen's egg

Amino acids(mg/g)	RESM	Hen's egg (a)	%Chemical Score
Lysine	0.87	7.26	11.97
Methionine	1.36	3.52	38.64
Threonine	28.47	5.49	518.60
Leucine	7.89	9.58	82.36
Valine	23.8	18.04	296.14
Arginine	1.67	7.06	23.65
Phenylalanine	25.53	6.58	388.00
Histidine	24.34	2.96	822.30
Tryptophan	3.03	1.92	157.81

(a) Eka (1987)

Table 3c: Comparing recommended FAO/WHO essential amino acid provisional pattern with those of Rumen Epithelial Scrappings meal

Amino acid (mg/g)	RESM	FAO/WHO (b)
Lysine	0.87	
Methionine	1.36	2.20
Threonine	28.47	2.60
Leucine	7.89	4.80
Valine	23.81	4.20
Arginine	1.67	2.00
Pheny		
Alanine	25.43	2.80
Histidine	24.34	2.40
Tryptophan	3.03	1.40

(b) Betschart et al (1975

Results of the proximate composition of the experimental material and other parameters are as shown in Tables 1-3c. Figure 1 shows the processing techniques of the RESM while Table1 shows the proximate composition of wet, sun dried, and oven dried RESM compared. Table 2 gives the major mineral constituents of RESM and Table 3a shows amino acid composition of RESM and Table 3b compares the amino acid of RESM with those of hen's egg and chemical score calculated and Table 3c compares the amino acid of RESM with recommended FAO/WHO essential amino acid provision.

Kumar (1989) indicated that feed processing (rendering) is the performance of all the necessary operations to achieve the maximum potential and utilization value of feedstuff. The processing method used for the RESM in this study indicated that moisture was reduced through pressure, sun drying and milling which also reduced the particle size.

Covet (1972) reported that drying ensures reduction/destruction of microbes and prevent stickiness and lumps formation. Currently European Union (EEC 1991) requires that all animal by product meals be processed at 133^0C and 30psi for 20 minutes. This process attempts to make animal by- products a safe feed ingredient for animals or meats for human consumption.

The moisture content particularly of the sun dried RESM which is the processing method that is more economically viable to rural livestock farmers is within the acceptable range for a good keeping period (Eka, 1987) with a lipid content of 5.08 % sun dried RESM is comparable with meat meal, meat and bone meal, condensed fish solubles, shrimp waste meal, anchovy fish meal, mullet fish meal (Olomu, 2011) and maggot meal (Akpodiete *et al* 1997). A CP range of 53% recorded for sun-dried RESM is lower than the values of 60-70% (Isa, 2001; Fajemisin, 2003 and Bawala, 2003) but higher than the 44.19% obtained by Ogunwole *et al* (2009).

The 53%CP was high though lower than that of herring fish meal but similar to sardine fish meal, meat meal, poultry by product meal, poultry offal meal, maggot meal and higher than those of shrimp meal and shrimp waste meal, crab meal Chad fish meal, milk powder and meat and bone meal (Olomu, 2011; Akpodiete *et al.,* 1997; Nutrient Master Plan (NMP), 1991) that are commercially exploited and thus RESM can be classified as animal by product protein source. RESM crude fiber of (2.33%) is lower than poultry feather meal, shrimp meal and shrimp waste meal, and crab meal, higher than that of fishmeal, but similar to meat and bone meal and meat meal (Olomu, 2011) Table 1.

Since the CF is an index of the feeding quality of product and stock feeds (Ayodele *et al.* 2000) then RESM may have high nutritional value. The crude protein values for the RESM tested in feeding assays (Alikwe, 2004) indicated the potentialities of the RESM as a good alternative protein sources in broiler diets. The average ash content of RESM was 15.98%. Olomu (2011) reported 28.80% for meat and bone meal and 25.00% for meat meal. Fetuga and Tewe (1985) reported 16.7% ash for meat meal. Skrede and Nes (1988) earlier reported 4.7%, 4.3% and 4.3% ash respectively for raw cattle tripe, raw mixed cattle waste and mixed hog wastes. However, the value obtained in this study is in agreement with that reported (Olomu, 2011) for poultry by-product meal 15.75% and dried fish soluble meal, 15.80%.

Considering the mineral element of RESM (Table 2) the sample appeared adequate in Ca—Na—K ---P—Mg—Zn—Fe & Cu for poultry feed. The mineral profile in Table 2 showed that RESM could be a good source of minerals in the ration of livestock. It is particularly rich in iron. The values reported here compared favorably with what obtained in literature for the same ingredient (Fajemisin, 2003).

Quantitative Chromatographic analysis of RESM hydrosylates revealed the presence of 18 amino acids. The amino acid profile (Table 3a) shows that RESM contains all the essential amino acids. The lysine, methionine and arginine content (0.87, 1.36, 1.67) mg/gm appears low while Threonine, Phenylalanine, Histidine and Valine (28.47, 25.53, 24.34, 23.81) mg/gm appears high but Leucine, Isoleucine and Tryptophan contents are moderate RESM is rich in Threonine, Phenylalanine, Tyrosine, Histidine, Glutamic acid, Leucine, and Arginine in this order. Other essential amino acids are moderate except Lysine which is the limiting amino acid (Table 3a). Comparing the amino acid in RESM with the WHO/FAO (Table3b) recommended provisional pattern, RESM is superior with respect to Threonine, Leucine, Valine, Phenylalanine, Histidine, and Tryptophan as indicated by the chemical score (Table 3b). It is only for Methionine and Arginine that supplementation may be required. The Phenylalanine of RESM (2.60%) is similar to that of Menhaden fishmeal of 2.61% but higher than that of crayfish meal and sardine fish meal, meat and bone meal, meat meal and poultry by-product meal (2.30%, 2.58%, 1.50%, 1.70%, and 2.10%, respectively) (Olomu,2011). Similarly the Threonine content of RESM (2.85%) is superior to that of meat meal, meat and bone meal and Poultry by-product meal. The Amino acid profile of RESM meets the minimum amino acid requirements for broiler production (NRC, 1994) as confirmed in the work of Alikwe, *et al* (2005).These, therefore suggest that RESM protein content could be of potential value to Poultry and other monogastric animals. The similarities in profile with that of meat meal and fish meal suggest its possible uses as livestock feed (Eka, 1987; Betschart *et al.,* 1973) with minimum supplementation.

The potential of RES as feedstuff and particularly as alternative protein resource is exemplified by the proximate composition, amino acid profile, mineral composition and the gross energy content of the analyzed RES meal samples. The safe use of animal by-products is an important means of disposing of materials that could otherwise be potential health and environmental risks and, at the same time, obtaining value from their use. Processing (rendering) removes the need to dispose of by-products in landfills or by other methods that might pose potential environmental risks, health risks, or strain existing space and/or facilities. The economic value of this service is certainly high, but difficult to measure.

CONCLUSION

Proximate, mineral and amino acid analysis of RESM showed that RESM contains an appreciable level of nutrients that are usable in the nutrition of livestock. With the increasing population and emergence of large and medium scale abattoir in Nigeria and rising cost of fish meal, the need to recycle RESM will increase To obtain high quality RESM, processing stages must be carefully monitored. Good hygiene during collection, processing, drying, and transportation coupled with microbial control measures should be strictly observed and sources of re infection avoided.. The result of this study therefore indicated that RESM contained useful nutrients and essential amino acids Positive effects detectable through biological evaluation of all monogastric animals are necessary to enhance the acceptability and commercialization of this abattoir by-product which hitherto constitutes an environmental pollutant. Utilization of by-products like RESM will be of dual significance not only in the provision of a relatively cheaper source of nutrients for animals but also in providing easier avenue for preventing environmental hazards.

REFERENCES

1. AOAC. 1999. *Method of Analysis of Association of Official Analytical Chemist, 16th Edition. V*ol 1: 440-442. AOAC: Gaithersburg, MD.

2. Abubakar, M.M. and I. Mohammed. 1992. "Utilization of Slaughter House By-Products for Sustainable Livestock Production in Nigeria". In: Ojo, J.A.T. (ed). *Mobilizing Finance for Natural Resources Conservation in Nigeria*. National Resources Conservative Council: Garki-Abuja, Nigeria.193-202.

3. Abubakar, M.M. 1998. "Slaughterhouse Byproducts for Sustainable Livestock Production in the Tropics". In: *Strategies and Tactics of Sustainable Agriculture in the Tropics*. Badejo, M.A. and O.A. Togun (eds.). University College Press: Ibadan, Nigeria. 196–210.

4. Adeniji, A.A. 2001. "The Potential of Bovine Blood-Rumen Content Meal as a Feedstuff for Livestock". *Trop Anim. Prod Invest*. 4:l51-156.

5. Adewoye, R.O. 1982 "The Utilization of the Byproducts of the Beef Industry": In Osinowo O.A., U.J. Ikhatua and W.O. Ekocha (eds.). *Beef Production in Nig. Proc. National Conference on Beef Production*. NAPRI: Zaria, Nigeria. 574-60.

6. Akinsoyinu, A.O. 1981 "Nutrient Requirements of Sheep and Goats in Nig.". In: Adu I.F. (ed.) et al. *NAPR Inst. Shika SRP-Nigeria Conf.* on SRP 6-10 Oct. 1985 ISBN 968-2364-18-5.

7. Akpodiete, O.J., A.D. Ologhobo, and O.G. Ayoade. 1997 "Replacement of Maggot Meal for Fish Meal in Broiler Chicken Diets". In: *Livestock Products*. Ologhobo, A.B., et al. (eds). 64-76.

8. Alhassan, W.S., E.U. Lufadeju, and S.A. Bello. 1985. "The Potential of a Dried Rumen Content Blood Mixture as Feed for Ruminant Animals". Paper presented at 10th Annual Conference of NSAP University of Ife: Ile-Ife, Nigeria.

9. Alikwe, P.C.N. 2004. "Biochemical and Nutritional Evaluation of Rumen Epithelial Scrapping Meal-Based Diets fed to Broilers". Ph.D. Thesis. University of Ibadan: Ibadan, Nigeria.

10. Alikwe, P.C.N., A.O. Akinsoyinu, B.B. Babatunde, and O.A. Ogunwole. 2005. "The Replacement Value of Rumen Epithelial Scrapping Meal (RESM) for Fish Meal in the Diets of Broilers". *Trop. J. Anim. Sci.* 8(1):69-73.

11. Ayodele, J.T, O.A. Alao, and T.O. Olagbemiro. 2000. "The Chemical Composition of *Sterculia setigera*". *Trop J Anim. Sci.* 3(2):69-76.

12. Bawala, T.O. and A.O. Akinsoyinu. 2006. "Nutritional Evaluation of Rumen Epithelial Tissue Scrapings in Goat Nutrition". *Nutrition and Food Sc.* 36(6):414 – 418.

13. Bawala,T.O., O.O. Olomola, A.O. Akinsoyinu, and J.O. Babayemi. 2003. "Performance of Lactating West-African Dwarf Goat Fed Urea-Rumen Epithelial Tissue Scrapping-Groundnut Cake Based Diet". *Ann. Con. Nig. Soc. Anim. Prod*. 27:105-109.

14. Betschart, A.A., C.K. Lyon, and G.O. Kohler. 1975. *Food Protein Sources*. Cambridge University Press: Cambridge, U.K.

15. Covet, V.L. 1972. "Pathogen and Livestock Wastes". *Ani. Waste Confr. Proc.* 44:68.

16. Duncan, D.B. 1955. "Multiple Range and Multiple F-Tests". *Biometrics*. 11:1-42.

17. Eka, O.U. 1987. "Evaluation of Nutritive Value of Feed for Growing Broilers in Northern Nigeria". *Nig. J. Sci.* 21:52-54.

18. European Economic Community (EEC). 1991. "Concerning the Protection of Water Pollution by Nitrates from Agricultural Sources Council Directives". 91/676/EEC.

19. Fajemisin, A.N., I.O.A. Adeleye, A.O. Akinsoyinu, O.A. Isah, and O.J. Babayemi. 2003. "Dry Matter and Mineral Degradability by West Africa Dwarf Goat on Rumen Epithelium Meals". *Ann Conf. Nig. Soc. of Anim Prod*. (NASP) 28:303-309.

20. Fetuga, B.L. and O.O. Tewe. 1985. "Potential of Agric Industrial by Products and Crop Residue as Livestock Feed Components". *Nig. Food J.* 2(2):136 – 142.

21. Gomez, M. 1983. "Development and Evaluation of Non-Conventional Feedstuffs for Animal Production Processing". Nairobi, Kenya.

22. Howie, S.A., S. Calsamiglia, and M.D. Stern. 1996. "Variation in Ruminal Degradation and Intestinal Digestion of Animal Byproduct Protein". *Anim. Feed Sci. Technol*. 63:1–7.

23. Isah, O.A. 2001. "Evaluation of Rumen Waste Based Diet in Goat Production". Ph.D Thesis. Univeristy of Ibadan: Ibadan, Nigeria..

24. Joslyn, A.M. 1990. *Methods of Food Analysis. Physical Chemical and Instrumental Methods of Analysis. 3rd Edition.* Academic Press: New York, NY. 1-3.

25. Kazimerz, S. 2003. “A Comparison of Sun-Cured and Dehydrated Alfafa Meal in the diet of Chicks”. *Poultry Sci*. 22: 659.

26. Kumar, M. 1989. “Processing of Animal By-Products in Developing Countries”. Commonwealth Science Council: London, UK. 21 – 28.

27. Lewis, E. and I.N. Boerman. 1995. “Procedures of Protein Evaluation”. In: *Protein as Human Food.* E.A. Lowrie (editor). *Proceedings of the 6th Easter School in Agriculture Sciences*. University of Nottingham: Nottingham, UK.

28. McNab, J.M. and D.W.F. Shannon. 1972. “Studies on the Process of Digestion in the Fowl: Dry Matter and Total Nitrogen”. *Br. Poult. Sci.* 13:395-502

29. Merck, E. and A.G. Darmstadt. 1979 *Thin Layer Chromotography Methods*. Touchstone: New York, NY. 56-61

30. Nutrient Master Plan (NMP). 1992. “Critical Nutrients and Feeding Implications of Different Classes of Poultry Pfizer”. Livestock Feeds Ltd.: Lagos, Nigeria.

31. Odukwe, C.A. and R.C. Njoku. 1987. “Evaluation of Blood Meal and its Potential as a Supplementary Sources of Lysine in Laying Chicken Diets”. *J.A.P. Res*. 7:9-18.

32. Ogunsanmi, A.O., S.O. Akpavie, and V.O. Anosa. “Serum Biochemical Changes in West Africa Dwarf Sheep Experimentally Infected with *Trypanosome brucei”*. *Revue Elev, Med. Vet. Pays Trop.* 47(2):195-200.

33. Olomu, J.M. 2011. *Monogastric Animal Nutrition - Principles and Practice. 2nd Edition.* St Jackson Publishing: Benin City, Nigeria. 478.

34. Orevi, M., Radenkovi Damnjanovi Brana, Vuini Marijana, Balti M,Teodorovi Radislava, Jankovi Ljiljana, Vuka Inovi Marija and M. Rajkovi. 2008 “Effects of Substitution of Fish Meal with Fresh and Dehydrated Larvae of the House Fly (*Musca domestica* L) on Productive Performance and Health of Broilers”. *Acta Veterinaria (Beograd)*, 58(4):357-368.

35. Oshodi, A.A. 1992. “Proximate Composition Nutritionally Valuable Minerals and Functional Properties of *Adenopus breviflorus* benth Seeds Flour and Protein Concentrate”. *Food Chemistry*. 45:79-83.

36. Pearson, D. 1976. *Chemical Analysis of Foods, 7th Edition*. Churchill, Livingstone: London,UK. 7-11.

37. Pearson, D. 1981; *Chemical Analysis of Foods, 7th Edition.* AVI Publishers: Roslyn, NY.

38. Polonen, I., V. Toivonen, and J. Mokelo. 1998. “Different Combination of Formic, Propionic and Benzoic Acids in Slaughter Offal Preservation for Feeding of Animals”. *Anim. Feed Sci. Techn.* 71:197-202.

39. Rosen, H. 1957. “A Modified Ninhydrin Colorimetric Analysis for Amino Acids”. *Arch Biochem. Bioph*. 67:10-1.

40. Skrede, A. and I.F. Nes. 1988. “Slaughterhouse By-Products Preserved *Lactobacillus planetarium* Fermentation as Feed for Mink and Foxes”. *Anim. Feed Sci. Technol.* 20:287–298.

41. Steel, R.G.D. and J.H. Torrie. 1980. *Principles and Procedures of Statistics*. McGraw Hill: New York, NY. 137-169

42. Tewe, O.O. 1986. “Feed Ingredients and Ration Formulation for Economic Gains”. *Proceedings of the 1st August School*. Dept. Animal Science. University of Ibadan: Ibadan, Nigeria. Sept. 22nd – 26th, 1986. 103

43. Tsalev, D.L. and Z.K. Zapranov. 1983. *Atomic Absorption Spectrometry in Occupation and Environmental Health Practice*. CRC Press Inc.: Boca Raton, Florida. 1:50.

44. Waring, J.J. 1969. “The Nutritive Value of Fish Meal, Meat and Bone Meal and Field Bean as Measured by Digestibility Experiments on Colostomized Fowl”. *Brit. Poult. J.* 10:97-186.

ABOUT THE AUTHORS

Dr. Philip C.N Alikwe, holds a Ph.D.in Animal Nutrition / Biochemistry and Toxicology from the University of Ibadan, Ibadan where he conducted his research under Professor Akinsoyinu. He is currently a Lecturer/Researcher in the Department of Livestock Production Technology at Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria. His research interests are in the areas of nutrition, biochemistry, and toxicology of food/feeds/feedstuff and their

Utilization by man/livestock. He is a member of NIAS, ASAN and NSAP.

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