FEEDING VALUE OF SHRIMP MEAL FOR GROWING PIGS

VALOR NUTRITIVO DE HARINA DE GAMBAS PARA CERDOS EN CRECIMIENTO

Fanimo A.O [1]*, B.O. Oduguwa[2], O.O. Oduguwa[1], O.Y. Ajasa[1] and O. Jegede[1]

[1]Department of Animal Production and Health. University of Agriculture. P M B 2240, Abeokuta. Nigeria.
[2]Research and Development Centre. University of Agriculture. P M B 2240, Abeokuta. Nigeria.
*Corresponding author current address: Institute of Animal Nutrition. Physiology and Metabolism. University of Kiel. D-24098 Kiel. Germany. Tel:+49-(0)431-880-4576; Fax:+49-(0)431-880-1528. E-mail: fanitunde_amos@yahoo.com

ADDITIONAL KEYWORDS

Performance. Nutrient digestibility. Chitin.

PALABRAS CLAVE ADICIONALES

Producción. Digestibilidad de los nutrientes. Quitina.

SUMMARY

The effect of feeding shrimp meal (SM) on nutrient digestibility, haematology, growth performance and meat quality in 16 Large White x Landrace growing pigs was investigated. Two diets were formulated, a control corn-soybean diet with fish meal (FM) and diet 2 with FM in the control diet replaced by SM. Faecal apparent digestibility was determined in four pigs per diet. Feeding of SM decreased ($p<0.05$) dry matter, crude protein, crude fibre and ash faecal apparent digestibility of the diet. Weight gain and feed/gain were reduced ($p<0.05$) in SM diet. Inclusion of SM in the diet had no significant effect on meat quality but reduced the blood total protein and albumin of the pigs. Across all treatments, the averages for percentages of carcass meat protein, lipid and ash were 72.0, 24.8 and 3.3 percent, respectively. The results indicate that feeding SM at a high level to replace FM will have detrimental effects on pig performance.

RESUMEN

En 16 cerdos Large White x Landrace en crecimiento, se estudió el efecto de la harina de gambas (SM) sobre la digestibilidad de los nutrientes, hematología, niveles de crecimiento y calidad de la carne. Se formuló una dieta control a base de soja y maíz con harina de pescado (FM) y otra, en la que la FM se sustituyó por SM. La digestibilidad fecal aparente fue determinada en cuatro cerdos por dieta. El consumo de SM redujo ($p<0,05$) la digestibilidad fecal aparente de la materia seca, proteína bruta, fibra bruta y cenizas. En la dieta con SM se redujeron ($p<0,05$) la ganancia de peso y la relación pienso/ganancia. La inclusión de la SM en la dieta no afectó a la calidad de la carne pero redujo la proteína total y albúmina de la sangre. Entre todos los tratamientos los niveles medios de proteína, lípidos y cenizas de la carne fueron respectivamente 72,0; 24,8 y 3,3 p.100. Los resultados indican que la alimentación con SM a alto nivel, para reemplazar a la FM, deprime la producción porcina.

INTRODUCTION

Shrimp meal has received attention

recently among farmers and researchers as a result of its high potential as a feed resource. Shrimp meal is basically the dried waste of the shrimp industry, consisting of the heads, hulls (or shells) and appendages. The chemical composition of SM is influenced by the constituents, method of processing and storage (Oduguwa *et al*., 1998). Shrimp meal has long been used as a source of marine protein in fish and crustacean feed. It is also used as a natural source of carotenoid pigment (astaxanthin) to produce desired colouration in trout, salmon, shrimp and feathers of exotic birds and as a flavouring agent in pet foods (Gernat, 2001). Fanimo *et al.,* (2000) showed that the protein quality of SM is inferior to that of fish meal. The authors indicted chitin for the inferior quality. Chitin is a homo-polymer of N-acetyl- β- D-glucosamine joined by (1,4) glycosidic linkages (MacDonald, *et al.,* 1991). Chitin is not readily digestible by monogastric animals. Gohl (1975) reported that about 10 percent of the crude protein in whole shrimp meal originates from chitin while up to 50 percent of the nitrogen in the meal originate from chitin.

Previous works indicated that SM is a suitable protein rich concentrate for broilers (Ilian *et al.,* 1985, Islam *et al*., 1994, Fanimo *et al*., 1996, Arellano *et al*., 1997 and Rosenfeld *et al*., 1997) and laying hens (Toan and Ngoan, 2003). Hirano *et al.* (1990) reported that some species of birds produce chitinase in the proventriculus, hence when chitin and chitosan were fed to hens and broilers, the two ingredients were 88 and 98 percent digestible.

Although SM has high potential in broilers, little work has been done on its use in pig feeding. This study was therefore designed to provide insight into the performance, haematological indices and meat quality of pigs fed sun dried shrimp meal.

MATERIALS AND METHODS

The composition of the fish meal

Table I. *Analysis (percent) of shrimp meal and fish meal (as fed).* (Análisis porcentual de las harinas de gambas y de pescado consumidas).

	Shrimp meal	Fish meal
Dry matter	92.30	96.10
Crude protein	39.45	64.50
Crude fibre	12.30	0.08
Ether extract	9.00	7.00
Ash	24.00	9.60
Calcium	15.77	3.00
Phosphorus	0.45	2.00
Methionine	0.80	1.09
Lysine	1.66	4.14
Arginine	1.60	3.61
Tryptophane	0.40	0.56
Threonine	1.42	2.38
Aspartic acid	3.38	5.19
Serine	1.42	2.40
Glutamic acid	4.52	7.75
Proline	1.34	3.27
Glycine	1.96	5.38
Alanine	1.92	4.14
Cysteine	0.40	0.90
Valine	1.98	3.00
Isoleucine	1.50	2.10
Leucine	2.18	4.14
Tyrosine	1.84	1.66
Phenylalanine	4.36	2.24
Histidine	0.64	1.55

and shrimp meal is presented in **table I**. Shrimp waste collected from the shrimp processing plant was sun dried immediately after delivery for three days. The experiment involved two diets. Diet 1 was the control treatment containing 50 g/kg fish meal. Diets 2 contained 80 g/kg SM as a replacement for the crude protein contribution of fish meal in diet 1. The diets were made iso- nitrogenous and iso-caloric with 155 g/kg crude protein and 11.5 MJ metabolizable energy/kg **(table II)**.

Table II. *Composition of experimental diets (percent).* (Composición porcentual de las dietas).

Ingredients and analysis	Diet 1	Diet 2
Corn	38.0	38.0
Corn bran	35.0	32.0
Dry brewer's grain	14.5	14.5
Full-fat soybean	5.0	5.0
Fish meal	5.0	0.0
Shrimp meal	0.0	8.0
Bone meal	1.0	1.0
Oyster shell	0.5	0.5
Salt	0.5	0.5
Premix[a]	0.5	0.5
Determined analysis		
Crude protein	15.52	15.36
Ether extract	2.17	2.63
Crude fibre	8.93	8.64
Ash	7.0	7.0
Moisture	14.07	14.92

[a]Provided per kg diet: 5000 IU vitamin A; 1000 IU vitamin D; 0.8 mg vitamin E; 0.4 mg menadione K_3; 1.2 mg riboflavin; 1.0 mg pantothenic acid; 0.004 mg vitamin B_{12}; 3 mg niacin; 4 mg vitamin C; 112 mg choline; 24 mg manganese; 8 mg iron; 0.048 mg selenium; 5 mg antioxidant (BHT).

ANIMALS AND PROCEDURE

The experiment was carried out at the Teaching and Research Farm of the University of Agriculture, Abeokuta, where the prevailing climate is humid tropical. The pigs were allocated to treatments on basis of initial weight and sex. There were four males and four females per treatment all of the Large White x Landrace breed. The pigs were penned per group of two animals. Water was supplied *ad libitum*. Dietary treatments were introduced when the pigs reached 20 kg live weight. There was one week adaptation to diets and environment during which the pigs were injected with Ivomec^R against endo- and ecto-parasites. The diets were offered at a daily rate of 1000 g at 20 kg live weight, with 100g increments per 2.5 kg live weight gain. The pigs were fed twice daily. Feeding levels were adjusted after the weekly weighing of the pigs. The experiment lasted 12 weeks. The pigs were slaughtered at the last day of the experiment and hot eviscerated carcass weights were recorded. The carcasses were then split. The left side of the carcass was stored at –10°C, then cut and meat portion was sampled, ground, mixed and freeze-dried before chemical analysis. Pig response was assessed in terms of daily live-weight gain, feed conversion efficiency and killing-out proportion.

FAECAL DIGESTIBILITY

Eight male pigs (four per treatment) were assigned at random at the last

week to the two experimental diets. Seven days was adaptation to the experimental diets. Feed was offered twice daily in equal proportions at 8.00 and 17.00 hours while water was provided throughout the day. Faeces from each pig were collected twice per day on day 8, 9 and 10 in labelled polyethylene bags and stored at –10°C. After the collecting period, the total amount of faeces from individual pigs were homogenised. Afterwards one defrosted aliquot from faeces was taken to analyse the content of nitrogen and DM, another quota were freeze dried and milled for other analyses. Composition of feed and faecal samples was determined using the technique outlined by the Association of Official Analytical Chemists (1990). Faecal apparent digestibility for dry matter, crude protein, crude fibre, ether extract and ash were determined for each diet. Amino acid profile was determined as described by Llame and Fontane (1994).

MEAT COMPOSITIONAL PROFILE AND SENSORY EVALUATION

The meat samples were analysed (AOAC, 1990) to determine dry matter by oven drying, protein by the Kjeldahl method, fat by Fosslet fat analysis, and ash by muffle furnace. A total of two samples per carcass were analysed.

For the sensory evaluation, frozen meat from the ham were thawed, the skin and bones remained intact. The meat was cooked at 170°C in a conventional preheated gas oven for 20 min. Cooked meat was removed from the oven, allowed to cool for 10 min., deboned and muscles cubed and served to a 20-member trained panel. A modified hedonic scoring scale was employed (Williams and Damron, 1998). The panellists were instructed to score each sample for juiciness, flavour intensity, overall tenderness, and off-flavour. Eight-point scale were employed for juiciness, flavour intensity, and tenderness where 8= extremely juicy/intense/tender, 7=very juicy/intense/tender, 6= moderately juicy/intense/tender, 5= slightly juicy/intense/tender, 4= slightly dry/bland/tough, 3= moderately dry/bland/tough, 2= very dry/bland/tough and 1= extremely dry/bland/tough. A six-point scale was employed for off-flavour where 6 = none detected, 5 = threshold, barely detected, 4= slight off-flavour, 3= moderate off-flavour, 2= strong off-flavour, and 1= extreme off-flavour. Panellists were requested to identify any off-flavours detected such as rancid, bitter, metallic, or other unique off-flavours.

BLOOD ANALYSIS

Four (2 males and 2 females) out of the 8 experimental pigs per treatment were randomly selected and bled before the morning feeding in the last day of the experiment. Blood was drawn into sodium heparinised vacutaner tubes and another sample into tubes without anti-coagulant. The heparined blood samples were centrifuged at 1006 g for 10 min and the serum was separated stored frozen at –10°C until analysed. Blood parameters measured in the samples included total protein, urea, creatinine, albumin, cholesterol, red

blood cell (RBC), white blood cell (WBC), mean corpuscular value (MCV), mean corpuscular haemoglobin concentration (MCHC) and haemoglobin. The blood chemistry data were obtained according to procedures reported by Onifade and Tewe (1993) and Onifade *et al*. (1999).

STATISTICAL ANALYSIS

All data were analysed by ANOVA using General Linear Models (GLM) procedures (SAS Institute, 1991). A probability of $p<0.05$ was required for statements of significance.

RESULTS AND DISCUSSION

The effect of treatment on growth traits is shown in **table III**. Feed intake was not affected by treatment ($p>0.05$) and was 1.45±0.02 kg on the average. A significant ($p<0.05$) decrease in weight gain was observed with SM diet compared to the FM diet. Due to the decrease in the weight gain, feed efficiency was poorer ($p<0.05$) for the SM diet. These data agrees with earlier findings by Fanimo and Oduguwa (1999) that there was significant decreased in the growth performance of weaner pig when FM was totally replaced by SM in the diets. Ngoan (2000) also reported that completely replacing the crude protein of fish meal with shrimp by-product reduced performance of fattening pigs. The same trend as for growth performance was observed in the apparent faecal nutrient digestibility (table 3). Feeding SM decreased ($p<0.05$) the digestibility of dry matter, crude protein, crude fibre and ash by 7.1, 9.44, 11.73 and 14.81 percent, respectively. Similar results was reported by Ngoan *et al*. (2000)

Table III. *Growth performance and apparent faecal nutrient digestibility of weaner pigs fed fish and shrimp meal supplemented diets.* (Eficacia de crecimiento y digestibilidad fecal aparente de los nutrientes en cerdos en crecimiento alimentados con dietas suplementadas con harinas de pescado o gambas).

Parameters	Fish meal	Shrimp meal	SEM
Final liveweight (kg)	73.70[a]	62.41[b]	3.54
Feed intake(kg)	1.51	1.56	0.02
Weight gain(kg/day)	0.41[a]	0.32[b]	0.04
Feed / gain	3.68[b]	4.88[a]	0.09
Dry matter digestibility (percent)	73.8[a]	66.7[b]	2.43
Crude protein digestibility (percent)	68.8[a]	59.4[b]	1.02
Crude fibre digestibility (percent)	75.4[a]	63.7[b]	2.44
Ether extract digestibility (percent)	69.7	62.9	3.71
Ash digestibility (percent)	71.1[a]	56.3[b]	3.43

Means on the same row with different superscripts were significantly different ($p<0.05$).

Table IV. *Haematological parameters of weaner pigs fed fish and shrimp meal supplemented diets.* (Parámetros hematológicos de los cerdos que consumían dietas suplementadas con harina de pescado o gambas).

Parameters	Fish meal	Shrimp meal	SEM
Packed cell volume (percent)	35.0	35.5	2.06
Haemoglobin (g/dl)	11.75	11.85	0.72
Red blood cell (ml/mm^3)	4.0	4.0	0.24
White blood cell (No/mm^3)	4700	5600	122.3
Mean corpuscular volume (cu.microns)	88.5	89.5	0.35
Mean corpuscular haemoglobin Concentration (percent)	34.0	33.5	0.15
Urea (mg/dl)	42.0^b	47.0^a	0.71
Creatinine (mg/dl)	2.2	2.1	0.03
Total protein (mg/dl)	98.5^a	84.5^b	2.48
Albumin (mg/dl)	59.0^a	47.0^b	1.41
Cholesterol (mg/dl)	160.5	163.0	14.95

Means on the same row with different superscripts were significantly different ($p<0.05$).

that nutrient digestibility of diets based on shrimp by-product silages were lower than for similar diets based on fish meal. These results might be attributed to the high level of chitin in SM and inferior amino acid balance (Fanimo *et al.,* 1996; Ngoan *et al*., 2000). A major concern with SM is the chemical nature of the exoskeleton of the shrimp, which is mainly composed of chitin, an N-acetylated glucosamine polysaccharide that forms part of the protein complex and is considered to have low digestibility (Austin *et al*., 1981). Due to this low digestibility, chitin physically blocks the access of digestive enzymes to lipids and proteins, thus affecting the utilization of these nutrients (Castro *et al*., 1989; Karasov, 1990). Also, Karasov (1990) reported the energy value of chitin to be very low, due to poor absorption. Chitin reduces dietary energy (Gernat, 2001), hence pigs fed SM diet slightly increased feed consumption to maintain their energy needs.

The haematological indices **(table IV)** were remarkably similar and within normal ranges (Adesehinwa, 1997). Total protein and albumin decreased ($p<0.05$) while urea increased in the pigs fed SM diet. The increased blood urea values, reduced total protein and albumin values for SM diet agree with the earlier results on growth rate and digestibility, and confirm the low value of the SM protein compared to FM, since plasma urea N, total protein and albumin are good indices of the quality of dietary protein (Eggum, 1970; Lewis *et al.,* 1977).

The effect of treatments on meat

Table V. *Meat compositional profile (percent dry matter) and sensory evaluation of pigs fed fish and shrimp meal supplemented diets.* (Composición porcentual y evaluación sensorial de la carne de cerdos alimentados con piensos suplementados con harina de pescado o gambas).

Parameters	Fish meal	Shrimp meal	SEM
Killing out percentage	0.74	0.69	0.03
Meat juiciness	5.10	6.05	0.31
Meat flavour	5.00	5.20	0.54
Meat tenderness	5.05	5.10	0.48
Off – flavour in meat	5.05	5.70	0.35
Meat crude protein (percent)	74.4	69.5	2.22
Meat lipid (percent)	22.2	27.3	0.73
Meat ash (percent)	3.4	3.2	0.28

quality is shown in **table V**. The SM tended to reduce (p>0.05) the killing-out proportions of the pigs. Ngoan (2000) reported that complete replacement of fish meal protein with shrimp by-product did not alter carcass characteristics of fattening pigs. No significant effect (p>0 05) in juciness, flavour, tenderness or off-flavour were detected among the meat samples from pigs fed the diets. Meat composition indicated no differences among diets for percentages of meat protein, lipid and ash. The off-flavour scores for all samples were above the threshold value of 5, indicating that no off-flavour was detected. This agrees with the finding of Arellano *et al.* (1997) that 3, 6 and 9 percent of SM in broiler diets produced no peculiar odours or flavours in the breast meat. The SM diet, which tended to be higher in ether extract, were consistently rated higher in juiciness and flavour when compared to the FM control diet. Many of the flavour components of meat are fat-soluble. The presence of fat also contributes to the juiciness characteristics of muscle foods (Williams and Damron, 1998). Other compositional profile for all the meat treatments were similar, indicating that the SM had no adverse effect on the composition of the meat. The results of this study reveal that the feeding value of shrimp meal is lower than that of fish meal, and its use at high level to replace fish meal will have detrimental effects on pig performance. With further research into processing treatments that could increase chitin digestion in shrimp meal, it may be possible to increase its feeding value for pigs.

AKNOWLEDGEMENTS

The authors appreciate the support of Research and Development Center (RESDEC), University of Agriculture, Abeokuta, Nigeria for the research grant for this study and CHI Industry, Lagos for supplying the shrimp waste.

REFERENCES

Adesehinwa, A.O.K. 1997. Utilisation of maize offal in the diets of pigs enriched with conventional animal protein sources. Ph.D thesis, Department of Animal Science, University of Ibadan, Nigeria.

A.O.A.C. 1990. Official Methods of Analysis. 15th Ed. Association of Official Analytical Chemists, Washington, DC.

Arellano, L., L. Carillo, F. Perez-Gil, E. Avila and F. Ramos. 1997. Shrimp head meal utilization in broiler feeding. *Poult. Sci.*, 76: 85. (Abstr.).

Austin, P.R., C.J. Brine, J.E. Castle and J.P. Zikakis. 1981. Chitin: *New facets of research. Sci.*, 212: 749-753.

Castro, G., N. Stoyan and J.P. Nyers. 1989. Assimilation efficiency in birds: A function of taxon and food type? *Comp. Biochem. Physiol.,* 92A: 271-278.

Eggum, B.O. 1970. Blood urea measurement as a technique for assessing protein quality. *Brit. J. Nutr.,* 24: 983-988.

Fanimo, A.O., E. Mudama, T.O. Umukoro and O.O. Oduguwa. 1996. Substitution of shrimp waste meal for fish meal in broiler chicken rations. *Trop. Agric.*, (Trinidad) 73: 201-205.

Fanimo, A.O. and O.O. Oduguwa. 1999. Replacement of fish meal with shrimp waste meal in weaner pig ration. *Trop. J. Anim. Sci.*, 1: 51-55.

Fanimo, A.O., O.O. Oduguwa, A.A. Onifade and T.O. Olutunde. 2000. Protein quality of shrimp waste meal. *Biores. Technol.*, 72: 185-188.

Gernat, A.G. 2001. The effect of using different levels of shrimp meal in laying hen diets. *Poult. Sci.*, 80: 633-636.

Gohl, Bo. 1975. Tropical feeds: Feeds information summaries and nutritive values. FAO feed information centre. Animal production and health division, FAO Rome.

Hirano, S., C. Itakura, H. Siro, Y. Akiyama, I. Nonaka, N. Kanabara and T. Kawakami. 1990. Chitosan as an ingredient for domestic feeds. *J. Agric. Food Chem.*, 38: 1214-1217.

Ilian, M.A., C.A. Bond, A.J. Salam and S. Al-Hooti. 1985. Evaluation of shrimp by- catch meal as broiler feedstuff. *Nutr. Rep. Int.*, 31: 487-492.

Islam, M.A., M.D. Hossian, S.M. Baibul and M.A.R. Howlider. 1994. Unconventional feed for broilers. *Ind. Vet. J.*, 74: 775-780.

Karasov, W.H. 1990. Digestion in birds: Chemical and physiological determinants and ecological implications. *Stud. Avian Biol.*, 13: 391-415.

Lewis, A.J., E.R. Peo, P.J. Cummingham and P.D. Moser. 1977. Determination of the optimum dietary proportions of lysine and tryptophan in growing rats based on growth, food intake and plasma metabolites. *J. Nutr.*, 107: 1361-1368.

Llame, C.R. and J. Fontaine. 1994. Determination of amino acids in feeds: Colaborative study. *J. AOAC International*, 77: 1362-1402.

McDonald, P., R.A. Edwards and J.F.D Greenhalgn. 1991. Animal Nutrition. 14th Ed. Longman Scientific and Technical Publication.

Ngoan, L.D. 2000. Evaluation of shrimp by-product for pigs in central Vietnam. PhD thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden. Agraria 248, 53 pp.

Ngoan, L.D., L.V. An, B. Ogle and J.E. Lindberg. 2000. Ensiling techniques for shrimp by-products and their nutritive value for pigs. Asian-Aus. *J. Anim. Sci.,* 13: 1278-1284.

Oduguwa, O.O., A.O. Fanimo, E.A. Iyayi, O.O. Kalejaiye and O.A. Oyekola. 1998. Preliminary studies on the effects of different processing methods on the nutritive value of shrimp waste meal. *Nig. J. Anim. Prod.*, 25: 139-144.

Onifade, A.A., R.I. Obiyan., E. Onipede, D.O. Adejumo, O. A Abu and G.M. Babatunde. 1999. Assessment of the effects of supplementing rabbit diets with a culture of *Sacchaomyces cecevisae* using performance, blood composition and clinical enzyme activities. *Anim. Feed Sci. Technol.*, 77: 25-32.

Onifade, A.A. and O.O. Tewe. 1993. Alternative tropical feed resources in rabbit diets: growth

performance, diet's digestibility and blood composition. *Wld. Rabbit Sci.*, 1: 17-24.

Rosenfeld, D.J., A.G. Gernat, J.D. Marcano, J.G. Murillo, G.H. Lopez and J.A. Flores. 1997. The effect of using different levels of shrimp meal in broiler diet. *Poult. Sci.*, 76: 581-587.

SAS Institute. 1991. SAS User's guide:Statistics. Version 6.04 Edition. SAS Institute Inc., Cary, NC.

Toan, N.H. and L.D. Ngoan. 2003. Evaluation of shrimp by-product for laying hens in smallholder systems in Thua Thien Hue province. In: Proc. Final National Seminar-Workshop on Sustainable Livestock Production on Local Feed Resources (Eds: R. Preston and B. Ogle). HUAF-SAREC, Hue city, 25-28 March, 2003. Retrieved from http:/ www.mekarn.org/sarec03/toan.htm.

Williams, S.K. and B.L. Damron. 1998. Sensory and objective characteristics of broilers fed rendered whole-hen meal. *Poult. Sci.*, 77: 329-333.

Recibido: 10-7-03. Aceptado: 19-11-03.