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Whole Rocky Fresh Water Prawns, *Caridina africana* (Kingsley, 1882) as Replacement for Fish Meal in Diets for African Catfish, *Clarias gariepinus* (Burchell, 1822)

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ABSTRACT

Specimens of *Caridina africana* were oven dried at 110°C for 24 h and refrigerated at 20°C prior to proximate analysis. Whole Rocky Fresh Water Prawn Meal (WRFWPM) was evaluated as a dietary replacement for fish meal in the diet of *C. gariepinus* fingerlings. The diets were fed to triplicate groups of *C. gariepinus* fingerlings (10.6±0.08 g) reared in concrete tanks to assess the effect of its partial or complete replacement with fish meal for 90 days. The diets comprised a control which contained fish meal as a major protein source at 0% and four others on weight basis at 25, 50, 75 and 100% in which fish meal was progressively substituted with WRFWPM. The crude protein content was 40% and fed at 4% body weight of the fish per day. Results show that the daily body weight gain, feed conversion ratio, protein efficiency ratio and protein productive values were highest in diet with 50% replacement, closely followed by diet with 25% replacement. All parameters were significantly different for all diets (p<0.05). Higher dietary inclusion of WRFWPM at 75 and 100% led to decrease in growth performance and nutrient utilization of *C. gariepinus* fingerlings. The cost of WRFWPM was significantly lower than that of fish meal. Though, the economic viability of *C. africana* is yet to be evaluated due to its tiny size, its substitution as a fish meal replacer in the diet of *C. gariepinus* is considered profitable.

Key words: *Caridina africana*, *Clarias gariepinus*, prawn, digestibility, replacement

INTRODUCTION

Fish plays an important role in food protein supply, especially in developing countries. Cultured fish need to be fed balanced diets so as to grow appreciably within a short period to meet the ever-increasing demand of animal protein which is chronically lacking in man's diet (FAO, 2000). Fish feed constitutes about 60% of the input required for high fish production in an aquaculture system and it is used at low levels in most feeds for all categories of all domesticated and cultured animals. Fish meal is the traditional protein source of choice and an essential component of the feeds of most cultured fish species. Unfortunately, fish meal is very expensive in Nigeria because Nigeria is not a fish producing country (FAO, 2002). Local availability of fish meal is not sufficient and thus, it must be imported. Hence, there is need to seek for alternative sources in order to reduce the cost of fish feed.

There has been renewed interest and concern to evaluate feed ingredients in order to partially or totally replace fish meal with other readily available and inexpensive plant and animal protein sources (Al-Ogaily and Al-Asgah, 2003; Falaye, 1992; Balogun and Ologhobo, 1989; Smith *et al.*, 1988), shrimp and prawn by-products, periwinkle, crab, lizard, frog etc are protein sources that can substitute fish meal at lesser cost. However, different species of the above protein sources have been studied and found to be of high nutritive value (Mba, 1980; Umoh *et al.*, 1980; Egwele, 1982; Akegbejo-Samson, 1999; Bello-Olusoji *et al.*, 2000; Oyekanmi, 2002, 2004).

Prawns and Shrimps are abundant in inland waters and along the seven coastal states of Nigeria where brackish water aquaculture is intensively and extensively practiced. They are locally available and cheap, especially during the flooding seasons which make them a suitable ingredient in fish diets. According to Marioghae (1980), the penaeid shrimps are mostly exploited by the industrial shrimp fishery in Nigeria except *C. africana* which is considered small in size for any relevant Catch Per Unit Effort (CPUE). Most shrimp species are favoured mainly because of their relatively large size and economic importance in the international market. Crustaceans are valued food organisms that are heavily exploited in West Africa (Chemonics, 2002). *Caridina africana*, according to Bello-Olusoji *et al.* (2004), are small in size ranging between 17.0-30.1 mm. The pleuron of the second abdominal segments overlaps those of the first and third segments. There are five pairs of walking legs (periopods) and the first and second legs (chelipeds) are shorter than the other three pairs of walking legs. The study determined the growth response of *C. gariepinus* to diets with varying levels of whole rocky fresh water prawn meal used as a replacement for fish meal. The tiny size of *C. africana* and its low market preference makes the specie a suitable choice for this study in order to enhance its economic viability.

MATERIALS AND METHODS

Caridina africana was collected at the first layer of Erin-Ijesa Waterfalls using scoop nets and locally fabricated sieves because of the shallow nature of the water body and tiny size of the species ($\bar{x}$ 0.38-0.47 g). The prawns were transported in boxes of cold water to the laboratory to subdue post mortem digestion.

Fresh fishmeal, maize and other feed ingredients were obtained fresh locally from a reputable fish feed farm in Akure.

They were boiled in hot water at 70°C for 30 min until all the water was completely absorbed in order to prevent nutrient loss. The boiled prawn product was oven dried at 110°C for 24 h and milled using Moulinex standard blender. All the feed ingredients were ground into fine particles and passed through fine mesh sieve. All diets were formulated to contain 40% crude protein (Tacon, 2003) and pelleted into 2 mm diameter sizes using locally made dice. The diets were stored in air tight polythene bags at room temperature to keep it fresh, prevent rancidity and development of *Aspergillus*. Five diets were prepared in which fish meal was replaced with whole rocky fresh water prawn meal at 0, 25, 50, 75 and 100% levels on weight basis. Amino acid level was also analysed as shown in Table 1.

C. gariepinus fingerlings were obtained from a reputable fish farm in Akure and subsequently acclimatized in concrete tanks for 2 weeks. The 25 fingerlings with mean weight of 10.6 ± 0.8 g were stocked into each concrete tank of triplicate per dietary treatment. Each concrete tank measured 2.5×0.7×0.58 m with water volume maintained at 0.17 m which was impounded with fallowed tap water from an overhead reservoir. All the fish were batched weighed weekly and feed adjustment made based on 4% body weight. The experiment lasted for 90 days.

Table 1: Amino acid composition of experimental diets and the whole body of experimental fish (g/100 g)

Amino acid	Fish fingerlings	Experimental diets				
		1	2	3	4	5
Lysine	7.61	1.17	2.01	2.50	1.03	1.08
Histidine	2.61	4.31	3.50	3.73	2.18	2.83
Arginine	5.03	2.63	5.19	5.61	3.41	3.09
Threonine	5.11	2.29	3.28	3.26	2.61	2.83
Valine	3.44	3.41	4.66	4.46	4.11	3.89
Methionine	2.43	0.50	1.93	1.43	0.41	0.53
Cysteine	1.58	2.03	2.34	2.11	1.88	1.73
Isoleucine	3.57	5.14	6.63	6.51	5.10	5.61
Tyrosine	2.51	2.80	1.93	1.78	2.16	2.44
Aspartic acid	7.78	8.44	6.33	6.35	8.68	7.98
Sarine	44.86	3.47	3.83	3.96	3.16	3.84
Glutamic acid	10.64	11.38	11.88	12.33	10.18	11.83
Glycine	6.49	4.38	4.11	3.50	4.03	4.94
Alanine	4.56	4.33	3.46	2.44	2.02	2.08

Feed ingredients, experimental diets and fish carcasses were analysed for proximate composition using the AOAC (1990) method:

$$\text{Weight gain} = \text{Final weight of fish} - \text{Initial weight of fish}$$

Specific Growth Rate (SGR) was calculated as:

$$\text{SGR (\% per day)} = \frac{\log W_2 - \log W_1}{T_2 - T_1} \times 100 \quad (1)$$

where, W_2 is weight of fish at time T_2 (final), W_1 is weight of fish at time T_1 (initial). Feed Conversion Ratio (FCR) was calculated from the relationship of feed intake and net weight gain:

$$\text{FCR} = \frac{\text{Total feed consumed by fish (g)}}{\text{Weight gain by fish (g)}} \quad (2)$$

Protein Efficiency Ratio (PER) and protein fed were estimated:

$$\text{ADG} = \frac{W_t - W_o}{t}$$

and:

$$\text{PER} = \frac{\text{Fish weight gain (g)}}{\text{Protein intake (g)}}$$

Wt and wo represent final and initial body weights of fish, respectively and t represent the experimental period. Apparent nutrient digestibility measurements using chromic III oxide as digestibility marker was determined in the faeces:

$$APD (\%) = 103 - \left(100 \times \left(\frac{Cr_2O_3 \text{ in diet} (\%)}{Cr_2O_3 \text{ in faeces}} \right) \times \left(\frac{Protein \text{ in faeces} (\%)}{Protein \text{ in diet} (\%)} \right) \right)$$

Gross energy (KJ g⁻¹ DM) was calculated as 23.43 KJ g⁻¹ for protein, 17.15 KJ g⁻¹ for carbohydrates and 39.75 KJ g⁻¹ for lipid. Cost analysis of replacing fish meal with whole rocky fresh water prawn meal based on the prevailing prices of the ingredients was assessed.

Water quality parameters were measured during each sampling. Temperature and dissolved oxygen were measured *in situ* with a WTM, OxiCal-SL portable electronic probe. The water pH was also measured with Suntex model SP-701 pH meter. Ammonia and nitrite were also measured with the aid of a visible spectrophotometer after it had been treated with Nessler's reagent. Mortality was monitored daily to determine survival (%).

Statistical analysis: Statistical comparisons of the results were made by using analysis of variance (ANOVA). Duncan's multiple range tests was also used to evaluate the difference between means for individual diets.

RESULTS AND DISCUSSION

Table 2 and 3 show the proximate composition of diets and their nutrient composition, respectively. The result shows that fish survival was high (96%) in all experimental groups (Table 4). The best growth responses were obtained with fish fed diet 3 (50% whole rocky fresh water prawn meal replacement), while the least was from diet 1 (0% WRFWPM replacement). The growth performance and nutrient utilization are shown in Table 4. The nutrient utilization parameters of fish on the different diets show that the best FCR, SGR and PER were obtained for diet 3, while the least SGR and PER were for diet 1. The highest FCR was for diet 5 (100% WRFWPM replacement). Differences obtained in the various nutritional parameters (FCR, PER, PPV) were significant for all diets (p<0.05). Final weight gain by fish fed diets 1, 2, 3, 4 and 5 was not significantly different (p<0.05).

Table 2 show that the crude protein content of the diets indicated that they met the optimal dietary protein level required by *C. gariepinus*. Fatureti *et al.* (1986) reported 40% optimal dietary protein level for fingerlings of *C. gariepinus* while Balogun *et al.* (1992) reported 37.5%. Similarly, Ayinla (1991) showed a level of 33.5% crude protein for fingerlings to adult of the same species. The cost of whole rocky fresh water prawn meal is lower than that of fish meal. The use of leaf meal as

Table 2: Proximate composition of dietary ingredients (g/100 g dry matter)

Components	Crude protein	Lipid (ether extract)	Crude fibre	Ash	Dry matter
Fish meal	70.30	8.10	2.40	9.6	93.10
Whole rocky fresh water prawn meal	58.79	5.42	0.21	14.7	79.12
Yellow maize	9.50	3.90	2.00	1.8	85.60
Blood meal	82.60	1.50	0.40	5.1	87.80
Groundnut	64.10	7.40	3.50	8.6	76.90

Table 3: Ingredients and nutrient composition (g/100 g of diets)

Ingredients	Experimental diets (%)				
	1	2	3	4	5
	0%	25%	50%	75%	100%
	WRFWPM	WRFWPM	WRFWPM	WRFWPM	WRFWPM
	100% FM	75% FM	50% FM	25% FM	0% FM
Fish meal	62.00	47.00	31.00	15.00	0.00
Whole rocky fresh water prawn meal (WRFWPM)	0.00	15.00	31.00	47.00	62.00
Yellow maize	15.00	15.00	15.00	15.00	15.00
Groundnut cake	3.00	3.00	3.00	3.00	3.00
Blood meal	9.00	9.00	9.00	9.00	9.00
Brewer's waste	4.25	4.25	4.25	4.25	4.25
Bone meal	2.50	2.50	2.50	2.50	2.50
Oyster meal	0.40	0.40	0.40	0.40	0.40
Vitamin/mineral premix	0.60	0.60	0.60	0.60	0.60
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Starch (blinder)	0.50	0.50	0.50	0.50	0.50
Vegetable oil	2.50	2.50	2.50	2.50	2.50
Chemical composition: Crude protein	38.30	37.60	38.90	3.78	36.60
Crude lipid (Ether extract)	6.81	6.45	7.63	7.49	7.33
Crude fibre	3.44	3.56	3.73	3.63	3.69
Moisture	8.88	9.41	9.83	9.46	9.49
Ash (Total)	8.61	8.78	9.44	9.53	9.59
NFE	39.96	34.20	30.47	32.09	33.30
Dry matter (DM)	87.50	88.40	88.30	89.50	89.80
Gross energy ¹ (KJ g ⁻¹ DM)	20.07	20.28	21.41	21.09	2.00

NFE: Nitrogen free extract: 100 (Moisture+crude protein+crude lipid+crude fibre+ash), ¹Calculated as 23.43 KJ g⁻¹ for lipid

Table 4: Growth performance, nutrient utilization of *Clarias gariepinus* fed diets of varying levels of whole rocky fresh water prawn meal as a replacement for fish meal

Parameters	Diet					SEM
	1	2	3	4	5	
	0%	25%	50%	75%	100%	
	WRFWPM	WRFWPM	WRFWPM	WRFWPM	WRFWPM	
	100% FM	75% FM	50% FM	25% FM	0% FM	
Initial mean weight (g)	10.73	10.57	10.56	10.56	10.61	
Final (Mean) weight (g)	38.40 ^a	38.40	43.51 ^a	38.18 ^a	36.91 ^a	1.71
Survival (%)	96.00 ^a	96.00 ^a	97.00 ^a	96.00 ^a	96.00 ^a	1.04
Average daily weight gain	0.50 ^a	0.50 ^a	0.59 ^a	96.00 ^a	0.47 ^a	0.12
Specific growth rate	2.30 ^{ab}	2.30 ^{ab}	32.53 ^a	0.47 ^a	2.23 ^b	0.08
Food conversation ratio	2.33 ^a	2.33 ^a	2.16 ^a	2.30 ^{ab}	2.62 ^b	0.16
PER	2.74 ^{ab}	2.74 ^{ab}	2.85 ^b	2.16 ^a	2.72 ^a	0.02
PPV (%)	35.34	35.34 ^a	38.63 ^a	2.73 ^a	36.18 ^a	1.40
Apparent protein digestibility (%)	83.11 ^{ab}	83.11 ^{ab}	86.61 ^{ab}	87.81 ^a	86.14 ^a	1.61
Moisture	8.86	7.58	8.61	8.63	7.23	1.14
Protein	66.80	69.44	72.41	70.88	70.46	1.99
Ash	113.01	13.612	12.63	12.76	12.76	1.37
Crude fibre	2.70	2.73	2.61	2.55	2.46	0.33
Ether extract	8.63	6.64	4.19	5.18	7.19	1.82

Values in the same row having same letter are not significantly different (p<0.05). SEM: Standard error of the error of the pooled means

a possible fish meal substitute to reduce the cost of fish feed is receiving increasing attention by fish nutritionists around the world (Bairagi *et al.*, 2004; Amisah *et al.*, 2009). It is, however, important that the selected protein sources do not conflict with human food security interests.

Table 1 shows the calculated levels of Essentials Amino Acids (EAA) composition of the different diets. When compared to the EAA of the whole fingerlings, diet 3 shows a close relationship. That means that the performance of diet 3 implied a better balance of amino acids. This is similar to the findings of Smith *et al.* (1988). This is closely followed by diet 2 (25% WRFWPM replacement) as shown in Table 4.

CONCLUSION AND RECOMMENDATION

Results of this study show that 50% replacement of whole rocky fresh water prawn meal with fish meal in practical diets of *C. gariepinus* is preferable based on final weight. Inclusion at 25% ranked next and showed a slightly better performance when compared to diets 4 and 5. Fair feed conversion ratio and growth rate were evident in diets that had 75 and 100% whole rocky fresh water prawn meal inclusion. It could be recommended that a higher percentage of whole rocky fresh water prawn meal inclusion is not recommended for *C. gariepinus*, 50% inclusion will go a long way to reduce the cost of fish meal by 50% as the cost of whole rocky fresh water prawn meal is significantly lower than that of fishmeal and it is readily available in some fresh waters especially Erin-Ijesa waterfalls and Osun State, Nigeria (Oyekanmi, 2011) where the species was obtained.

REFERENCES

- AOAC, 1990. Official Methods of Analysis. 12th Edn., Association of Official Analytical Chemists, Washington, DC., USA.
- Akegbejo-Samson, Y., 1999. Growth response and nutrient digestibility by *Clarias gariepinus* fed varying levels of dietary periwinkles flesh as replacement for fishmeal in low cost diets. Applied Trop. Agric., 4: 37-41.
- Al-Ogaily, S.M. and N.A. Al-Asgah, 2003. Effect of feeding different levels of alfalfa meal on the growth performance and body composition of Nile Tilapia (*Oreochromis niloticus*). Fingerlings. Asian Fisher. Sci., 16: 59-67.
- Amisah, S. M.A. Oteng and J.K. Ofori, 2009. Growth performance of the African catfish, *Clarias gariepinus*, fed varying inclusion levels of *Leucaena leucocephala* leaf meal. J. Applied Sci. Environ. Manage., 13: 21-26.
- Ayinla, A.O., 1991. Feed requirement ad fattening of broodstock. Proceedings of the Fish Seed Propagation Course, August 14-28, 1991, Logos, Nigeria, pp: 20-23.
- Bairagi, A., K. Sarkar Ghosh, S.K. Sen and A.K. Ray, 2004. Evaluation of the nutritive value of *Leucaena leucocephala* leaf meal, inoculated with fish intestinal bacteria *Bacillus subtilis* and *Bacillus circulans* in formulated diets for rohu, *Labeo rohita* (Hamilton) fingerlings. Aquacul. Res., 85: 436-446.
- Balogun, A.M. and A.D. Ologhobo, 1989. Growth performance and nutrient utilization of fingerling *Clarias gariepinus* (Burchell) fed raw and cooked soybean diets. Aquaculture, 76: 119-126.
- Balogun, A.M., O. Oluayo and E.A. Fasakin, 1992. Protein and amino acid requirements of warm water fishes: A Tool to efficient and low-cost fish feed production in Nigeria. Proceedings of the 10th Annual Conference of the Fish Society of Nigeria, November 16-20, 1992, Abeokuta, pp: 95-104.

- Bello-Oluseji, A.O., F.B. Oyekanmi and E.A. Fasakiin, 2000. Nutritional values and flesh yield of some unprotected crustaceans in the South Western Nigeria. Proceedings of the 14-15th Annual Conference/International Workshop of Nigeria Association for Aquatic Science, October 25-28, 2000, Nnamdi Azikwe University, Awka, pp: 14-14.
- Bello-Oluseji, A.O., A.T. Omolayo and A. Arinola, 2004. Taxonomical studies on rocky freshwater prawns at Erin-Ijesha waterfalls. *J. Food Agric. Environ.*, 2: 280-283.
- Chemonics, 2002. Subsector assessment of the Nigerian shrimp and prawn industry. Subsector assessment of the Nigerian shrimp and prawn industry. USAID PCE-I-00-99-00003-00, Chemonics International Inc., Washington, DC., USA., November, 2002, pp: 1-85. http://pdf.usaid.gov/pdf_docs/PNACY677.pdf
- Egwele, A.U., 1982. The chemical and biological evaluation of the nutritive value of some lesser-eaten protein sources. M.Sc. Thesis, University of Ibadan, Nigeria.
- FAO, 2000. The State of World Fisheries and Aquaculture. Food and Agriculture Organization (FAO), Rome, Italy.
- FAO, 2002. Farming fresh water Prawns: A manual for the culture of the giant river prawn. (*Macrobrachium rosenbergii*). FAO Fisheries Technical Paper No. 428, FAO, Rome, Italy, pp: 1-72.
- Falaye, A.E., 1992. Utilization of agro-industrial wastes as fish feed stuffs in Nigeria. Proceedings of the 10th Annual Conference of the Fish Society of Nigeria, November 16-20, 1992, Nigeria.
- Faturoti, E.O., A.M. Balogun and L.L.C. Ogwu, 1986. Nutrient utilization and growth responses of *Clarias lazera* fed different dietary protein levels. *Niger. J. Applied Fish. Hydrobiol.*, 1: 41-45.
- Marioghae, I.E., 1980. Review of research on panacid shrimps in Nigeria. Proceedings of the Workshop on the Niger Delta Mangrove Ecosystem, May 19-23, 1980, University of Port-Harcourt.
- Mba, A.U., 1980. Chemical composition of some local sources of protein foods for man. *Nig. J. Nutr. Sci.*, 1: 142-147.
- Oyekanmi, F.B., 2002. Comparative studies of the nutritional value, flesh yield, waste yield and length weight relationship of fresh and marine shrimp of commercial importance. *Int. J. Emerging Sci.*, 5: 145-154.
- Oyekanmi, F.B., 2004. Shrimp by-product meal as replacement for fish meal in diets for catfish, *Clarias gariepinus* (Burchel, 1822). *Pacesetter J.*, 11: 127-137.
- Oyekanmi, F.B., 2011. Bio-ecology of fresh water prawns *Macrobrachium vollenhovenii* (Herklots, 1857) and *Caridina africana* (Kingsley, 1822) at Asejire Lake and Erin-Ijesa waterfalls, Osun State, Nigeria. Ph.D. Thesis, University of Agriculture, Nigeria.
- Smith, R.R., H.L. Kincaid, J.M. Regenstein and G.L. Rumsey, 1988. Growth, carcass composition and taste of rainbow trout of different strains fed diets containing primarily plant or animal protein. *Aquaculture*, 70: 309-321.
- Tacon, A.G.J., 2003. Global Trends in Aquaculture and Compound Aquafeed Production. In: *Aquafeed Directory and Buyer's Guide 2003*, Tacon, A.G.J. (Ed.). International Turret RAI, Uxbridge, pp: 8-23.
- Umoh, I.B., E.O. Ayalogu and O. Bassir, 1980. Evaluation of the nutritive value of some lesser known protein sources in Nigerian peasant diets. *Ecol. Food Nutr.*, 9: 81-86.