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Whole rocky fresh water prawns, *Caridina africana* as replacement for fish meal in diets for African catfish (*Clarias gariepinus*)

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Abstract

Specimens of Caridina africana were oven dried at 110°C for 24 hours and refrigerated at 20°C prior to proximate analysis. Whole rocky freshwater 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±0.08g) 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; 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 shows 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 of 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.

Keywords: C. africana, C. gariepinus, prawn, digestibility, replacement, proximate.

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 (Ali et al., 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; Yemi–Akegbejo Samsons, 1999; Bello–Olusoji et al. 2000; and Oyekanmi, 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 making 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 17.0-30.1mm. 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 (x 0.38-0.47g). 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 minutes 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 hours and milled using Moulinex standard blender. All he 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 2mm 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 analyzed as shown in Table 4

C. gariepinus fingerlings were obtained from a reputable Fish farm in Akure, and subsequently acclimatized in concrete tanks for two weeks. 25 fingerlings with mean weight of 10.6±0.8g were stocked into each concrete tank of triplicate per dietary treatment. Each concrete tank measured 2.5m x 0.7m x 0.58m 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.

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

Weight gain = Final weight of fish - Initial weight of fish, Specific growth rate (SGR) was calculated as:

SGR (% per day) = (Loge W2 - Loge W1) × 100 (1) T2 – T1 1 Where: W2 = Weight of fish at time T2 (final) W1 = Weight of fish at time T1 (initial) Feed conversion ratio (FCR). This was calculated from the relationship of feed intake and net weight gain.

FCR = Total feed consumed by fish (g) (2) Weight gain by fish (g), protein efficiency ratio (PER) and protein fed were estimated. ADG = wt – wo/t; SGR = 100 (In wt – In wo/t), FCR = weight of feed (g)/fish weight gain (g) and PER = fish weight gain (g) / 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 – (100 x (% Cr_2O_3 in diet/Cr_2O_3 in faeces) x (% protein in faeces / % Protein in diet). Grass energy (KJ per g DM) was calculated as 23.43KJ g^{-1} for protein, 17.15KJ g^{-1} for Carbohydrates, 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 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

Tables 1 and 2 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 3). 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 3. 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, EPR, 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 1 show that the crude protein content of the diets indicated that they met the optimal dietary protein level required by *C. gariepinus*. Faturoti 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 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 4. 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 similar to the findings of Smith et al, (1988). This is closely followed by Diet 2 (25% *WRFWPM* replacement) as shown in Table 3.

Table 1: Proximate composition of dietary ingredients (g/100g dry matter).

Components	Crude protein	Lipid (ether extract)	Crude fibre	Ash	Dry matter
Fish meal	70.30	8.10	2.40	9.60	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	1.80	85.60
Blood meal	82.60	1.50	0.40	5.10	87.80
Groundnut	64.10	7.40	3.50	8.60	76.90

Table 2: Ingredients and nutrient composition (g/100g) of diets.

Ingredients	Experimental diets (%)				
	1 0% WRFWPM 100% FM	2 25% WRFWPM 75% FM	3 50% WRFWPM 50% FM	4 75% WRFWPM 25% FM	5 100% WRFWPM 0% FM
Fish meal	62	47	31	15	0
Whole rocky fresh water prawn meal (WRFWPM)	0	15	31	47	62
Yellow Maize	15	15	15	15	15
Groundnut Cake	3	3	3	3	3
Blood meal	9	9	9	9	9
Brewer's waste	4.25	4.25	4.25	4.25	4.25
Bone meal	2.5	2.5	2.5	2.5	2.5
Oyster meal	0.4	0.4	0.4	0.4	0.4
Vitamin/mineral premix	0.6	0.6	0.6	0.6	0.6
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Starch (blinder)	0.5	0.5	0.5	0.5	0.5
Vegetable oil	2.5	2.5	2.5	2.5	2.5
Chemical composition: crude protein	38.3	37.6	38.9	3.78	36.6
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[1]	39.96	34.20	30.47	32.09	33.30
Dry matter (DM)	87.5	88.4	88.3	89.5	89.8
Gross energy[2] (KJ per g DM)	20.07	20.28	21.41	21.09	2

1. Nitrogen free extract: 100 (moisture + crude protein + crude lipid + crude fibre + ash). 2. Calculated as 23.43KJg^{-1} for lipid.

Table 3. Growth performance, nutrient utilization of catfish fed diets of whole rocky fresh water prawn meal as replacement for fish meal.

Parameter	Diet					SEM
	1 0% WRFWPM 100% FM	2 25% WRFWPM 75% FM	3 50% WRFWPM 50% FM	4 75% WRFWPM 25% FM	5 100% WRFWPM 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^{a}	96^{a}	97^{a}	96^{a}	96^{a}	1.04
Average daily weight gain	0.50^{a}	0.50^{a}	0.59^{a}	96^{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^{b}	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 denotes standard error of the error of the pooled means

Table 4. Amino acid composition of experimental diets and the whole body of experimental fish (g per 100g).

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

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, Osun State Nigeria (Oyekanmi, 2011) where the specie was obtained.

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