

# Growth Performance and Nutrient Utilization of African Catfish (*Clarias gariepinus*) Juveniles Fed Varying Inclusions of Defatted African Palm Weevils (*Rhynchophorus phoenicis*) Meal

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## Abstract

A feeding trial was conducted to examine the dietary effects of using African Palm weevil in the diet of Catfish. Five experimental diets containing 40% crude protein were formulated, four of these diets contained defatted African palm weevil larvae meal at varying inclusion levels denoted as APW25%, APW50%, APW75% and APW100% while the diet with fish meal (APW0%) served as control diet. The experiment was conducted in triplicates for 10 weeks using 15 aquaria glass tanks with 10 fish per tank. The percentage weight gain was significantly different ( $P>0.05$ ) across the fish fed experimental diets, with the highest percentage weight gain (1118.30g) recorded in fish fed diet APW100 and the lowest percentage weight gain (749.40g) recorded in fish fed diet FM. The feed conversion ratio (FCR) were not significantly different ( $P<0.05$ ) across the experimental diet. The highest FCR value ( $1.48\pm 0.42$ ) was recorded in the fish fed diet FM while the lowest FCR value ( $1.06\pm 0.01$ ) was recorded in fish fed diet APW100. There were no significant differences ( $P>0.05$ ) in the PER among the experimental diets. It could be concluded that defatted African palm weevil larvae meal in the diet in replacement of fishmeal in the diet *Clarias gariepinus* juvenile.

## Introduction

The growth of aquaculture depends on the availability of good quality and relatively inexpensive feed ingredients for the formulation of fish diet, supplemental feed brings greater yields in ponds than if the fish were left to depend on natural (aquatic) food, various feeds are used in culturing fishes to enhance adequate fish growth, reproduction and survival (Miles and Chapman, 2006).

The source of fish feed, such as fishmeal are very expensive especially imported ones because of high rate of foreign exchange, while aquaculture's share of fish meal and fish oil consumption has been increased reaching 88% by 2007 as reported by Tacon and Metian, (2008). Fishmeal which serves as the main protein source for fish feed because of its high quality protein

content, is not only expensive but also usually unavailable Tacon and Barg (1998), particularly in developing countries. Fagbenro and Davies (2003) and Ogunji *et al.*, (2003) reported that efforts have been made to replace fishmeal with vegetable protein from other sustainable sources by many researchers. The production of fish meal decreased between 1994 and 2012 and is now about 5 to 6 million tonnes (Médale *et al.*, 2013) and (FAO, 2014). As a consequence, there has been an ongoing search for alternative sources of protein that would allow aquaculture to remain economically and environmentally sustainable (Barroso *et al.*, 2014).

Approximately 1,900 insect species are eaten worldwide, mainly in developing countries (Arnold, 2013). They constitute quality food and feed, Furthermore, in the recent years, insects have received

wide attention as a potential source of protein both for humans and livestock. Research have shown current status on the insects that are the best candidates as fish feed ingredients in partial or complete substitution for fish meal, with regard to their nutritional attributes, ease of rearing, and biomass production. According to Riddick *et al.*, (2013) larvae or pupae of Diptera black soldier fly (*Hermetia illucens*) and house fly (*Musca domestica*), larvae of mealworm *Tenebrio molitor* (Coleoptera), adult Orthoptera and pupae of silkworm *Bombyx mori* (Lepidoptera) has been used as replacement for fishmeal, and the results were positive.

The larva of the African palm weevils (*Rhynchophorus phoenicis*) popularly known as "Edible worm" is a delicacy in many parts of Nigeria and other countries in Africa where it is found (Ekpo, 2003). Several researches have been done on the nutritional composition of African palm weevils *Rhynchophorus phoenicis* with a protein content of (66.09% CP) as reported by Elemo *et al.*, (2011), as well as the anti-nutritional factor which gives information on the usefulness of *R. phoenicis* in the animal and fish feeds as an alternative protein source (Ekpo, 2003). To the knowledge of this researcher no work has been done on the incorporation of this useful insect in animal or fish feeds. This research is therefore, aimed at evaluating for the first time, the substitution of fish meal with African palm weevil larvae meal, in catfish diets. It is believed that this study would provide the springboard on the usefulness of African palm weevil meal in the diet of *Clarias gariepinus* juvenile, and thus provide an inexpensive animal protein source for aquafeeds.

## Materials and Method

The experiment was carried out at the Teaching and Research Farm of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria.

## Sample Collection

Samples of *R. phoenicis* were obtained from the wild, the larvae were cleaned thoroughly with water and transported to the laboratory in a well-ventilated plastic container and was oven dried at 80°C for 24hrs as recommended by Banjo *et al.* (2006). The larvae were defatted (i.e. the fat content was extracted) by the method of (Bligh and Dyer, 1959). Proximate analysis of the defatted sample was done according to the method described by (AOAC, 2010).

## Preparation of Experimental Diets

Five iso-nitrogenous diets were formulated to contain 40% crude protein with varying proportions at 0% (Control), 25% (APW), 50% (APW), 75% (APW), and 100% (APW) inclusion level of defatted *R. phoenicis* meal using trial and error method. The feed components include yellow maize, fish meal, soya beans, wheat offal, iodized salt, vegetable oil and vitamin premix trial (Table 1). Each of the feed ingredients was weighed and poured on a plastic container which was thoroughly mixed together thereafter boiled water. The dough was pelleted using a Horbart A-200T mixing and pelleting machine. The pellets were of 2mm in diameter. The pelleted diets were sun-dried on raised platform.

## Feeding Trial

This was conducted in 15 aerated glass tanks (0.3x05x. Juvenile from the same brood stocks were weighted and stocked randomly at ten (10) juvenile per tank in 60 litres of domestic water within the fish farm of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure, Ondo State, Nigeria. The juveniles were fed experimental diets twice daily at 5% body weight between 8.00-9.00 hours and 16.00-17.00 hours

**Table 1.** Gross Composition of Experimental Diet (g/100g)

Ingredient	APW0	APW25	APW50	APW75	APW100
Fishmeal (65%CP)	35	26.25	17.50	8.75	-
<i>R. phoenicis</i> (66%CP)	-	8.62	17.23	25.85	34.46
Soybean meal(48%CP)	30	30	30	30	30
Fish oil	1	1	1	1	1
Maize	24	24.13	24.27	24.40	24.54
Salt	2	2	2	2	2
Starch	5	5	5	5	5
Premix	3	3	3	3	3
Total	100	100	100	100	100
Cost / (1kg)	682.1	611.74	541.35	471	399.94
Estimated Crude Protein (%)	39.05	39.05	39.05	39.05	39.05
Proximate Composition(%)					
Moisture	4.2	4.2	5.5	8.5	6.3
Ash	20.38	18.6	18.6	15	14.8
Crude Protein	39.75	41.40	41.65	42.88	43.75
Crude Fibre	0.82	1.23	1.63	1.60	1.95
Lipid	8.0	8.6	8.6	8.3	8.6
NFE	26.85	25.75	24.02	23.72	24.60

throughout the study period of 70 days. Feeding was monitored for each unit to ensure that fishes were not underfed or overfed. Experimental units were cleaned daily while changing of total water was done twice a week. Weekly weight gain and feed intake was recorded fortnightly. An electronic table top weigh balance (Metler, PB8001 UK) was used in weighing the fish and feed. The data on weight gain; feed conversion ratio and survival rates for the dietary. Water quality parameters of the experiment varied as follows: temperature, pH, dissolved oxygen and conductivity of the culture water used for the 15 treatments. Temperature was 28.05°C to 28.45°C, pH 6.60 to 6.75, dissolved oxygen 5.4 to 5.9mg/l and conductivity was 270.5 to 329.5s/m.

Growth Parameters were assessed by using the following formula

$$\text{Mean Weight Gain} = \text{Final Weight Gain} - \text{Initial Weight Gain}$$

$$\text{Specific growth rate} = \frac{\log_e W_2 - \log_e W_1}{T} \times 100$$

Where

$W_2$  = Final Body Weight

$W_1$  = Initial Body Weight of fish

T = Duration of study in days

$$\text{Daily Growth Rate} = \frac{\text{fish weight gain}}{\text{number of culture days}}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{total dry feed intake by fish(g)}}{\text{wet weight gain by fish(g)}}$$

$$\text{Survival rate (SR)} = \frac{N_1 - N_0}{N_1} \times 100$$

Where

$N_0$  = number of fish stocked

$N_1$  = number of fish at the end of experiment

$$\text{Protein Gain} = \text{Final Carcass weight} - \text{Initial Carcass weight}$$

$$\text{Protein Fed} = \frac{\%CP \text{ Feed} \times \text{Feed Intake}}{100}$$

$$\text{Protein Efficiency Ratio} = \frac{\text{Fish weight gain}}{\text{protein fed}}$$

$$\text{Apparent Net Protein Utilization} = \frac{\text{Net protein gain}}{\text{protein fed}} \times 100$$

Proximate analysis of diets and experimental fish was done using the methods described by AOAC (2010). Data were analysed by oneway ANOVA (Analysis of Variance) using Statistical Package for Social Sciences (SPSS v.21). Means were separated using New Duncan Multiple Range Test (DMRT).

## Results

### Proximate Composition of Defatted African Palm Weevil Larvae Meal (*Rhynchophorus phoenicis*) and Fishmeal

The result of the proximate composition of defatted African palm weevil larvae meal

(*Rhynchophorus phoenicis*) and fishmeal is presented in Table 2. The proximate composition of defatted African Palm Weevil larvae compares favourably with the fish meal used in this experiment. The crude protein content of African palm weevil was 65.58% as compared to 64.86% for fish meal.

### Growth Performance and Nutrient Utilization

The growth performance and nutrient utilization of African Mud Catfish fed experiment diets is presented in Table 3. There was significant difference in the final mean weight (FWG), mean weight gain (MWG), daily growth rate (DGR), and specific growth rate (SGR). The final weight gain increases as the inclusion level of APW increases. There was no significant difference ( $P < 0.05$ ) in the Feed conversion ratio (FCR), Protein intake, Protein Efficiency ratio (PER) and Survival across the treatments. Fish fed diet APW100 had the highest MWG, DGR, SGR, Protein Intake, PER and the lowest FCR. Fish fed diet APW0 had the lowest MWG, DGR, SGR, Protein Intake, PER and the highest FCR.

The mean weight gain recorded in this study ranged from 41.76±6.22 in APW0 to 62.23±2.36g in APW100. Fish fed diet APW100 recorded the highest Specific Growth Rate (SGR) value of 1.55±0.03 and the lowest of 1.31±0.08 in fish fed diet APW0. The fish fed diet APW0 recorded the highest feed conversion ratio (FCR) value of 1.48±0.42 and the lowest value is recorded in fish fed diet APW100 of 1.06±0.01. The protein efficiency ratio (PER) ranged from 1.75±0.3 to 2.31±0.02, which was highest in fish fed diet APW75 and lowest in fish fed diet FM. The result obtained for PER shows that there were no significant differences ( $P > 0.05$ ) among the diets. The percentage survival in all the fish fed experimental diets were not significantly different ( $P > 0.05$ ) from each other. The fish fed diet APW0 had the lowest percentage survival value of 76.66% and fish fed diet APW75 and APW100 had the highest value of 96.66% and 96.66% respectively.

### Carcass Composition of African Mud Catfish *Clarias gariepinus* Juvenile Fed Experimental Diet for 70 days

Result of carcass composition of experimental fish fed experimental diets is presented in Table 4. Crude protein content of carcass of fish fed varying inclusion level of APW was significantly different ( $P < 0.05$ ). The highest crude protein was obtained in fish fed diet APW100 (62.86±0.02%) while control diet had the lowest crude protein (60.22±0.06%). The crude protein content of initial fish was significantly higher than those of experimental fish at the end of the experiment. There was significant difference ( $P < 0.05$ ) in the ash content of experimental fish. The ash content was highest in diet APW100 (14.60±0.00%) and least in diet APW25 (12.33±0.57%). The highest fat content was obtained in fish fed diet APW25 (18.00±0.00%) while the least was

**Table 2.** Proximate Composition of Defatted African Palm Weevil Larvae Meal (*Rhynchophorus phoenicis*) and Fishmeal

Components	Mean value	
	APW %	FM %
Moisture	9.00	8.60
Ash	12.00	14.00
Lipid	4.00	9.00
Protein	65.58	64.86
Fibre	1.49	0.07

**Table 3.** Growth Performance and Nutrient Utilization of African Mud Catfish *Clarias gariepinus* Juveniles Fed Experimental diets for 70days

Parameters	APW0	APW 25	APW 50	APW 75	APW 100
Initial Mean weight	5.57±0.00 <sup>a</sup>	5.56±0.01 <sup>a</sup>	5.48±0.01 <sup>a</sup>	5.57±0.00 <sup>a</sup>	5.56±0.01 <sup>a</sup>
Final Mean Weight	47.33±6.22 <sup>a</sup>	50.27±0.87 <sup>a</sup>	63.20±2.35 <sup>b</sup>	63.34±0.78 <sup>b</sup>	67.79±2.37 <sup>b</sup>
Mean weight gain	41.76±6.22 <sup>a</sup>	44.71±0.88 <sup>a</sup>	57.72±2.45 <sup>b</sup>	57.77±0.77 <sup>b</sup>	62.23±2.36 <sup>b</sup>
Daily growth rate	0.59±0.08 <sup>a</sup>	0.63±0.01 <sup>a</sup>	0.82±0.03 <sup>b</sup>	0.82±0.01 <sup>b</sup>	0.88±0.03 <sup>b</sup>
Specific growth rate	1.31±0.08 <sup>a</sup>	1.36±0.01 <sup>a</sup>	1.51±0.03 <sup>b</sup>	1.50±0.01 <sup>b</sup>	1.55±0.03 <sup>b</sup>
Total feed intake	61.76±5.29 <sup>a</sup>	57.46±3.89 <sup>a</sup>	64.55±4.00 <sup>a</sup>	62.54±1.54 <sup>a</sup>	66.42±2.37 <sup>a</sup>
FCR	1.48±0.42 <sup>a</sup>	1.28±0.06 <sup>a</sup>	1.11±0.02 <sup>a</sup>	1.08±0.01 <sup>a</sup>	1.06±0.0 <sup>a</sup>
Protein intake	24.70±2.11 <sup>a</sup>	22.98±1.55 <sup>a</sup>	25.82±1.60 <sup>a</sup>	25.01±0.61 <sup>a</sup>	27.361±0.94 <sup>a</sup>
PER	1.75±0.36 <sup>a</sup>	1.95±0.10 <sup>a</sup>	2.24±0.04 <sup>a</sup>	2.31±0.02 <sup>a</sup>	2.27±0.04 <sup>a</sup>
Nitrogen Metabolism	789.26 ±11.56 <sup>a</sup>	845.02 ±16.75 <sup>a</sup>	1091.00±46.31 <sup>b</sup>	1091.00±14.71 <sup>b</sup>	1176.10±44.64 <sup>b</sup>
%Survival	92.66±8.81 <sup>a</sup>	90.00±5.77 <sup>a</sup>	93.33±6.66 <sup>a</sup>	96.66±3.33 <sup>a</sup>	96.66±3.33 <sup>a</sup>

Means on the same row with different superscripts are significantly different (P<0.05)

**Table 4.** Carcass Composition of African Mud Catfish *Clarias gariepinus* Juveniles Fed Experimental Diet for 70days

Parameter	Initial	APW0	APW 25	APW 50	APW 75	APW 100
Moisture	6.00±0.01 <sup>e</sup>	4.60±0.05 <sup>a</sup>	4.71±0.15 <sup>b</sup>	4.90±0.05 <sup>c</sup>	5.00±0.15 <sup>d</sup>	4.60±0.00 <sup>a</sup>
Ash	12.14±0.22 <sup>a</sup>	14.33±0.57 <sup>b</sup>	12.33±0.57 <sup>a</sup>	14.00±0.00 <sup>b</sup>	12.80±0.17 <sup>a</sup>	14.60±0.00 <sup>b</sup>
Crude Protein	64.50±0.00 <sup>f</sup>	60.22±0.06 <sup>a</sup>	62.62±0.05 <sup>d</sup>	62.40±0.05 <sup>b</sup>	62.51±0.01 <sup>c</sup>	62.86±0.02 <sup>e</sup>
Fat	9.00±0.00 <sup>a</sup>	14.00±0.00 <sup>b</sup>	18.00±0.00 <sup>c</sup>	14.00±0.00 <sup>b</sup>	17.66±0.51 <sup>c</sup>	14.00±0.00 <sup>b</sup>
Crude fibre	0.07±0.00 <sup>a</sup>	0.06±0.00 <sup>a</sup>	0.07±0.01 <sup>a</sup>	0.07±0.36 <sup>a</sup>	0.08±0.00 <sup>a</sup>	0.08±0.00 <sup>a</sup>
NFE	8.29±0.00 <sup>d</sup>	6.79±0.06 <sup>c</sup>	2.27±0.57 <sup>a</sup>	4.63±0.01 <sup>b</sup>	1.95±0.05 <sup>a</sup>	3.86±2.82 <sup>b</sup>

Values are presented as mean ± SD; values with similar superscripts on the same row are not significantly different (P>0.05)

in fish fed diet APW0, APW50 and APW100 (14.00±0.00%). There was significant difference in the NFE content of experimental fish.

## Discussion

The result of this study showed an increase in the body weight of the experimental fish. The experiment showed that there was a general increase in weight gain in all the treatment which indicates that the experimental fish were able to convert feed protein to flesh or body tissue. It was observed from the study that the mean weight gain of the fish showed that fish fed diet APW50, APW75 and APW100 had no significant

difference (P>0.05) with the value of 57.72g, 57.77g and 62.23g respectively. The superiority shown could be attributed to the high protein content of the insect. The findings from this study also agree very closely with those of Ajonina and Nyambi (2013), who observed the best growth performance of *Clarias gariepinus* fingerlings, fed experimental diets containing dried maggot meal over those solely fed on fish meal diet. Fasakin *et al.*, (2003) reported that fish performed better when fed diets containing defatted maggot meals than full-fat maggot meal, and compared favourably with fish fed the fish meal-based diet.

The non-significant differences (P>0.05) of the evaluated growth and nutrient utilization indices among

the five treatments imply that African palm weevil larvae meal can successfully replace the entire fishmeal portion of the fish diet. This study corroborates with the finding of Ogunji *et al.* (2006), who observed a better growth performance and nutrient utilization of *Clarias gariepinus* fed experimental diets containing maggot meal over those solely fed on fish meal diets. This is a reflection of the nutritive quality and acceptance of this biomaterial. These results are also in agreement with Alegbeleye *et al.*, (1991) and Idowu *et al.*, (2003) who reported that maggot meal, like other animal protein sources was well accepted and utilized by catfish *Clarias gariepinus*.

The non-significant difference ( $P>0.05$ ) in the values of FCR of fish fed experimental diet which ranged from  $1.08\pm 0.01$  to  $1.48\pm 0.42$  is possibly indicative that both protein sources compared favourably in feed to flesh conversion. It has been reported that the biological value of maggot meal is equivalent to that of whole fish meal (Ajani *et al.*, 2004). This fact is further strengthened by the results obtained in this study. The PER values were good and not significantly different ( $P>0.05$ ) from control diet, which ranged between  $1.75\pm 0.36$  to  $2.31\pm 0.01$  and this corroborate with the results reported by Adebayo and Quadri (2005), that amino acid profile of maggot meal is similar to that of fish meal and meat meal, with a positive linear effect on the fish body protein of *Heterobranchus bidorsallis*.

The cost of producing a kilogram of African Palm Weevil larvae ranged from N399.94k - N611.74k is low when compared with Fish meal of N682.10k this indicate that using APW in replacement to Fish meal can reduce cost of production.

The proximate composition of the carcass of fish fed the experimental diets showed significant difference ( $P<0.05$ ), the crude protein values obtained for the fish fed experimental diet were significantly lower than the initial fish with a range of  $60.22\pm 0.06$  to  $64.50\pm 0.02$ , the high in crude protein of the initial fish could be due to the foreign feed (skretting) given to fish before they were acquired for the experiment. The final fat content values of the fish on all the diet were significantly higher than the initial ( $P<0.05$ ) with a range of  $9.00\pm 0.00$  to  $18.00\pm 0.00$ . This increase in lipid deposits in the carcass of fish fed experimental diet of defatted African palm weevil larvae meal could be due to fish oil used for the formulation of the experimental diet which may be responsible for the better growth in terms of weight rather than the crude protein. It has also been reported that defatted African palm weevil larvae meal is rich in essential amino acids necessary for growth and development as reported by FAO, (1991), Ekpo and Onigbinde, (2005).

The result obtained is in agreement with the finding of Ng *et al.*, (2001) who reported that catfish fed dried mealworm-based diets had significantly more lipids in their carcass, and Makkar *et al.*, (2014) reported similar result for channel catfish fed defatted black soldier fly larvae meal. This study reveals the possibility

of utilizing defatted African palm weevil larvae meal in the diet of *Clarias gariepinus* juvenile.

## Conclusion

This study shows that feeding African mud catfish, *Clarias gariepinus* juvenile with diets containing defatted African palm weevil, *R. phoenicis* meal gave better growth performance, carcass composition, and nutrient utilization. African Mud Catfish, *Clarias gariepinus* was able to utilize defatted African palm weevil meal as protein source better than fishmeal. The protein content of African palm weevil, *R. phoenicis* is enhanced if some level of defatting is done to further increase the protein component thus reducing overhead cost associated with fishmeal importation in developing countries like Nigeria.

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