\Faculty of Natural and Applied Sciences Journal of Scientific Innovations
Print ISSN: 2814-0877 e-ISSN: 2814-0923
www.fnasjournals.com
Volume 7; Issue 1; December 2025; Page No.82-88.
DOI: https://doi.org/10.63561/fnas-jsi.v7i1.1133

Growth Performance of *Clarias gariepinus* Fed Diet Containing *Rhynchophorus ferrugineus* (Red Palm Weevil Larvae) as a Replacement for Fish Meal

[1]Ohiri, R.C., *[2]Wogboroma, S.E., &[1]Essien, E.B.
[1]Department of Biochemistry, University of Port Harcourt,Choba, Nigeria.
[2]Department of Chemistry, Ignatius Ajuru University of Education, Port Harcourt, Nigeria.

***Corresponding author email:** sandrawogboroma@iaue.edu.ng

Abstract
This work was carried out to determine the potential use of *Rhynchophorus Ferrugineous* (red palm weevil larva (PWL) to substitute fish meal in fish feed. Nine groups of eight fishes each totaling 72 were given three types of feed. One feed was formulated with 100% PWL, another with 100% fish meal using trial and error method and a commercial fish feed. All feeds were analyzed and administered to the fishes. Proximate analysis of the feed samples showed crude protein composition to be 33%, 36% and 33% respectively. The fishes were given the feeds at quantities weighing 4% of their body weight daily. Highest weight gains were observed in all fishes at week 3 with a value of 101$\pm$9.00g for PWL groups, fish meal (FM) groups had 128.0$\pm$14.00g, while commercial fish feed (CFF) groups had 124$\pm$27.22g. These changes in weight were not statistically significant when compared with each other at $P \geq 0.05$. The CFF group had the highest specific growth rate of 3.20g per day, while FM fish had 3.10g per day. PWL fishes by week three had the highest feed conversion ratio of 1.06$\pm$0.13. PWL and FM had mortality rate of 4.00% while the CFF had mortality rate of 0.00%. PWL can be used as alternative to FM in fish diet because PWL fishes had high feed conversion ratio and no significant difference in weight gain between groups; however, further research can be used to determine if various combined inclusions of FM and PWL would produce better growth performance.

Keywords: Palm Weevil Larvae, Fish Meal, Feed Formulation, Defatted, Oven Dried

Introduction

Fish is an English word that is related to the Latin word '*Piscis*' (online, Oxford University press, nd). They are animals that live in water, possess gills, back bone and have no legs and they include hag fishes, bony and cartilaginous fishes (Abdulkareem et al., 2024), While shell fish is a term that is used to refer to invertebrates with exoskeleton and they include mollusk, crustaceans and ehcinoderms (Venugopal &Gopakumar, 2017). The expression "fishing" can refer to catching fish and other aquatic creatures like crustaceans (crayfish, crabs, prawns), echinoderms (starfish), shellfish tilapia and cephalopods. According to FAO data, there are an estimated thirty-eight million fishermen and fish farmers worldwide. Over eight hundred and twenty million people are directly and indirectly employed in fishing and fish farming (FAO, 2024). Fishing has been done in ancient times for at least forty thousand years (Stewart, 1994). Fishing boats have been used to travel across oceans in search of fish since the 16th century, and since the 19th century, it has been possible to use larger boats and, in some instances, process the fish on board as a result of technological advancements.

Fish has long been an important part of the human diet. Humans have obtained fish from lakes, seas, rivers and oceans. Fishing has been done both at subsistence and at commercial levels in different countries of the world (Virdin et al., 2023; Lackey, 2005). In Nigeria, settlements close to water bodies such as rivers, lakes, ponds, seas have a large portion of their population as fisher men; there are over thirteen million hectares of water but only about two million hectares are available for fishing (FAO, 2006) with production of eighty-five thousand tons of fish yearly (FDF, 2008) by the 764,615 who are reportedly engaged in fishing activities (Odioko, 2022). Over 125 billion Naira is spent on fish importation (Olaoye & Ojebiyi, 2018). As the human population grows, the demand for fish has greatly increased causing increased pressure on the water bodies, thus reducing the number of fish obtained from the water bodies over time (FAO, 2020). This indicates that natural fish stocks are no longer enough to meet the demands of the ever-growing world population (Allan et al., 2005). Many are also now very conscious about healthy eating and prefer the healthy protein from fish than other forms of livestock (Morale & Higuchi,2018; de Boer et al., 2020). This was what led to the birth of fish farming or aquaculture which is the aquatic counterpart of agriculture (FAO, 2014), it is the practice of breeding and growing fish in plastic tanks, concrete tanks, earthen ponds and other forms of enclosure such as cages for the purpose of food (Azevedo et al., 2011). In Nigeria, fish farming accounts for 3.5% of the total gross national product (GNP) and in theworld it accounts for 0.2% of the worlds fish supply (CBN, 2011). Nigeria has an annual fish demand is 1.4 million tons but production is just about 800,000 tons showing a deficiency in production and this has led to mass importation of fish into the country (Uzowanne et al., 2023; Adekoya & Miller,2004). Fish farming is the most efficient method of animal husbandry; feed is totally converted to food; this means that if a fish consumes 1kg of feed, it will put on 1kg weight (Robbinson& Li, 2010). China produces six percent of the world's cultured fish (Jia et al, 2018). Major species of farmed fishes of the world include; Nile tilapia, Atlantic salmons and others (FAO, 2014). In Nigeria, aquaculture is almost synonymous to catfish and Tilapia Farming (Adewunmi &Olaleye, 2011) and feeding takes the highest portion of total production cost (Craig,2017) of about 60-80 % of cost of operation (Rolla & Hassan, 2007). The feed ingredients or stuff used in production of fish feeds are mainly by products of plants and animals from the food processing industries. In the recent past, because of insecurity especially in areas where traditional crops used to produce local fish feeds are farmed, there is now a serious drop in farming activities to produce traditional crops such as soybeans, millet etc. leading to heavy reliance on imported feed stuff, (Fasakin et al., 2001; Gabriel et al., 2007). The fish feed industries use fish meal, fish oil and other ingredients during feed production. In fact, 60% of fish meal and 80% of fish oil use in manufacture of fish feed are both expensive and there is a high demand for fish and fish oil (Majluf, 2024; Naylo et al., 2009). Imported Fish meal not only increases the general cost of production, it also retards the growth of the aquaculture industry (O'Keefe &Campbadal, 2015). The shortage of fish meal and fish oil is presently as a result of high demand of fish by consumers and other industries dependent on fish. Aquaculture-fish accounts for 50% of fish consumed worldwide (Fry et al, 2016). Therefore, there is an urgent need for a nutritious alternative source of animal protein for producing fish feeds in order to reduce competition for scarce and expensive feed ingredients.

Materials and Methods

Proximate Analysis of Red palm weevil larvae

Red palm weevil larvae (*RhynchophorusFerrugineus*) in very good health were harvested from infested palm trees in Bayelsa state, Nigeria. The samples were sent alive in a sterile container to Kannins Farms at Plot 39 Rd 17, Okania New Lay Out, Mgbouba, Port Harcourt and asphyxiated by freezing for 48 hours. Proximate analysis was carried out using the AOAC (2000), to determine moisture, ash, fiber, crude protein, nitrogen free extract and lipid extract. The proximate analysis was repeated on the palm weevil larvae after defatting to determine if the crude protein level increased. Corn, soya meal, fish meal, GNC (groundnut cake) and wheatwere purchased from Modern Agro at Rumuokoro fly over, by GT Bank and their proximate analysis were all determined for feed formulation.

Fish Feed Formulation and Production

The feed was formulated using trial and error method (Saxena, 2010). Hot water was used to mix and dissolve the binder according to measurement. All powdered ingredients including soy bean meal, palm weevil larvae meal, wheat, groundnut cake, fish meal, vitamin premix, methionine and lysine were weighed according to the calculated values and added into a big bowl. The binder mixture was then added to the bowl of powdered ingredients. Then palm oil was added and all ingredients thoroughly mixed to look like dough such that a morsel can be made from the mixture with a squeeze. The mixture is then introduced into the pelleting machine and the dough like mixture is cut into tiny sizes that fishes can consume.

Fish Feeding and Determination of Growth Rate

Seventy-two fishes were arranged into three groups, each group is in triplicates. There were eight fishes in each set of the triplicates. Each set of fish numbering eight each was introduced into twenty liters of water. The first group of triplicates was fed feed formulated with fish meal; the second group of triplicates was fed with feed formulated with

Cite this article as:
Ohiri, R.C., Wogboroma, S.E., & Essien, E.B. (2025). Growth performance of *clarias gariepinus* fed diet containing *rhynchophorus ferrugineus* (red palm weevil larvae) as a replacement for fish meal. *FNAS Journal of Scientific Innovations, 7*(1), 82-88. https://doi.org/10.63561/fnas-jsi.v7i1.1133

palm weevil larvae meal and the last triplicate group were fed with a commercially produced feed. The fishes were first acclimatized for two weeks before being arranged into groups. The bulk weight of each set was determined using a kitchen scale. Then they were all fed four percent of their body weight as their daily ration. The ration was divided into two and fishes were fed morning and evening for one month. Then total weight gain, specific growth rate and feed conversion ratio were determined.

Results

Wheat flour had the highest carbohydrate observed in this analysis with a value of 77.10%. Highest crude protein (CP), crude fiber (CF) and Fat was observed in palm weevil larvae with percentage concentrations54.68, 23.15 and 10.38 respectively. Soy bean flour and Fish meal had the highest moisture and ash with concentrations of 7.70 % and 22.40 % respectively (table1).

Table 1: Proximate analysis of feed stuff

Sample	Moisture	Ash	Fat	CP	CF	Carbohydrate
Soy beans	7.70	6.80	6.70	43.40	16.60	18.70
GNC	6.30	4.09	8.10	33.00	22.10	26.40
PWL	7.07	1.40	10.38	54.68	23.15	3.30
Wheat	6.90	1.30	2.10	15.00	6.40	77.10
Fish meal	5.00	22.40	8.90	54.53	2.56	6.51

GNC= ground nut cake, PWL= palm weevil larvae CF=crude fiber.

The Moisture content of the two formulated feed are equal, with a value of 8.03±0.09 %, while Ash, Fat, Crude Protein (CP) and Crude Fiber (CF) were in the Palm Weevil Larvae (PWL) feed with percentage values of 5.33±0.12, 7.16±0.33, 33.40±1.15 and 9.00±0.57 respectively (table 2).

Table 2: Proximate Analysis of Formulated Fish Feeds

	PWL	**FM**
Moisture	$8.03±0.09^{ab}$	$8.03±0.20^{ba}$
Ash	$5.33±0.12^{ab}$	$5.5±0.26^{ba}$
Fat	$7.16±0.33^{ab}$	$6±0.54^{ba}$
CP	$33.40±1.15^{ab}$	$36.7±0.97^{ba}$
CF	$9.00±0.57^{ab}$	$8.3±0.25^{ba}$

Values are mean ± SD of triplicate determination. Values with similar superscript;abc along the rows are not significantly different at P ≥ 0.05, while values with similar superscript down the column;defg are not statistically different.

Key - PWL= palm weevil larvae feed, FM = fish meal feed, CFF = commercial fish feed, CP= crude protein, CF=crude fiber.

Group 1 (G1) and group 2 (G2) fishes fed with commercial fish feed (CFF)gained the highest weight with values of 148g and 150g in weeks 1 and 2 respectively. In week 3, group 3 (G3) fishes fed withfish meal feed (FM) had the highest weight gain with a value of 142g, while group 1 (G1) fed with commercial fish feed (CFF) had the highest weight gain of 129g (table 3).

Table 3: Weight gain by fish fed ofFishes Fed with Normal and Formulated Fish Meals

	PWL			**FM**			**CFF**		
	G1	**G2**	**G3**	**G1**	**G2**	**G3**	**G1**	**G2**	**G3**
Week 0	0	0	0	0	0	0	0	0	0
Week 1	86	80	63	99	88	120	148	100	82
Week 2	18	32	25	60	89	128	86	150	80
Week 3	92	110	101	128	114	142	135	114	93
Week 4	93	105	102	120	93	120	129	102	90

PWL=palm weevil larvae feed, FM= fish meal feed, CFF=commercial fish feed.

Cite this article as:
Ohiri, R.C., Wogboroma, S.E., & Essien, E.B. (2025). Growth performance of *clarias gariepinus* fed diet containing *rhynchophorus ferrugineus* (red palm weevil larvae) as a replacement for fish meal. *FNAS Journal of Scientific Innovations, 7*(1), 82-88. https://doi.org/10.63561/fnas-jsi.v7i1.1133

Fishes fed with commercial fish feed (CFF) had the highest average weight gain for weeks 1 and 2, with values of 110±34.1g and 105±38.8 respectively. Highest average weight gain of 128.0±14 and 111±15.59 for week 3 and 4 were observed in fishes fed withfish meal feed (FM) (table 4).

Table 4*: Average Weight Gain (g)ofFishes Fed with Normal and Formulated Fish Meals*

	PWL	FM	CFF
Week 0	0	0	0
Week 1	$75.0 \pm 11.70^{ac;d}$	$102.3 \pm 16.30^{b;de}$	$110 \pm 34.1^{ca;def}$
Week 2	$25.0 \pm 7.00^{a;e}$	$92.3 \pm 34.10^{b;ed}$	$105 \pm 38.8^{c;edf}$
Week 3	$101 \pm 9.00^{ab;fg}$	$128.0 \pm 14.00^{bac;fg}$	$124 \pm 227.22^{cb;fedg}$
Week 4	$100 \pm 6.25^{abc;gf}$	$111 \pm 15.59^{bac;gf}$	$107 \pm 19.97^{cab;gdef}$

Values are mean ± SD of triplicate determination. Values with similar superscript; abc along the rows are not significantly different at P ≥ 0.05 while values with similar superscript down the column; defg are not statistically different.

For weeks 1 and 2, the fishes consumed more of fish meal feed (FM) with average feed consumption of 84.53±12.81g in week 1 and 113.23±13.2g in week 2. Fishes consumed more of commercial fish feed (CFF) in weeks 3 and 4, with average consumption of 146.62±38.89g and 178±43.6g respectively.

Table 5: Average Weight of Feed (g) Consumed by Fishes Fed with Normal and Formulated Fish Meals

	PWL	FM	CFF
Week 1	$76.67 \pm 3.49^{abc;d}$	$84.53 \pm 12.81^{bac;de}$	$83.00 \pm 25.99^{cab;de}$
Week 2	$99.6 \pm 7.88^{abc;ef}$	$113.23 \pm 13.2^{bac;edf}$	$101.46 \pm 20.86^{cab;ed}$
Week 3	$106 \pm 6.68^{abc;fe}$	$126.83 \pm 15^{bac;fe}$	$146.62 \pm 38.89^{cab;fg}$
Week 4	134.84 ± 5.72^{abc}	$156.48 \pm 19.61^{bac;g}$	$178 \pm 43.6^{cab;gf}$

Values are mean ± SD of triplicate determination. Values with similar superscript ;abc along the rows are not significantly different at P ≥ 0.05 while values with similar superscript down the column ;defg are not statistically different.
Key - PWL= palm weevil larvae feed, FM = fish meal feed, CFF = commercial fish feed.

Fed conversion ratio for weeks 1 and 2 were highest in fishes fed with palm weevil larvae feed with values of 1.03±0.15 for week 1 and 4.26±1.63 for week 2. Value of 1.26±0.17 and 1.65±0.22 observed in fishes fed with commercial fish feed (CFF) were the highest feed conversion ratio observed in weeks 3 and 4 of this study (table 6).

Table 6 Average Feed Conversion Ratio of Fishes Fed with Normal and Formulated Fish Meals

	PWL	FM	CFF
Week 1	$1.03 \pm 0.15^{abc;dfg}$	$0.84 \pm 0.20^{bac;def}$	$0. 74 \pm 0.15^{cab;defg}$
Week 2	$4.26 \pm 1.63^{a;e}$	$1.27 \pm 0.18^{bc;edfg}$	$1.00 \pm 0.30^{cb;edfg}$
Week 3	$1.06 \pm 0.13^{abc;fdg}$	$1.19 \pm 0.2^{bac;fedg}$	$1.26 \pm 0.17^{cab;fdeg}$
Week 4	$1.22 \pm 0.70^{abc;gdf}$	$1.42 \pm 0.21^{bac;gef}$	$1.65 \pm 0.22^{cab;gdef}$

Values are mean ± SD of triplicate determination. Values with similar superscript ;abc along the rows are not significantly different at P ≥ 0.05 while values with similar superscript down the column ;defg are not statistically different.
Key - PWL= palm weevil larvae feed, FM = fish meal feed, CFF = commercial fish feed.

Highest specific growth rate of 3.3 was observed in fishes fed with commercial fish feed, while those fed with fish meal feed and palm weevil larvae formulated feed had specific growth rates of 3.2 and 2.4 respectively (table 7).

Cite this article as:
Ohiri, R.C., Wogboroma, S.E., & Essien, E.B. (2025). Growth performance of *clarias gariepinus* fed diet containing *rhynchophorus ferrugineus* (red palm weevil larvae) as a replacement for fish meal. *FNAS Journal of Scientific Innovations, 7*(1), 82-88. https://doi.org/10.63561/fnas-jsi.v7i1.1133

Table 7: Specific Growth Rate of Fishes Fed with Normal and Formulated Fish Meals

PWL	FM	CFF
2.40	3.20	3.30

Key - PWL= palm weevil larvae feed, FM = fish meal feed, CFF = commercial fish feed.

A high mortality rate of 4.00% was observed in Fishes fed with fish meal feed, while those fed with commercial fish feed and palm weevil larvae formulated feed had mortality rates of 0.0%, indicating 100% survival (table 8).

Table 8: Mortality Rate (%) of Fishes Fed with Normal and Formulated Fish Meals

PWL	FM	CFF
0.00	4.00	0.00

Key - PWL= palm weevil larvae feed, FM = fish meal feed, CFF = commercial fish feed.

Discussion

Proximate analysis of the feed samples showed CP level 33%, 36% and 33% respectively for PWL, FM and CF fed fishes, there was no significant difference in the weight gained. This falls within the acceptable range of Crude protein requirement of catfish diet of 30-35% and (Craig et al., 2017; Li et al., 2001). This disagrees with Rapatsa and Moyo (2022), who stated that Catfish requires 40-42% crude protein content feed. The continuous weight gain observed in all the fishes throughout the duration of this study indicates that all the fishes responded positively to the three different feeds.The slight drop in weight observed mainly in week 2 and slightly in week 1 by fishes fed PWL could be attributed to a period of feed acclimatization or adjustment to the new diet. Adjustment in diet could be as a result or effect of micro or macro nutrients being present in the feed or the effect of their break down compounds on both either gene expression or repression. This finding agrees with the report of Barnes, (2008), which reported that the interaction of nutrients and other bioactive food components with single nucleotide polymorphisms in genes lead to altered absorption, metabolism, and functional responses to bioactive nutritional factors. He also reported the ability of bioactive components to regulate transcriptome gene expression, protein abundance and turnover levels (Barnes, 2008).

Four percent (4%) body weight of feed consumption by the fish agrees with the report of Craig et al. (2017), where feed consumption was reported to be between 1% and 5% of body weight. Though the Feed Conversion Ratio (FCR) was within the normal range for all fed groups, Fishes fed with PWL formulated feed had highest FCR with a value of 1.06±0.13. This finding is in concord with the report of Fry et al. (2018), which showed FCR ranges of 1.0 to 2.4 in farmed fishes. Although the CF fed Fishes had the highest specific growth rate of 3.30g per day, a non-significant decrease of 3.20g per day was observed in FM fed Fishes and a significant decrease of 2.40g per day was observed in Fishes fed with PWL formulated feed. The mortality rate of 4.00% observed in FM fed Fishes against the 0.00% observed in CF fed Fishes and in Fishes fed with PWL formulated feed strongly indicates that PWL formulated feed can be used to replace the FM feed especially at the early stage of growth, where mortality and survival are prioritized.

Conclusion

The findings from this study strongly indicates that fish meal (FM) can be replaced with a less expensive Palm Weevil Larvae (PWL) formulated feed in fish feeding especially when survival rate is prioritized against growth response. However, a combination of fish meal (FM) and Palm Weevil Larvae (PWL) formulated feed may yield optimum survival rate and positive growth response result.

Recommendations

1. Palm Weevil Larvae (PWL) should be considered as a viable alternative protein source to fish meal in fish feed formulation, particularly in aquaculture systems where the cost of conventional fish meal is high.

Cite this article as:
Ohiri, R.C., Wogboroma, S.E., & Essien, E.B. (2025). Growth performance of *clarias gariepinus* fed diet containing *rhynchophorus ferrugineus* (red palm weevil larvae) as a replacement for fish meal. *FNAS Journal of Scientific Innovations, 7*(1), 82-88. https://doi.org/10.63561/fnas-jsi.v7i1.1133

2. Fish farmers are encouraged to explore the use of locally available Palm Weevil Larvae as a sustainable and cost-effective ingredient in fish feed production to reduce dependence on expensive commercial feeds.
3. Further studies should investigate different combined inclusion levels of fish meal and Palm Weevil Larvae in fish diets to determine the optimal ratio that will enhance both growth performance and survival rate.
4. Additional long-term feeding trials with larger sample sizes and different fish species should be conducted to validate the effectiveness and consistency of Palm Weevil Larvae–based feeds in aquaculture production.
5. Research should also focus on improving the processing, preservation, and large-scale production of Palm Weevil Larvae to ensure its availability and suitability for commercial fish feed formulation.
6. Government and aquaculture development agencies should support research and training on the use of alternative protein sources such as Palm Weevil Larvae to promote sustainable and environmentally friendly fish farming practices.

References

Abdulkarim, M., Magaji, I. M., Nayaya, A. J., Yusuf, Z. A., & Jibril, S. A. (2024). Fisheries and Wildlife. *Available online at: academia. edu. Retrieved 12th August*.

Adekoya, B. B. & Miller, J.W. (2004). Fish cage culture potential in Nigeria- An overview. *National Cultures and Agriculture Focus*. 1(5):10-12.

Adewumi, A. A., &Olaleye, V. F. (2011). Catfish culture in Nigeria: Progress, prospects and problems. *African Journal of Agricultural Research* 6(6), 1281-1285.

Allan, J. D., Abell, R., Hogan, Z. E. B., Revenga, C., Taylor, B. W., Welcomme, R. L., &Winemiller, K. (2005). Overfishing of inland waters. *Biological Science,* 55(12), 1041-1051.

Association Of Official Analytical Chemists (2000). Official Method 925.10. In *Official Methods of Analysis of AOAC International*, 17th ed., Arlington, VA

Azevedo-Santos, Valter Monteiro de; Rigolin-Sá, Odila; Pelicice, Fernando Mayer (2011).

Barnes, S. (2008). Nutritional genomics, polyphenols, diets, and their impact on dietetics. *Journal of the American Dietetic Association*, *108*(11), 1888-1895.

CBN (2011): Annual Report and Statement of Accounts. Central Bank of Nigeria (CBN) Publishers, Abuja. Retrieved on 17th March 2021 from http://www.cbn.gov.ng. Climate-data .org (CDO)(2021). Climate, Enugu, Nigeria.

Craig, S. R., Helfrich, L. A., Kuhn, D., & Schwarz, M. H. (2017). Understanding fish nutrition, feeds, and feeding.

de Boer, J., Schösler, H., &Aiking, H. (2020). Fish as an alternative protein–A consumer-oriented perspective on its role in a transition towards more healthy and sustainable diets. *Appetite*, *152*, 104721.

Food and Agriculture Organization of the Unites Nations (2024). State of the worlds fisheries and aquaculture 2024: Blue transformation in action. https://doi.org/10.4060/cd0683en

Food and Agricultural organization. (2006). Fisheries management in the Federal Republic of Nigeria

Food and Agricultural organization. (2014). The state of the world fisheries. Rome, FAO.

Fasakin EA, Bulogun AM, Fagbenro OA (2001). Evaluation of Sun-Dried Water fern, Azolla Africana and Duckweed, Spirodelapolyrrhiza, in Practical Diets for Nile Tilapia, Oreochromis niloticus (L) Fingerlings, *Journal of Applied Aquaculture*.11(2):83-92.

FDF, 2008. Fisheries Statistics of Nigeria. Fourth edition, 1995 – 2007, Nigeria 48pp.

Food and Agricultural organization. Action, I. (2020). World Fisheries And Aquaculture.

Fry, J. P., Mailloux, N. A., Love, D. C., Milli, M. C., & Cao, L. (2018). Feed conversion efficiency in aquaculture: Do we measure it correctly? *Environmental Research Letters, 13*(2), 024017. doi.org

Gabriel, U. U, Akinrotimi, O. A, Bekibele, D. O, Onunkwo, D. N and Anyanwu P. E. (2007) Locally produced fish feed: potentials for aquaculture development in sub-Saharan Africa. *African Journal of Agricultural Research* 2(7): 287-295.

Jia, J., Miao, W., Cai, J., & Yuan, X. (2018). Contribution of Chinese aquaculture to the sector, globally, and to overall food security. *Aquaculture in China: Success Stories and Modern Trends*, 1-24.

Lackey, R. T. (2005). Fisheries: history, science, and management. Water encyclopedia: surface and agricultural water, 121-129.

Li, M. H., Manning, B. B., Robinson, E. H., Bosworth, B. G., & Wolters, W. R. (2001). Comparison of growth, processing yield, and body composition of USDA103 and Mississippi "Normal" strains of channel catfish fed diets containing three concentrations of protein. *Journal of the World Aquaculture Society*, *32*(4), 402-408

Majluf, P., Matthews, K., Pauly, D., Skerritt, D. J., &Palomares, M. L. D. (2024). A review of the global use of fishmeal and fish oil and the Fish In: Fish Out metric. *Science advances*, *10*(42), eadn5650.

Morales, L. E., & Higuchi, A. (2018). Is fish worth more than meat?–How consumers' beliefs about health and nutrition affect their willingness to pay more for fish than meat. *Food Quality and Preference*, *65*, 101-109.

Naylor, R. L., Hardy, R. W., Bureau, D. P., Chiu, A., Elliott, M., Farrell, A. P., ... & Nichols, P. D. (2009). Feeding aquaculture in an era of finite resources. *Proceedings of the National Academy of Sciences*, *106*(36), 15103-15110.

Odioko, E., &Becer, Z. A. (2022). The economic analysis of the Nigerian fisheries sector: A Review. *Journal of Anatolian Environmental and Animal Sciences*, *7*(2), 216-226.

O'Keefe, T., &Campabadal, C. A. (2015). Storage and handling of feeds for fish and shrimp. In Feed and feeding practices in aquaculture (pp. 299-313). *Woodhead Publishing*.

Olaoye, O. J., &Ojebiyi, W. G. (2018). Marine fisheries in Nigeria: A review. *Marine ecology-Biotic and abiotic interactions*.

Oxford University Press. (n.d.). Success. In Oxford English dictionary. Retrieved March 6, 2024, from https://www.oed.com/view/Entry/192994

Rapatsa, M., &Moyo, N. (2022). A review and meta-analysis of the effects of replacing fishmeal with insect meals on growth of tilapias and sharptooth catfish. *Aquaculture Nutrition*, *2022*, 1-10.

Robinson, E. H., & Li, M. H. (2010). Channel catfish, Ictalurus punctatus, size and feed conversion ratio. *Journal of the World Aquaculture Society*, 41(5), 829-833.

Rola, W. R., & Hasan, M. R. (2007). Economics of aquaculture feeding practices: a synthesis of case studies undertaken in six Asian countries. FAO Fisheries Technical Paper, 505, 1.

Saxena, P., & Chandra, M. (2010). Animal diet formulation models: a review (1950–2010). *International Journal of Agricultural and Food Science*, *1*(1), 1-10

Stewart, H. (1994). *Indian fishing: Early methods on the Northwest Coast*. University of Washington Press. (Original work published 1977)

Uzonwanne, M. C., Mbah, C. C., Onyedibe, F. C., & Obi, C. I. (2023). Impact of Fish Production on the Gross Domestic Product in Nigeria. *Journal of Economics, Management and Trade*, *29*(8), 88-98.

Venugopal, V., &Gopakumar, K. (2017). Shellfish: nutritive value, health benefits, and consumer safety. *Comprehensive Reviews in Food Science and Food Safety*, *16*(6), 1219-1242.

Virdin, J., Basurto, X., Nico, G., Harper, S., del Mar Mancha-Cisneros, M., Vannuccini, S., ... & Franz, N. (2023). Fishing for subsistence constitutes a livelihood safety net for populations dependent on aquatic foods around the world. *Nature Food*, *4*(10), 874-885.

Cite this article as:
Ohiri, R.C., Wogboroma, S.E., & Essien, E.B. (2025). Growth performance of *clarias gariepinus* fed diet containing *rhynchophorus ferrugineus* (red palm weevil larvae) as a replacement for fish meal. *FNAS Journal of Scientific Innovations, 7*(1), 82-88. https://doi.org/10.63561/fnas-jsi.v7i1.1133