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Research Article

Dietary Effects of Processed African Palm Weevil (*Rhynchophorus phoenicis*) Larvae with Phyto-Additives on Growth Performance and Nutrient Utilization of *Clarias gariepinus* Juveniles

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ABSTRACT

A feeding trial was carried out for 70 days to examine the dietary effects of using processed African Palm Weevil Larvae with phyto-additives in the diet of *Clarias gariepinus* juveniles. Seven experimental diets with three replicates per treatment containing 45% crude protein were formulated, six of these diets contained processed African palm weevil larvae with phyto-additives as TEL, COR, CYM, TELCOR, TELCYM and CORCYM while the diet with fishmeal served as control. A total of 420 juveniles, mean weight 7.51 ± 0.01 were obtained and 20 fish were allotted into a circular basket each. Each basket were embedded into a polygon tank filled with water. The mean weight gain was significantly different (P>0.05) across the fish fed experimental diets, with highest mean weight gain (32.28 g) recorded in the COR group and the lowest mean weight gain (19.82 g) recorded in the CORCYM group. The Feed Conversion Ratio (FCR) were significantly different (P>0.05) across the experimental groups. The highest FCR value (1.59 ± 0.02) was recorded in the control group and the lowest FCR value (1.27 ± 0.03) was recorded in the COR group. There were no significant differences (P<0.05) in the Protein Efficiency Ratio (PER) among experimental groups. The physico-chemical parameters such as temperature, pH and dissolved oxygen were within optimum range for *Clarias gariepinus*. From this study, it could be concluded that processed African palm weevil larvae with phyto-additives can successfully replace fishmeal in the diet of *Clarias gariepinus* juveniles.

Keywords: African palm weevil larvae; Phyto-additives; Growth performance; Nutrient utilization

INTRODUCTION

Aquaculture is an inevitable way of meeting the protein requirement of global population through fish production and supply and has grown tremendously in recent years. The growth has been facilitated by increased feed-based intensive fish culture system. The growing concern of fish farmers is related to cost of production in which cost of feeding takes higher percentage [1].

Fish meal is one of the most expensive ingredients used in the production of aqua feed. Dependence on fish meal in fish feed production translates to high cost of feeding in fish production. However, efforts are being made on replacing fish meal with plant and animal based materials. Plant protein could not replace higher amount of fish meal due to the presence of Non-Starch Polysaccharide (NSP) with high fibre content, imbalance amino acid profile with the associated limitation of anti-nutritional factors [2]. Hence, there is a need to explore other alternative and sustainable solutions.

The use of insect as an alternative protein source for animal feeding has been justified in terms of amino acids composition, lipid, vitamins and minerals compared to other conventional protein source [3]. Many fish species consume insects as part of their diets in nature [4]. Some insects in the orders Hymenoptera, Diptera and Coleoptera have been found in the guts of omnivorous and carnivorous fishes and *Clarias gariepinus* is an omnivore feeding on different trophic levels in nature [5].

The African palm weevil (*Rhychophorus phoenicis*) known as edible worm is a specie of beetles belonging to the family Curculionidae. It has been identified as a suitable insect meal for feeding *Clarias gariepinus*. Researches have been carried out on the nutritional composition of Africa palm weevil (*Rhychophorus phoenicis*) and it shows that it has a protein content ranging between 32%-66% [6-8]. Although, the studies of Agbanimu and Adeparusi (2020) with that of Fakayode and Ugwumba et al, showed that African palm weevil can be used to replace the diet of Clariidae at 25% inclusion level and above reporting that below 25% inclusion level of Africa

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palm weevil larvae does not enhance the growth of Clariidae [9,10]. Thus the goal of this study is to use African palm weevil larvae at lower inclusion level (17%) with some pyhto-additives (as a growth promoters) in the diet of *Clarias gariepinus* as this will also help in reducing associated cost of production while using higher inclusion level of African palm weevil larvae. The phyto-additives used are *Telfairia occidentalis*, *Corchorus olitorious* and *Cymbopogon citratus*. *Telfairia occidentalis* (Ugwu leaf) is a dark greenish leafy vegetable commonly used in soup and folk medicine for the management of many diseases in Nigeria [11]. Phytochemical evaluation of the vegetable reveals that it contains oxalates, saponins, glycosides, flavonoids, alkaloids and resins [12].

Corchorus olitorious (Jute leaf) is an erect, annual herb belonging to the flowering plant of the family Tiliaceae [13]. The leaves of jute which are demulcent, diuretic, febrifuge and also serve as a tonic are very popular as a leafy vegetable in many Asian, African and European countries.

Cymbopogon citratus (Lemon grass leaf) are commonly used as lemon flavouring in herbal teas made by decoction or infusion, as well as other formulations. The tea made from its leaves is mostly used as antispasmodic, analgesic anti-inflammatory, antipyretic, diuretic and sedative [14]. Lemon grass leaf have anti-inflammatory properties and can be used as feed additive for fish feed [15]. Hence the need for this study.

MATERIALS AND METHODS

Study area

The study 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.

Samples collection

Samples of African Palm Weevil (*Rhynchophorus phoenicis*) larvae were obtained from Igbokoda, Ondo state. The larvae were cleaned thoroughly with water to remove debris and then oven dried at 80°C for 12 hours as recommended by Banjo et al. Fresh Lemongrass leaf, Ugwu leaf and Jute leaf were collected from markets and environments within Akure metropolis and taken to Crop Science and Protection Department for proper identification. The leaves were plucked out of their stem and air-dried at room temperature to reduce the moisture content. They were then milled separately into a fine powder using binatone electric blender (Model BLG 402) and sieved to obtain a fine powder after which they were packed in a Ziploc bag and stored at room temperature until needed for feed formulation.

Preparation of experimental diets

Seven iso-nitrogenous diets were formulated to contain 45% crude protein with single and composite phyto-additives as TEL (*Rhynchophorus phoenicis* with *Telfairia occidentalis*), CYM(*Rhynchophorus phoenicis* with *Cymbopogon citratus*), COR (*Rhynchophorus phoenicis* with *Corchorus olitorious*), CORCYM (*Rhynchophorus phoenicis* with *Corchorus olitorious* and *Cymbopogon citratus*), TELCYM (*Rhynchophorus phoenicis* with *Telfairia occidentalis* and *Cymbopogon citratus*) and TELCOR (*Rhynchophorus phoenicis* with *Telfairia occidentalis* and *Corchorus olitorious*) with the CONTROL diet containing fish meal using trial and error method. The feed components include Palm weevil larvae, fish meal, soybean meal, groundnut cake, yellow maize, cassava flour (as binder), vitamin C, vitamin-mineral premix, bone meal, groundnut oil, lysine, methionine, di-calcium phosphate, baker's yeast, and phyto-additives (Table 1). Each of the ingredients was weighed and poured in a plastic container and thoroughly mixed together to obtain a homogenous mixture. The homogenous mixture was then extruded using an extruder (Henan Lima Machinery Manufacture Co. Ltd.) with a 2 mm die.

Table 1: Ingredients composition of the experimental diets (g/100g) for *Clarias gariepinus*.

Ingredients	CONTROL	TEL	CYM	COR	CORCYM	TELCOR	TELCYM
Fishmeal (72%)	34	17	17	17	17	17	17
Palm weevil (65%)	0	17	17	17	17	17	17
Soybean (42%)	20	20	20	20	20	20	20
Groundnut cake (45%)	20	20	20	20	20	20	20
Yellow maize (10%)	11	11	11	11	11	11	11
Cassava flour	3	3	3	3	3	3	3
Yeast (48%)	5	5	5	5	5	5	5
Dicalcium phosphate	1	0.5	0.5	0.5	0.5	0.5	0.5
Lysine	1	1	1	1	1	1	1
Methionine	1	1	1	1	1	1	1

Vitamin-mineral premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin C	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bone meal	1	1	1	1	1	1	1
Groundnut oil	2	2	2	2	2	2	2
Phyto-additives	0	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100	100
Feed proximate composition (DM %)							
Moisture	7.65	7.57	7.81	7.29	7.77	7.28	7.96
Crude protein	44.83	45.05	44.89	45.12	44.86	45.37	44.75
Lipid	5.87	4.91	5.61	5.43	5.30	5.75	5.57
Fibre	10.66	10.70	10.89	10.45	10.96	10.95	10.86
Ash	10.02	12.19	12.57	12.48	12.24	12.12	12.36
NFE (Nitrogen Free Extract)	18.97	19.59	18.24	19.24	18.88	18.52	18.46

Note: Premix: Vitamin A; 10,000,000.00 I.U, Vitamin D3; 2,000,000.00 I.U, Vitamin E; 23.000.00 mg, Vitamin K3; 2,000.00 mg, Vitamin B1; 3,000.00 mg, Vitamin B2; 6,000.00 mg, Niacin; 50,000.00 mg, Calcium Pantothenate; 10,000.00; Vitamin B6; 5,000.00 mg, Vitamin B12; 25.00 mg; Folic Acid; 1,000.00 mg, Biotin; 50.00 mg, Choline Chloride; 400,000.00 mg, Manganese; 120,000.00 mg, Iron; 100,000.00 mg, Zinc; 80,000.00 mg, Copper; 8,500.00 mg, Iodine; 1,500.00 mg, Cobalt; 300.00 mg, Selenium; 120.00 mg, Anti-oxidant; 120,000.00 mg. (Source: Chemiconsult International Limited, Ikeja, Lagos, Nigeria). Recommended Inclusion Rate is 2.5 kg per tonne of final feed. CP: Crude Protein, NFE: Nitrogen Free Extract, DM: Dry matter.

Experimental setup

Completely Randomized Design (CRD) was used for the study. Four hundred and fifty *Clarias gariepinus* juveniles (average weight 7.01 ± 0.01 g/fish) was obtained from the teaching and research farm of the department of fisheries and aquaculture technology, federal university of technology, Akure, Ondo State. They were acclimatized for 14 days and fed with 2 mm commercial feed twice a day before the commencement of experiment. Fish was starved for 24 hours prior to being placed on experimental diets. Twenty one circular baskets covered with mesh net with a dimension of 49 × 71.5 cm2 was used and each was embedded in a polygon tank filled with water. The culture water was from the earthen pond at the Teaching and Research Farm and changed every two weeks. Three baskets per experimental diet represent replicate per experimental diet. Twenty *Clarias gariepinus* juveniles were allotted into each of the twenty one baskets and feed to satiation twice daily between 08:00-09:00 and 16:00-17:00 hours for a period of 70 days. The water quality parameters were observed fortnightly (pH, 7.43 ± 0.02, dissolved oxygen, 5.55 ± 0.15 mg/L and temperature, 27.13 ± 0.01). The fish were maintained under natural photoperiod and observed dead fish were removed daily.

Growth indices

Weighing of fish was done using an electrical weighing balance (Model no: XY15KMB) before the experiment commence and fortnightly during the period of the experiment to adjust the feeding level. At the end of the experiment, individual weights of all surviving fish from all the groups was weighed to obtain their final mean weight after evacuation of feed by starving for 24 hours.

Calculations

The formulas below were used for the evaluation of growth performance and nutrient utilization among experimental groups.

Proximate analysis and statistical analysis

Proximate analysis of diets and experimental fish was done using the methods described by AOAC [16]. All data were checked for normality using one-way Analysis Of Variance (ANOVA) and homogeneity of variance using Levene's test to test for significant difference in the means using Statistical Package for Social Sciences (SPSS 22.0 for windows). Where there is significant difference, the means were separated using Duncan's multiple range test. Mean difference was considered statistically significant with a 95% confidence level and all data were presented as means ± standard errors.

RESULTS

Proximate composition (dry matter) of *Clarias gariepinus* juveniles fed experimental diets

The proximate composition of the whole *Clarias gariepinus* juveniles fed experimental diets as shown in Table 2. The crude protein, ash content, moisture content and nitrogen free extract was not significantly different (P>0.05) but ranged between 52.38 ± 9.99 to

61.47 ± 2.65, 4.65 ± 1.07 to 10.29 ± 3.71, 21.83 ± 0.25 to 29.54 ± 5.72 and 5.32 ± 0.85 to 15.22 ± 1.99 respectively among the seven treatments where COR has the highest value of crude protein and lowest value of nitrogen free extract (61.47 ± 2.65 and 5.32 ± 0.85 respectively) and TELCOR has the lowest value of crude protein and highest value of moisture content (52.38 ± 9.99 and 29.54 ± 5.72 respectively). The lipid content varies significantly (P<0.05) among treatments ranging between 0.50 ± 0.37 to 3.06 ± 0.32. The TELCYM recorded the highest values of lipid and ash content (3.06 ± 0.32, 10.29 ± 3.71 respectively) and CONTROL the lowest value of lipid content (0.50 ± 0.37).

Growth performance, nutrient utilization and survival of Clarias gariepinus fed experimental diets

The catfish juveniles were sampled fortnightly during the period of experiment to determine the growth performance. The initial weight of the catfish juveniles ranged between 7.50 ± 0.01 and 7.52 ± 0.02 (Table 3). The growth performance in terms of Final Mean Weight (FMW), Mean Weight Gain (MWG) and Specific Growth Rate (SGR) were significantly different (P<0.05) among the groups. COR has the highest FMW, MWG and SGR (39.78 ± 0.11, 32.28 ± 0.10 and 2.01 ± 0.10 respectively) while the lowest FMW, MWG and SGR was recorded in CORCYM (27.32 ± 0.16, 19.82 ± 0.16 and 0.94 ± 0.41 respectively. Survival among the experimental group was significantly different (P<0.05) with the highest value recorded in TELCOR (95.00 ± 0.00) and lowest value in CORCYM (55.00 ± 15.00).

The nutrient utilization parameters expressed as Feed Intake and Feed Conversion Ratio (FCR) as shown in Table 3 were significantly different (P<0.05) among treatments. The COR group had the highest value of Feed Intake (41.00 ± 0.71) while the lowest value of Feed Intake was recorded in CORCYM group (29.70 ± 1.43). The FCR recorded shows that the COR group had the lowest value (1.27 ± 0.03) and highest value in the CONTROL group (1.59 ± 0.02). The PER among the group were not significantly different (P>0.05) with values ranging between 1.88 ± 0.03 to 2.19 ± 0.06.

Table 2: Proximate composition of whole body (dry matter) of *Clarias gariepinus* juveniles fed experimental diets.

Parameters	CONTROL	TEL	CYM	COR	CORCYM	TELCOR	TELCYM
Moisture	28.74 ± 3.12a	24.54 ± 1.48a	28.73 ± 1.35a	25.79 ± 1.73a	22.82 ± 1.47a	29.54 ± 5.72a	21.83 ± 0.25a
Crude protein	56.58 ± 1.57a	52.83 ± 3.07a	53.95 ± 3.98a	61.47 ± 2.65a	56.41 ± 8.21a	52.38 ± 9.99a	56.96 ± 1.65a
Lipid	0.50 ± 0.37a	1.68 ± 0.01ab	2.29 ± 1.18ab	1.78 ± 0.35ab	1.86 ± 0.25ab	1.97 ± 1.03ab	3.06 ± 0.32b
Ash	5.14 ± 1.66a	5.72 ± 0.39a	7.82 ± 0.03a	5.64 ± 0.42a	8.47 ± 0.56a	4.65 ± 1.07a	10.29 ± 3.71a
NFE	9.04 ± 0.27a	15.22 ± 1.99a	7.22 ± 1.42a	5.32 ± 0.85a	10.44 ± 7.05a	11.47 ± 6.38a	7.86 ± 5.42a

Note: NFE: Nitrogen Free Extract, Data expressed as Mean ± SE, values along row with same superscript a, b, c were not significantly different (p>0.05).

Table 3: Growth performance and survival of *Clarias gariepinus* fed experimental diets.

Parameters	CONTROL	TEL	CYM	COR	CORCYM	TELCOR	TELCYM
IMW(g)	7.52 ± 0.00a	7.52±0.02a	7.51 ± 0.00a	7.51 ± 0.01a	7.50 ± 0.00a	7.52 ± 0.02a	7.52 ± 0.02a
FMW(g)	29.48 ± 0.75a	33.97±1.96abc	38.28 ± 3.82bc	39.78 ± 0.11c	27.32 ± 0.16a	32.57 ± 2.30ab	30.17 ± 1.28b
MWG(g)	21.96 ± 0.75a	26.44 ± 1.98abc	30.76 ± 3.83bc	32.28 ± 0.10c	19.82 ± 0.16a	25.05 ± 2.28ab	22.66 ± 1.27b
SGR(g/day)	1.49 ± 0.12ab	1.96 ± 0.13b	2.00 ± 0.06b	2.01 ± 0.10a	0.94 ± 0.41b	2.01 ± 0.05b	1.45 ± 0.25ab
FI	34.95 ± 1.53ab	36.16 ± 0.55ab	38.71 ± 2.86b	41.00 ± 0.71b	29.70 ± 1.43a	33.97 ± 1.60ab	34.84 ± 3.84ab
FCR	1.59 ± 0.02c	1.38 ± 0.12abc	1.27 ± 0.06a	1.27 ± 0.03ab	1.50 ± 0.08abc	1.36 ± 0.06abc	1.53 ± 0.08bc
PER	1.88 ± 0.03a	2.09 ± 0.15a	2.19 ± 0.06a	2.15 ± 0.04a	2.06 ± 0.11a	2.11 ± 0.05a	1.94 ± 0.13a
Survival (%)	72.50 ± 7.50ab	87.50 ± 2.50b	80.00 ± 5.00b	77.50 ± 2.50ab	55.00 ± 15.00a	95.00 ± 0.00b	85.00 ± 0.00b

Note: Mean ± SE, values along row with different superscript a, b, c were significantly different (p<0.05). IMW: Initial Mean Weight, FMW: Final Mean Weight, MWG: Mean Weight Gain, SGR: Specific Growth Rate, FI: Feed Intake, FCR: Feed Conversion Ratio, PER: Protein Efficiency Ratio.

DISCUSSION

In this study, the evaluation of the whole body composition of experimental fish shows that there was no significant difference (P>0.05) in the crude protein, moisture content, ash and nitrogen free extract of whole body of *Clarias gariepinus* fed experimental diets. The insignificant difference explained the assertion that African Palm Weevil Larvae with phyto-additives can successfully replace fishmeal in the diet of African catfish. This agrees with the result of Fakayode and Ugwumba et al, who observed that *Rhynchophorus phoenicis* can be used to replace fish meal in the diet of *Clarias gariepinus* and *Heterobranchus longifilis*. Although, the COR group has the highest value of crude protein (61.47 ± 2.65) which may be attributed to the high crude protein, low crude fibre and moisture in the diet. The significant difference observed in the body crude lipid content maybe as result of imbalance in protein to energy ratio and this conforms to the study of Emilie et al, who reported significant difference in the crude lipid of Salmon salar fed *Musca domestica* as a replacement of fishmeal in the fish diet.

The growth performance and survival of *Clarias gariepinus* in this study showed that there is an increase in body weight. The experiment shows that the final mean weight, mean weight gain and specific growth rate were statistically significant (P<0.05) where the COR group recorded the highest final mean weight, mean weight gain and specific growth rate while the CORCYM group had the lowest final mean weight, mean weight gain and specific growth rate. This report maybe be attributed to the feed intake among experimental group as weight gain, feed conversion ratio and specific growth rate are usually considered as the most important measurement of quality of diets [17].The result obtained corroborates with the work of Agbanimu and Adeparusi (2020) which stated that African Palm Weevil Larvae enhances the growth performance of *Clarias gariepinus* fed replacement of fishmeal also with the work of Dada and Sonibare (2015) who reported that plant additives can be used as a growth promoter in the diet of *Clarias gariepinus* [18].

Improved Survival of fish was observed in fish fed with *Rhychophorus phoenicis* larvae with phyto-additives compared to that of the fish fed with the control diet. The improved survival of the treatment groups may be attributed to the antiviral and anti-inflammatory properties of the plant-additives [9]. The lower survival in the CYM group may be due to cannibalism, loss of appetite and eventual mortality.

The nutrient utilization recorded shows that the Feed Intake (FI) differs significantly among the experimental groups with the COR groups having the highest feed intake. This result indicates that the presence of *Corchorus olitorious* in the diet of the COR group enhances the digestive process in the fish thereby increasing the intake of feed among the treatment. Zakaria and Shuranjan et al, reported that jute leaves are rich in dietary fibre and this dietary fibre is one of the major elements that help in enhancing digestive processes. The variation in Protein Intake of fish in this study is as a result of the feed intake. The Feed Conversion Ratio (FCR) is a good indicator of how the feed is efficiently converted into fish flesh. The improvement in FCR for the insect meal-based diets compared to that of the control indicates that the fish were able to convert their diets into flesh more than that of the control. This report corroborates with the study of Ojewole et al, who reported a lower FCR in the *Clarias gariepinus* fed composite insect meal compared that of the experimental group fed fishmeal [19]. The Protein Efficiency Ratio (PCR) in this study were good and not significantly different from the control diet, which ranged between 1.88 ± 0.03 to 2.19 ± 0.06 as this agrees with the report of Agbanimu and Adeparusi et al, who reported that catfish fed African palm weevil larvae had no significant difference and the value ranges between 1.75 ± 0.36 to 2.31 ± 0.01 [20].

CONCLUSION

This study reveals that feeding *Clarias gariepinus* juveniles with diets containing processed African palm weevil (*Rhynchophorus phoenicis*) with phyto-additives gave a better growth performance, whole-body composition and nutrient utilization. For in-feed application to African Mud catfish farmers African palm weevil larvae with *Corchorus olitorious* should be used as a replacement for fishmeal as it is shown to yield better results than other groups in the current study thus reducing associated cost with the use and importation of fishmeal in developing countries like Nigeria.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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