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Effects of Replacement of Fishmeal with Palm Grub (*Oryctes rhinoceros* (Linnaeus, 1758)) Meal on the Growth of *Clarias gariepinus* (Burchell, 1822) and *Heterobranchus longifilis* (Valenciennes, 1840) Fingerlings

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ABSTRACT

A study was conducted to investigate the effects of replacement of fishmeal with palm grub; insect larva on two popularly mud catfish species in Nigeria. *Clarias gariepinus* (0.73±0.01 g) and *Heterobranchus longifilis* fingerlings (0.67±0.01 g) were fed five isonitrogenous diets of about 40% crude protein, with varying levels (0-100%) of palm grub meal for 12 weeks. The differences in the growth and nutrient utilization of the fingerlings on the various diets were generally insignificant ($p>0.05$) above 25% inclusion level of palm grub. *C. gariepinus* and *H. longifilis* fingerlings fed 25% palm grub inclusion diet had the highest weight gain (5.30 and 4.05 g, respectively), relative (726.0 and 595.6%) and specific (1.09 and 1.00%) growth rates while those fed 100% palm grub inclusion diet showed least growth; weight gain (2.68 and 2.15 g), relative (367.1 and 316.2%) and specific (0.80 and 0.45%) growth rates, respectively. Food conversion and protein efficiency were also best in fingerlings fed 25% palm grub meal diet (0.70 and 1.35 for *C. gariepinus*; 0.75 and 1.35 for *H. longifilis* respectively) with decreasing efficiency as palm grub inclusion level increased in the diets. The study showed that palm grub can be used to completely replace fishmeal in mud catfish diets. However, for optimal growth and nutrient utilization, 25% level of replacement of fishmeal with palm grub meal is most adequate in *C. gariepinus* and *H. longifilis* fingerlings diets.

Key words: Palm grub diets, *Clarias gariepinus, Heterobranchus longifilis,* growth, nutrient utilization

INTRODUCTION

In aquaculture, about 40% of the running cost is usually expended on feeding the cultured fish due to high cost of feed ingredients, the most important of these is fishmeal. However, shortage and high cost of fishmeal has affected the cost of fish feeds severely, making it expensive, hence the search for alternative and cheaper sources of animal protein in fish feeds.

Insects in nature constitute a significant biomass, as is exemplified by the insect pests (Anand *et al*., 2008). These are mostly primary consumers and highly reproduced. The many benefits that insects offer are often overlooked and underestimated. For instance, they can be used in human and animal nutrition, in medicine and also as in recycling of organic matter (Anand *et al*., 2008).

Palm grub, *Oryctes rhinoceros* is an insect pest of palm trees and coconut trees (Bedford, 1980), available from the wild and also culturable under laboratory conditions (Omoyinmi *et al*., 2005a). Some farmers rear it in some villages in south western, Nigeria. Omoyinmi *et al*. (2005b) reported that the nutritive value of palm grub makes it suitable as replacement for fishmeal in fish feeds. This study was carried out to investigate the effects of the replacement of fishmeal with palm grub (*O. rhinoceros*) meal on the growth of *Clarias gariepinus* and *Heterobranchus longifilis*, two popularly cultured mud catfish species in Nigeria.

MATERIALS AND METHODS

Experimental diets: *O. rhinoceros* larvae purchased from Igbokoda, Ondo state, were killed by asphyxiating them in a deep freezer for 48 h. The samples were dried in an oven at 60°C for 3 h. The dried samples were ground into powdered meal. Crude protein, crude lipid, crude fibre, ash and moisture contents of the palm grub were determined according to association of official analytical chemist methods (AOAC, 1990). Other ingredients namely: fishmeal, corn meal, starch, vitamin and mineral premix were purchased from Mirth Agric Nigeria Ltd., Ibadan. Five diets of about 40% crude protein were formulated using algebraic method as described by Falayi (2003). Palm grub meal was used to replace fishmeal at various inclusion levels of 0% (control), 25, 50, 75 and 100%. The diets were coded Diet A, B, C, D and E, respectively. The percentage composition of ingredients in each diet is shown in Table 1. The dry ingredients were ground to powder and the appropriate quantities for each diet were thoroughly mixed in a bowl for 30 min to ensure homogeneity of the ingredients. Starch was prepared with hot water and added as a binder. The feeds were oven-dried at 60°C for 3 h as crumbs. After cooling, the feeds were labeled and stored in airtight polythene bags in a deep freezer in the laboratory. Proximate analyses of each diet were carried out as reported earlier.

Experimental design: A total of 600 fingerlings were purchased; 300 fingerlings each of *H. longifilis* (0.67±0.01 g) and *C. gariepinus* (0.73±0.01 g). The fishes were acclimatized in plastic tanks (40 L capacity each) in the laboratory for one week and were fed with Coppens feed before commencement of the experiment. Twenty fingerlings of known weights were stocked in each tank making a total of sixty fingerlings per experimental diet each for *C. gariepinus* and *H. longifilis*. The fingerlings were fed manually of 5% of their body weight twice daily, in equal

Table 1: Percentage composition of ingredients in the experiment diets (% dry weight)

	Diets (palm grub)				
Ingredients	A (control, 0%)	B (25%)	C (50%)	D (75%)	E (100%)
Fishmeal	49.9	42.0	32.7	19.0	0.0
Palm grub meal (GM)	0.0	14.0	32.7	57.2	79.5
Corn meal	41.6	35.5	26.1	15.3	12.0
*Vitamin and mineral premix	0.5	0.5	0.5	0.5	0.5
Starch (binder)	8.0	8.0	8.0	8.0	8.0
Inclusion level of GM	0.0	25.0	50.0	75.0	100.0

*25 kg of premix contains: Vitamins A: 12,500,000 IU, Vitamins D3: 2,500,000 IU, Vitamins E: 40,000 mg, Vitamin K3: 2,000 mg, Vitamin B1: 3,000 mg, Vitamins B2: 5,500 mg, Niacin: 55,000 mg, Calcium pantothenate: 11,500 mg, Vitamin B6: 5,000 mg, Vitamin B12: 25 mg, Choline chloride: 500,000 mg, Folic acid: 1,000 mg, Biotin: 80 mg, Manganese: 120,000 mg, Iron: 100,000 mg, Zinc: 80,000 mg, Copper: 8,500 mg, Iodine: 1,500 mg, Cobalt: 300 mg, Selenium: 120 mg, Anti-oxidant: 120,000 mg rations at 9.00 and 18.00 h for twelve weeks. Supplementary aeration was provided throughout the duration of the experiment by means of AC/DC Aquarium Pump. The tanks were covered with netting material to prevent the fishes from jumping out. Dirt, uneaten food and other unwanted particles were siphoned from the tanks daily, while complete changing of water was done weekly. Temperature and pH of the water were monitored daily during the study using Jenway pH/ temperature meter, Model 3510. The experiment was carried out in triplicates.

Sampling of fish: At the commencement of the experiment, length and weight of each fish in each tank was measured; total and average lengths and weights per tank and diet were calculated and recorded as initial length and weight. Subsequently, measurements were taken at weekly intervals to assess growth rate and also to review the feed rations. At the end of the experiment, final length and weight of all fish left in each tank were measured; total and average final lengths and weights were calculated. Proximate analyses of the fish carcass were carried out at the beginning and end of the study.

Evaluation of growth performance and nutrients utilization: Weekly growth rates, relative growth rate, specific growth rate, food conversion ratio, protein intake, protein efficiency ratio and protein productive value were calculated using the formulae described by Ugwumba and Ugwumba (2007).

Statistical analysis: All data collected were subjected to Analysis of Variance (ANOVA).

RESULT AND DISCUSSION

Water temperature during the study ranged from 23.2-26.0°C, pH 6.6-7.6 in *H. longifilis* tanks and 23.0-26.2°C, pH 6.4-7.7 in *C. gariepinus* tanks. The temperature and pH values fall within suitable levels reported by Alabaster and Lloyd (1982) for the culture of freshwater fishes. The crude protein of palm grub, 39.8% recorded in this study (Table 2) is higher than 30.63% for cultured palm grub reported by Omoyinmi *et al.* (2005a). The lipid content of palm grub analyzed from this study was high (50.3%). Tacon (1985) reported that feeding fish with a high lipid diet exposes them to a risk of fat deposition in the organs. However, in the present study final carcass lipid content were generally similar between the palm grub-based diets and the control for *H. longifilis* and even lower for some of palm grub-based diets than the control for *C. gariepinus*. Dietary lipids have been reported to be well digested by fish and serve as a better energy source for protein-sparing than carbohydrates (Okoye *et al.*, 2001). The crude protein content of the five experimental diets ranged from 39.4-41.2% dry weight and they were not significantly different (p>0.05) (Table 3). These dietary protein levels are close to 40% reported as optimum for

Table 2: Proximate composition of palm grub (% dry weight)

Nutrient	Conc. (% dry weight)
Crude protein	39.84
Crude lipid	50.28
Crude fibre	12.23
Ash	2.39

Table 3: Proximate composition of the experimental diets (% dry weight)

Nutrient	Diet A (control, 0% palm grub)	Diet B (25% palm grub)	Diet C (50% palm grub)	Diet D (75% palm grub)	Diet E (100% palm grub)
Crude protein	39.42	40.09	41.12	41.20	40.97
Crude lipid	11.44	12.68	13.02	14.92	15.69
Ash content	12.29	12.89	12.60	11.46	11.05
Crude fibre	9.82	9.14	10.12	10.92	11.10
Moisture content	11.98	12.04	12.20	11.82	12.08

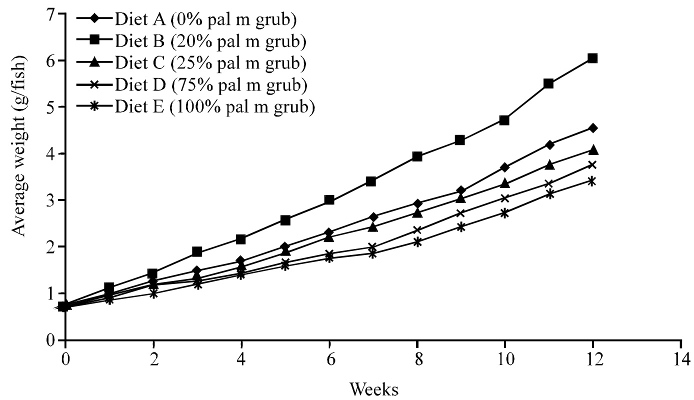

Fig. 1: Growth pattern of *C. gariepinus* on the experimental diets for twelve weeks

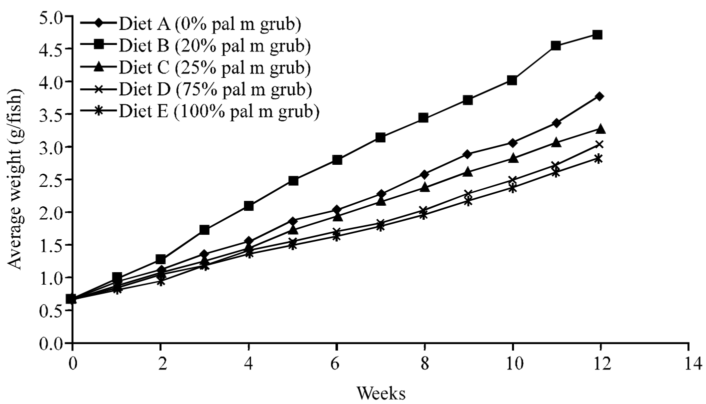

Fig. 2: Growth pattern of *H. longifilis* on the experimental diets for twelve weeks

C. gariepinus (Faturoti *et al*., 1986). Akinwande *et al*. (2002) reported that 38.86-41.22% crude protein were suitable levels for the culture of *C. gariepinus*. The dietary protein levels in the experimental diets in the present study therefore fall within the suitable levels for the culture of mud catfishes.

Progressive weight gain reported in all the treatments throughout the duration of experiment is an indication that the fishes responded positively to all the diets and that the protein content of the experimental diets was adequate for their growth (Fig. 1, 2). Growth rate was highest in fingerlings of both species fed 25% palm grub diet (relative growth rate: 726.0 and 595.0% for *C. gariepinus* and *H. longifilis*, respectively) and lowest in those fed 100% palm grub meal (367.1 and 316.2% for *C. gariepinus* and *H. longifilis* respectively) A similar pattern was observed for protein intake, protein efficiency and food conversion ratios (Table 4, 5).

Table 4: Growth and Nutrient Utilization of *C. gariepinus* fed the various diets

Constituent	Diet A (Control, 0% palm grub)	Diet B (25% palm grub)	Diet C (50% palm grub)	Diet D (75% palm grub)	Diet E (100% palm grub)
Duration (Week)	12.00	12.00	12.00	12.00	12.00
Number of fish stocked	60.00	60.00	60.00	60.00	60.00
Number of fish	51.00	52.00	52.00	50.00	53.00
Initial mean length (cm)	3.80	3.70	3.80	3.60	3.70
Final mean length (cm)	10.90	14.30	9.50	8.70	8.10
Mean length gain(cm)	7.10	10.60	5.70	5.10	4.40
Initial mean weight(g/fish)	0.74	0.73	0.74	0.72	0.73
Final mean weight(g/fish)	4.52	6.03	4.04	3.74	3.41
Mean weight gain(g/fish)	3.78	5.30	3.30	3.02	2.68
Weekly growth rate(g/fish/week)	0.32	0.44	0.28	0.25	0.22
Relative growth rate (%)	510.80^{ab}	726.00^{a}	445.90^{b}	419.40^{b}	367.10^{b}
Specific growth rate(%/day)	0.94^{a}	1.09^{a}	0.88^{a}	0.85^{a}	0.80^{a}
Food conversion ratio	0.89^{a}	0.70^{a}	0.99^{a}	1.04^{a}	1.13^{a}
Protein intake	3.08^{ab}	3.94^{a}	2.83^{b}	2.66^{b}	2.58^{b}
Protein efficiency ratio	1.23^{a}	1.35^{a}	1.17^{a}	1.14^{a}	1.04^{a}
Protein productive value	0.71^{ab}	1.05^{a}	0.61^{b}	0.46^{b}	0.23^{b}
Survival (%)	85.00^{a}	86.70^{a}	86.70^{a}	83.30^{a}	88.30^{a}

Values with the same superscripts are not significantly different at p>0.05

Table 5: Growth and Nutrient Utilization of *H. longifilis* fed the various diets

Constituent	Diet A (Control, 0% palm grub)	Diet B (25% palm grub)	Diet C (50% palm grub)	Diet D (75% palm grub)	Diet E (100% palm grub)
Duration (Week)	12.00	12.00	12.030	12.00	12.00
Number of fish stocked	60.00	60.00	60.00	60.00	60.00
Number of fish	41.00	44.00	43.00	43.00	43.00
Initial mean length (cm)	2.80	3.10	2.90	3.20	3.00
Final mean length (cm)	9.10	11.40	8.10	7.20	7.10
Mean length gain(cm)	6.30	8.30	5.20	4.00	4.10
Initial mean weight(g/fish)	0.67	0.68	0.67	0.68	0.68
Final mean weight(g/fish)	3.77	4.73	3.27	3.02	2.83
Mean weight gain(g/fish)	3.10	4.05	2.60	2.34	2.15
Weekly growth rate(g/fish/week)	0.26	0.34	0.22	0.20	0.18
Relative growth rate (%)	462.70^{ab}	$5 95.60^{a}$	388.10^{b}	344.01^{b}	316.20^{b}
Specific growth rate(%/day)	0.89^{a}	1.00^{a}	0.82^{a}	0.77^{ab}	0.45^{b}
Food conversion ratio	0.87^{a}	0.75^{a}	1.00^{a}	1.03^{a}	1.08^{a}
Protein intake	2.72^{ab}	2.99^{a}	1.94^{b}	1.73^{b}	1.55^{b}
Protein efficiency ratio	1.14^{a}	1.35^{a}	1.34^{a}	1.35^{a}	1.39^{a}
Protein productive value	1.18^{a}	0.97^{a}	1.32^{a}	1.32^{a}	1.49^{a}
Survival (%)	68.30^{a}	73.30^{a}	71.70^{a}	71.70^{a}	71.70^{a}

Values with the same superscripts are not significantly different at p>0.05

The fact that fingerlings fed 25% grub inclusion had better growth performance than the other diets is not surprising because protein intake was highest for this diet and the values for the two species were significantly different (p<0.05) from those of the other diets. Cowx (1992) reported that protein intake of fish is the major determinant of growth. Hossain and Jauncey (1989) had earlier reported that a mixture of protein sources was much more effective than single source of protein. This was confirmed by the mixed diet of fishmeal and palm grub at 25% inclusion level which had

Table 6: Carcass composition of *C. gariepinus* fed experimental diets at the beginning and end of the feeding trials (% dry weight)

		Final				
Nutrient	Initial	Diet A (control, 0% palm grub)	Diet B (25% palm grub)	Diet C (50% palm grub)	Diet D (75% palm grub)	Diet E(100% palm grub)
*Moisture	76.35	78.63	76.98	78.84	78.09	78.01
Crude protein	66.24	68.42	70.83	67.98	67.47	66.90
Crude lipid	12.30	18.41	22.02	14.64	16.80	13.49
Crude fibre	0.50	0.43	0.50	0.53	0.41	0.43
Ash	20.96	22.80	21.86	22.80	20.99	20.96

*Wet weight (%)

Table 7: Carcass composition of *H. longifilis* fed experimental diets at the beginning and end of the feeding trials (% dry weight)

		Final				
Nutrient	Initial	Diet A (control, 0% palm grub)	Diet B (25% palm grub)	Diet C (50% palm grub)	Diet D (75% palm grub)	Diet E(100% palm grub)
Moisture	74.84	72.92	73.27	73.62	73.62	73.94
Crude protein	58.40	62.02	62.32	61.82	61.50	59.89
Crude lipid	15.74	15.82	15.87	15.92	15.95	16.07
Crude fibre	0.60	0.55	0.59	0.57	0.61	0.72
Ash	20.12	21.23	21.18	21.22	20.92	21.03

wet weight (%)

better growth over the control diet of fishmeal as the only animal protein source. However, differences in growth were generally insignificant ($p>0.05$) above 25% palm grub meal inclusion levels. Fingerlings of the two species were capable of utilizing the formulated diets effectively as reflected by the generally low food conversion ratios in all treatment. However, the best food conversion was obtained at 25% palm grub diet. Growth and nutrient utilization of *C. gariepinus* were superior to *H. longifilis*. At the end of the experiment, carcass protein increased from 66.2-66.9-70.8% for *C. gariepinus* and from 58.4-59.9-62.3% for *H. longifilis* (Table 6, 7). The differences in protein retention in all the diets were not significantly different ($p>0.05$), indicating that palm grub meal inclusion level did not influence protein retention in the two species. Higher protein intake values in *C. gariepinus* than *H. longifilis* indicated that palm grub is probably better for the growth of *C. gariepinus* than *H. longifilis*. Survival rate was high during the experiment but the values were higher for *C. gariepinus* (83.3-86.7%) than *H. longifilis* (68.3-73.3%), further indicating more suitability of palm grub meal as dietary ingredient for *C. gariepinus* than *H. longifilis* (Table 4, 5).

CONCLUSION

The study has shown that palm grub meal can be used to completely replace fishmeal in the diet of *C. gariepinus* and *H. longifilis* fingerlings. However, for optimum growth and nutrient utilization, 25% level of replacement of fishmeal with palm grub meal is recommended. The study also showed that palm grub meal is a more suitable feed ingredient for growth and nutrient utilization of *C. gariepinus* than *H. longifilis*.

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