

Original Research Article

REPLACEMENT OF FISH MEAL WITH BAMBARANUT WASTE

MEAL IN THE DIETS OF LARVAL AFRICAN CATFISH *CLARIAS*

GARIEPINUS BURCHELL (1822)

ABSTRACT

Background: High cost of fishmeal adversely affects production of African catfish fingerlings. There is need for alternatives feed made from affordable and available feed palntand affordable feed to meet growing feed demands in the larviculture of African catfish. Fishmeal is costly and elevates prices of fish feed.

Aims: To substitute fishmeal (FM) with bambaranut waste meal (BNWM) in five novel diet of larval African catfish *Clarias gariepinus* average weight $1.850 \pm 0.79g$. and examine their growth and nutritional performances.

Place and duration: The experiment was carried out at the Fisheries and Hybrobiology, research unit department of Zoology University of Nigeria Nsukka between Nov.29 and 30 of December.

Methodology: We substituted FM-BNWM per diet as follows; feed 1, F1, 0-94%; F2, 5-89%; F3, 20-74 %; F4, 35-59%; and feed 5 (F5), 55-39%. Other ingredients were vitamin premix, vitamin C and palm oil. Catfish larvae were fed the experimental diets (F1-F5) for 30d.

Results: African catfish larvae grew with optimal SGR of 8.2% day⁻¹ for those fed with F5 and 7.2% day⁻¹ for those fed with F4. The catfish fed with F1 and F2 had lowest but similar SGR 5.0 and 5.3% day⁻¹ respectively. Food conversion ratio were similar for larvae fed with F5, F4 and F3 (P<0.05). Similarly FCR were similar for larvae fed with F1 and F2 (P<0.05). The weight gains of the larvae were best and similar for those fed F5 (5.0g) and F4 (4.5g), but better than F3 (3.5g). Those fed with F1 had least weight gain of (2.2g). There was however no difference in length gains of larvae fed with F5, F4 and F3. Based on these results, inclusion levels of 59% BNWM and 35% FM seem optimal for larval African catfish. Inclusion of BNWM above 59% significantly reduced growth rate.

Conclusions: The study shows that BNWM can supplement FM up to 59% in diets of African catfish. The lack of significant differences between FCR and SGR of F5 and F4 is important. It shows that BNWM which is discarded in mills is a valuable resource that holds profitable potential aquafeed production.

Key words: Specific growth rate, feed conversion ratio, bambaranut waste meal, fishmeal.

INTRODUCTION

African catfish is omnivorous and in addition possesses fast growth, hardiness and high fecundity and commands good market prices [1, 2]. Despite the boom in culturing African catfish, the production of fingerlings still remains a problem. Fingerling

production in sub Saharan Africa is hampered by high cost of feed and cost of imported live feed like artemia. The cost of fishmeal is responsible for high cost of fish feed [3]. Generally growth and intensification of aquaculture production also depends on development of sustainable protein source, to replace fish meal in aqua diets like plant protein [4].

One of the major problems of culturing African catfish is the high cost of imported feed and lack of adequate and nutritious local fish feed due to cost of fish meal [5, 6]. Poor feed production impacts negatively on fingerling production which reduces number of fish seed used for restocking. The availability of fingerlings produced under controlled conditions, making use of natural as well as high protein diet is hampered in Africa by the cost of feed and artemia [7].

Artemia is the most commonly used live feed for African catfish larvae but artemia is relatively costly in developing countries [8,9]. The requirement for live feed for *C. gariepinus* appears to have a short duration. Species can be weaned unto dry feed at a relatively early stage [10]. The inability of *C. gariepinus* to utilize dry feed effectively has been attributed to lack of functional stomach at start of exogenous feeding [10]. The age of the catfish larvae is determinant of its ability to utilize exogenous diets. However, [11] noted that in ontogeny *C. gariepinus*, the connection between the esophagus, the intestine and the anus opened at 144 hours post fertilization (h-PF). Complete eye differentiations took place 164 h-PF. Eye differentiation was concomitant with first feeding suggesting a key role of visual senses in feeding behavior [11].

Larviculture of African catfish therefore needs live food at least for the first four days of exogenous feeding after which they can be weaned to dry diets [9]. The dry feed

must then be nutritious and acceptable to African catfish [12]. The organoleptic qualities of the feeds must be enhanced through inclusion of ingredients like fishmeal to enhance acceptability.

The cost of fishmeal makes sourcing of alternative proteins imperative to sustain the increasing culture of African catfish [13, 14]. There had been many alternatives like Soybean meal [15], Palm fruit and bambaranut [16], groundnut cake [17], sesame seed meal [18], and cotton seed meal, [14]. Most of these analyses on alternative feeds ingredients were tested on fingerling stages of African catfish and not larval or post larval. There is paucity of articles on the effects of fishmeal supplementation on the growth and survival of larval African catfish example [17,12, 20].

High protein diet is very essential for growth and survival of early juveniles of *C. gariepinus*. Live feed like artemia and fish meal component of dry diets are both costly to the average fish farmer in Sub-Saharan Africa. There is need for the use of agro by products in fish feed production. This will reduce cost of production and enhance availability of feeds. Bambaranut waste meal (BNWM) is a byproduct of bambaranut flour production. Nigeria is a major producer of bambaranut which is also produced abundantly across the tropical world. Bambaranut is cheap, easily obtainable and the waste meal is either thrown away or sold at cheap prices. The protein content was reported to be about 24.14% [18] and carbohydrate content was estimated at 60% [20]. Bambaranut seed is also richer in essential dietary amino acids like lysine and methionine that is lacking in other known legumes. This paper examines the effects of addition of varying inclusion levels of bambaranut meal and fish meal in feeding *C. gariepinus* larvae.

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MATERIALS AND METHODS

95 **WATER QUALITY:**

96 This experiment was conducted in rectangular glass aquaria, length, 84cm, width, 40cm
97 and depth 40cm. Tanks were washed and half filled with water and aerated for 24hrs
98 before the introduction of fish. There was constant changing of water on a daily basis to
99 remove uneaten food and to maintain hygiene. Rubber siphon was used in removal and
100 introduction of the water. Water was supplied by University of Nigeria Nsukka water
101 works. The supplied water was allowed to settle in a basin and exposed to the air for at
102 least one hour. This was to make sure that harmful anions or cations like iron oxides that
103 may be in are oxidized.

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105 **CLARIAS GARIEPINUS LARVAE:** Larvae of *C. gariepinus* used for the experiments were
106 obtained from African regional aquaculture center Aluu in Port Harcourt. The larvae
107 were transported in oxygen bags and cold water bath, from Port Harcourt to our wet lab
108 at Nsukka. The journey was done in the evening to avoid stress of hot weather. On arrival
109 at Nsukka the larvae were allowed to rest for an hour and there was serial mixing of the
110 aquaria water and water from oxygen bags. Approximately quarter liter of water from the
111 aquaria was mixed with the oxygen bag water at intervals of 30min. Then the larvae were
112 allowed to swim freely, on their own into the aquaria. The stocking density of the larvae
113 was 15 larvae per aquaria.

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117 **WEIGHING AND MEASUREMENT OF LARVAE:**

118 The larvae were collectively weighed and average weight was taken on a weekly bases.

119 Weight measurements were taken per treatment replicate. There were three replicate per
120 treatment feed in this research. Weighing balance sensitive to 0.01g was used in weighing.

121 Length measurements were done using meter rule. The lengths were measured in
122 millimeter. Length measurements were done per fish for the entire replicate tank. Length
123 and weight measurements were done in the morning hour from 06-07hours GMT.

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125 **FEED PREPARATION:**

126 Bambaranut were obtained from the open market at Nsukka Enugu state milled and
127 sieved. The initial endosperm was removed and the remaining used for feed production.

128 Feed composition was calculated using square method [22]. Specific weight of
129 ingredients as shown in table 1 were measured and mixed with a Kenwood chef mixer for
130 30 minutes. In the process of mixing, 150mls of water was added to each of the feed type.

131 Mixed dough was condition by pressure cooking for 35 min.

132 Vitamin C and vitamin premixes were added and the dough was pulverized using 3mm
133 Kenwood meat mincer. The pellets were dried at 40°C and then refrigerated till needed.

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137 **EXPERIMENTAL FEEDING OF LARVAE:**

138 The feed was ground to powder and a little water was added to the feed to make a paste.

139 This was due to the size of fry. Feeding was done at 5% of fish body weight.

140 Larvae were fed twice daily in the mornings 08-09 hours and evenings, 17.00-1800 hours.

141 Feeding was usually in the morning immediately after cleaning up the aquaria.

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143 DATA ANALYSIS

144 One way ANOVA was used in calculating treatment and block effects and Fishers least

145 Significant difference (FLSD _{0.05}) was used in separating treatment means. Analysis were

146 done with Spss statistical package v.14.

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148 FISH GROWTH AND NUTRITIONAL PARAMETERS

149 Specific Growth rate (SGR) was calculated as follows:

150 $SGR (\%/day) = [(In \text{ Final body weight} - In \text{ initial body weight}) / Days (T_2 - T_1) \times 100]$

151 $Weight \text{ gain (g) (AWG)} = Final \text{ body weight} - Initial \text{ body weight} / 3$

152 $Feed \text{ conversion ratio (FCR)} = Food \text{ fed (g dry weight)} / Live \text{ weight gain (g)}$

153 $Length \text{ gain (mm) (ALG)} = Initial \text{ length} - Final \text{ length} / 3$

154 $Percentage \text{ weight gain (\% weight)}$

155 $(PWG) = (Final \text{ body weight} - initial \text{ body weight} / Initial \text{ body weight} \times 100.$

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159 RESULTS

160 A summary of the result of the experiment is presented in table 2.

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162 **Water quality:** The water quality was maintained at optimum level through out the

163 research. There was no case of water pollution through the period of the research.

Uneaten foods were removed and this was done during early hour of the morning when fish were not feeding well.

***C. gariepinus*:** The larvae of *C. gariepinus* readily accepted prepared feed. Larvae were affected by temperature drop (Table 3) which was as a result of the harmattan season. Low temperature resulted in late and reduced feeding and lower growth rate. There was no case of mortality throughout the period of the experiment.

SPECIFIC GROWTH RATE (SGR):

The larval SGR seemed to increase with increase in inclusion level of FM. The larvae fed with feed five (F5) had the highest SGR of 8.2 % day⁻¹ followed by those fed with feed four (F4) with SGR of 7.2% day⁻¹. There was significantly difference in the SGR of F5 and F4, (P>0.05). FLSD_{0.05} 0.71. The SGR of larvae fed with F3 was 6.0% day⁻¹, which was significantly different from those of F5 and F4 (P<0.05). The lowest SGR were for the larvae fed with feeds 1 (F1), 2.3% day⁻¹ and feed 2 (F2), 2.8% day⁻¹ respectively. There was however no significant difference (P<0.05) in the SGR of F1 and F2 larvae. The SGR of the larvae are presented in table 2.

FEED CONVERSION RATIO (FCR):

The FCR of larval catfish did not significantly reduce with increase in inclusion of FM. Although catfish fed with feed five (F5) had FCR as low as 1.1, it was not significantly different from the FCR of larvae fed with either feed 4 (F4) 1.4 or feed 3 (F3) 1.6

($P < 0.05$), FLSD_{0.05} 1.8. The lowest FCR of the catfish, were for those catfish fed with feed 1 (F1), 4.6 and feed 2 (F2), 4.5. There was no significant difference in the FCR of F1 and F2 ($P > 0.05$) FLSD_{0.05} 1.87 table (2). The larval FCR seems to be affected more by high inclusion levels of BNWM than FM. The larval feed conversion ratios were also adversely affected by change in water temperature. By observation we noted during the experimental period that catfish larvae accepted lesser, experimental diets and therefore had lower feed intake during low temperature periods (early morning hours of week two) of experiment (Table 3). In week two of the experiment water temperature fell as low as $21 \pm 0.01^\circ$, due to harmattan period in Nsukka around December period of the experiment.

WEIGHT GAIN:

The catfish had optimal weight gain when fed with F5 (weight gain of 5.00g), but this was not significantly different from the weight gain of those fed F4, 4.54g ($P < 0.05$). However the weight gain reduced to 3.53g and this significantly different from F5 and F4. Increasing inclusion of the BNM from 74% (F3) to 89% (F2) and 94% (F1) led to further reduction in weight gain of the larval catfish from 3.53g (F3), to 2.83g (F2) and 2.23g (F1). There was no significant difference in the AWG of feed2 and feed1 ($P < 0.05$) (Table 2).

LENGTH GAIN:

The length gain of catfish seems to increase with increase in FM inclusion. However the length gain of catfish fed with F5 (2.46mm), F4 (2.28mm) and F3 (1.89mm), were similar but not significantly different ($P < 0.05$). There was no significant difference in the

LG of catfish fed with F3 and F2. ($P < 0.05$, FLSD_{0.05}, 0.71). The lowest LG were measured for feed 1 LG 1.38mm and feed 2 LG 1.23mm respectively. There was however no significant difference in the ALG of feed 1 and 2 ($P < 0.05$) FLSD_{0.05} 0.71, (table 2).

PERCENTAGE WEIGHT GAIN:

The percentage weight gain of the catfish increased with increasing inclusion of FM as tabulated in table 3. The PWG of the catfish was 178.08% for the catfish fed with F5, but this was not significantly different from PWG of those fed with F4 (161.8%) ($P > 0.05$) Table 2. The lowest percentage gains were calculated for feed 1, PWG, 89.06 and feed 2 PWG, 96.75. However there was no significant difference in the PWG of catfish fed with F1 (89.06%) and F2 (96.75%), ($P > 0.05$, FSLD_{0.05} 18.63).

TEMPERATURE

The diurnal temperature variations in the experiment were measured with minimum and maximum thermometer inserted into the aquarium. There were notable temperature fluctuations during the second and third week of the experiment. The lowest temperature range measured was 21°-23°C in week 2 and 22°-25°C recorded in week 3 of the experiment. The highest temperature ranges were 25°C-29°C for week 1 and 26°C -28°C for the 4th week of the experiment. Temperature fluctuation affected fish welfare and feeding period of the catfish larvae. During the low temperature fluctuations of second and third week larvae were not accepting feed during early morning hours 08hr, as they were doing in previous week. Feeding rate was reduced with reduction in temperature.

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238 **DISCUSSION**

239 Larval African catfish growth rate was affected more by increasing inclusion levels of the
240 BNWM than FM. Although the combination of F5 (55FM:39BNWM) seems optimal in
241 terms of SGR ($8.2\% \text{ day}^{-1}$), the SGR of catfish fed with F4, (59BNWM:35FM) (7.2%
242 day^{-1}) was comparably close with $1\% \text{ day}^{-1}$ tradeoff. The performance of the catfish fed
243 with F4 suggests that African catfish larvae may not need up to 55% FM in their diets.
244 More so there were no significant differences in the weight gains and length gains of the
245 catfish irrespective of whether they were fed with F5, F4 or F3.

246 The increase in FCR of the catfish larvae fed with higher than 39% BNWM inclusion
247 levels suggests effects of high carbohydrate content of the ingredient. However there was
248 no significant difference in the FCR of catfish fed F5, F4 and F3. This seems to also
249 show that the catfish larvae utilized the BNWM efficiently well. African catfish is known
250 to utilize carbohydrates in feeds [22]. Bambaranut meal has 50% carbohydrates [19] and
251 30 % neutral sugar majorly glucose and galactose [22].

252 Although the catfish utilize BNWM effectively it was evident that inclusion level more
253 than 74% reduced growth rate considerably. The poor performances of the fish fed with
254 F2 and F1 were evident that BNWM should not be used alone in the diets of larval
255 African catfish. Complete substitution of FM with BNWM reduced larval growth rate
256 from $8.2\% \text{ day}^{-1}$ of F5, to $5\% \text{ day}^{-1}$ of F1. The inclusion of 5% FM in F2 could not
257 significantly increase growth rate. This suggests that catfish larvae assimilated more

nutrients from BNWM due to its higher inclusion level than FM. This was earlier reported by [13] for first feeding African catfish fed with diets substituting FM with BNM and corn meal. Although BNM contained essential amino acids like methionine and cystine, complete substitution of FM causes lack of other amino acids which could have been supplied by FM. Evidently, poor growth of fish fed with F1 and F2 could be as result of the poor amino acid profile of the diets. Poor array of essential amino in diets could lead to proteins catabolic processes and hence poor growth. Amino acids had been noted to be catabolic substrate in first feeding fish larvae [23].

The result of this experiment is in line with [2], who noted high SGR and weight gain in *C. gariepinus* fish fed 50 % FM diets It is also in line with earlier works of [24,25] who found 50% inclusion of fish meal optimal in fish feed of swim up fry's of channel catfish.

It may not be economical to produce 55% FM diet in sub- Sahara Africa due to the cost. Feed 3 and feed 4 compared favorably with F5 and could provide alternative to F5. The growth and nutritional effects of F3 is also in line with earlier work of [26], who found 20% fishmeal inclusion with soybean producing optimal weight gain in catfish.

The results on temperature effects highlights' importance of temperature in African catfish larviculture. Since the replicates tanks were randomly distributed the effects was similar for all treatment. However, low temperature ranges of the aquarium water in week 2, of the experiment were $21 \pm 0.01^{\circ}\text{C}$ to $23 \pm 0.01^{\circ}\text{C}$ (due to the harmattan season). Low temperature ranges $<23^{\circ}\text{C}$ reduces growth rate of African catfish. Optimal temperature range for raising of African catfish larvae is 30°C [27]. Catfish larvae that were reared entirely at 22°C showed more size variation than those on higher

temperatures. Size variation results from differential feed intake as a result of the low temperature regime. The increase in rearing temperature from week 3 to 4 of the experiment however increased growth rate. This is in line with [10], who noted that temperature is most important abiotic variable affecting growth and early juvenile of siluroides. For most siluroide species the optimal culture temperature range for larvae and early juveniles was 26°C-30°C [10].

Conclusions

BNWM can supplement up to 59% FM in diets of larval African catfish. The lack of significant differences between FCR and SGR of catfish fed with F5 and F4 shows BNWM supported catfish high growth rate even at almost 50% reduction in amount of fishmeal. BNWM which is discarded in mills is a valuable resource that holds profitable potential aquafeed production. BNWM is a plausible alternative to FM in larval diets but should not be used alone. This could be of serious financial implications in feed production especially in sub Saharan Africa and Asia. However more researches are needed on the effects of possible anti nutritional contents of BNWM. More researches are also needed on the adults or grow out stages to elucidate its effects on the grow out stage and brooder

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Table 1

422 Composition of experimental diets used in feeding larval African catfish for 30 d. Diets
423 varied as tabulated below in amounts of fishmeal and bambaranut waste meal.
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Ingredient	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Fishmeal	0	5	20	35	55
Bambaranut meal	94	89	74	59	39
Vit &Min premix	3.8	3.8	3.8	3.8	3.8
Vit. C	0.2	0.2	0.2	0.2	0.2
Palm oil	2	2	2	2	2
Total	100	100	100	100	100

Vit. A,4800, 000 I.U.D,vit. D, 800,000 I.U,vit.E, 12,000 I.U.D, vit. E, 12,000 I.U.D, vit. K,0.80g,
vit. B1,0.04g, vit. B2, 1.20g, vit. B12, 8.0g, vit.C, 100g, Folic acid, 0.80g, Biotin, 0.06g, Choline
Chloride,80.0g, manganese,10.0g, Iron, 50.0g, Copper, 10.0g, Iodine, 0.30g, Cobalt, 0.3g,
Selenium,0.4g.

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Table 2

Food conversion ratio (FCR), Average weight gain (AWG, g), Specific growth rate (SGR,%), length gain (LG, mm), Percentage weight gain (PWG, %) of larval

African catfish *Clarias gariepinus* fed with diets varying bambaranut waste meal and fishmeal for 30d.

Feed Types	FCR	AWG	SGR	ALG	PWG
Feed 1	4.6 ^b	2.23 ^c	5 ^d	1.23 ^b	89.06 ^b
Feed 2	4.5 ^b	2.83 ^{bc}	5.3 ^d	1.38 ^{ab}	96.75 ^b
Feed 3	1.6 ^a	3.53 ^b	6 ^c	1.89 ^a	140.35 ^a
Feed 4	1.4 ^a	4.54 ^a	7.2 ^b	2.28 ^a	161.8 ^a
Feed 5	1.1 ^a	5.00 ^a	8.2 ^a	2.46 ^a	178.08 ^a
FLSD _{0.05}	1.87	0.77	0.71	0.89	18.63

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Table 3

Variations in aquarium water temperature (°C) of larval African catfish *Clarias gariepinus* fed with diets varying bambaranut waste meal with fishmeal for 30d.

Weeks	Temperature variations		
	morning	evening	averages
Week 1	25° - 29°	27° - 31°	
	27° ± 0.09°	29° ± 0.40°	averages
Week 2	21° - 23°	22° - 24°	
	21 ± 0.01°	23 ± 0.01°	averages
Week 3	22° - 25°	22° - 24°	
	23 ± 0.07°	25.6° ± 0.06°	averages
Week 4	26° - 28°	28° - 32°	
	27 ± 0.04°	30 ± 0.06°	averages

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