EFFECTS OF TOTAL REPLACEMENT OF FISHMEAL WITH POUlTRY HATCHERY WASTE MEAL ON THE GROWTH RESPONSE OF CLARIID CATFISH (Clarias gariepinus) FINGERLINGS

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ABSTRACT

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This study examined the effect of total replacement of fishmeal (FM) with poultry hatchery wastes meal (PHWM) in practical diets on the growth responses of clariid catfish (Clarias gariepinus) fingerlings. Five isonitrogenous diets containing varying levels of (PHWM) in replacement for (FM) at (0.00%) control, 25%, 50%, 75% and 100% respectively were used (i.e. diets 1, 2, 3, 4, and 5 respectively). The five treatments were replicated thrice and fishes were cultured fed for nine weeks. Diet 5 (100% PHWM) had the best growth performance and feed utilization because it had the best values in weight gain (1.03g), feed intake (1.49g), best feed conversion ratio (1.45), relative weight gain RWG (12.4%) and specific growth rate SGR (1.67% per week). Diet 5 was significantly better (P<0.05) although growth was not significantly different (P>0.05) from Diet 4. Diet 5 had the next to the highest value in protein efficiency ratio (PER) with value of 2.34 while Diet 4 with value of 2.5 had the highest value of PER but not significantly superior (P>0.05) to diet 5. Similarly, Diet 5 also had the next to the highest value for NPU (86) while Diet 4 had the highest value (91) and was significantly different (P<0.05). Therefore, poultry hatchery waste meal (PHWM) can totally replace fish meal (FM) in the diet of clariid catfish without compromising growth and quality.

Keywords: Clarid catfish, Poultry hatchery waste meal, Diet, Fish meal.

INTRODUCTION

Commercial fish feed has been traditionally based on fish meal, a main animal protein source due to its high protein content and balanced amino acid profile. In addition to its excellent supply of essential fatty acid (EFA), mineral and vitamins (Tacon, 2011), fish meal is also very palatable and highly digestible to most freshwater and marine fishes (Watanabe et al., 2003). Rapid growth in aquaculture industry all over the world, has led to high demand for fish meal. Although the production of fishmeal and fish oil remained constant over the last two decades at about 6200 – 7000 tons year \(^{-1}\), relative amount used in fish feed increased from 15% in 1980 up to 43% in 1997 (FAO, 1997). These facts have made fish meal an expensive protein source for feed formulation in aquaculture. Consequently, alternative protein source for cultured fish food are being sought after. Arising from this, many poultry hatchery or incubators wastes are generated as by-products which cost little to process and transported. Such processed wastes have been found to be about 65% digestible (Rasool et al., 1999).

In Nigeria, aquaculture industry is currently faced with the problem of inadequate supply and prohibitive cost of quality fish feed. Fagbenro and Adeparsu (2003), and Omitoyin, (2005) have reported increasing attempt to develop practical diets for farmed fish in Nigeria. However most fish farmers, particularly those in the rural areas still depend on agricultural wastes including poultry hatchery waste meal for feeding of fish especially catfish (Obasa et al., 2008). It is noted that Nigeria produces large quantities of agricultural and agro-industrial by-products which serve as alternative feed sources for closed formula feeds. The fish farmers’ burden will be lessened when provided with an alternative to animal protein source in feed which contains all the nutrients as in fishmeal with same qualities that is, cheaper, palatable and locally available for use. The objective of this study is to determine the growth responses and nutrients utilization of Clarias gariepinus fingerlings fed dietary poultry hatchery waste meal in replacement for fishmeal.

MATERIAL AND METHODS

Culture unit and experimental fish

One hundred and two (102) experimental fish were obtained from the experimental fish farm of the Department of Fisheries, University of Benin, Benin City. Fingerlings of initial mean weight of 5.10±01 g were acclimated for one week in the Faculty of Agriculture, University of Benin laboratory. They were randomly distributed into fifteen (15) glass tanks. Each tank (45 cm x 60 cm x 35cm) was stocked with six (6) fingerlings. All glass tanks were filled to ¾ level of University of Benin domestic water supply and subjected to aeration.

Prior to treatment with experimental diets, ten (10) fingerlings were withdrawn for initial carcass analysis. The fingerlings were fed for 63 days with the test diets of poultry hatchery waste meal (PHWM) at laboratory conditions (mean temperature was 28°C and pH of 7.9). Five (5) isonitrogenous diets represented as Diet 1, (0%
PHWM); Diet 2, (25% PHWM); Diet 3, (50% PHWM); Diet 4, (75% PHWM); and Diet 5, (100% PHWM) were fed to the fish with each diet replicated thrice. The ingredients used in the diet formulation are shown in Table 1.

Culture Condition and Experimental Diets

Water supply was from the domestic water supply of the University of Benin. Fishes were fed twice daily (at 9.00 and 16.00 hours) to satiation as recommended by Martinez-Palacios et al. (1996). After each feeding unconsumed feed were removed by siphon and water totally changed. Tanks were washed during weekly weighing of fingerlings. This helps to keep water temperature, pH, dissolved oxygen, ammonia and nitrates under control. Poultry hatchery waste meal collected were boiled for 15 minutes, dried in smoking kiln at 65°C for 24 hours in order to subdue the presence of Escherichia coli and Salmonella sp (Khan and Bhatti, 2001). The waste were then ground to flour and analysed for proximate composition (Table 2) before being incorporated into the diets at various levels.

Table 1: Gross Composition of the Experimental Diets (%)

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Diet 1 0% PHWM</th>
<th>Diet 2 25% PHWM</th>
<th>Diet 3 50% PHWM</th>
<th>Diet 4 75% PHWM</th>
<th>Diet 5 100% PHWM</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHWM</td>
<td>-</td>
<td>7.00</td>
<td>14.00</td>
<td>21.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Fishmeal (65.5%)</td>
<td>28.00</td>
<td>21.00</td>
<td>14.00</td>
<td>7.00</td>
<td>-</td>
</tr>
<tr>
<td>Yellow maize</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Palm oil</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Bone meal</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
<td>0.60</td>
</tr>
<tr>
<td>Vitamin E gel</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

PHWM = Poultry Hatchery Waste Meal

Chemical analysis

Proximate analysis of the experimental diets, waste and that of experimental fish were carried out for moisture content, nitrogen, ether extract, crude fibre and nitrogen-free extract (NFE) according to the procedures of Association of Official Analytical Chemists (A.O.A.C., 2000).

Table 2: Proximate Composite (%) of Poultry Hatchery Waste Meal (PHWM) and Experimental Diets

<table>
<thead>
<tr>
<th>DIETS</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fibre</th>
<th>Moisture Content</th>
<th>NFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHWM</td>
<td>48.25</td>
<td>5.45</td>
<td>8.23</td>
<td>3.34</td>
<td>10.77</td>
<td>23.96</td>
</tr>
<tr>
<td>Diet 1 (CONTROL)</td>
<td>27.48</td>
<td>6.22</td>
<td>7.79</td>
<td>8.35</td>
<td>10.59</td>
<td>39.57</td>
</tr>
<tr>
<td>Diet 2</td>
<td>28.43</td>
<td>5.95</td>
<td>8.05</td>
<td>8.46</td>
<td>10.69</td>
<td>38.42</td>
</tr>
<tr>
<td>Diet 3</td>
<td>29.64</td>
<td>6.12</td>
<td>7.66</td>
<td>8.25</td>
<td>11.05</td>
<td>37.28</td>
</tr>
<tr>
<td>Diet 4</td>
<td>25.58</td>
<td>5.78</td>
<td>7.59</td>
<td>7.36</td>
<td>10.98</td>
<td>42.71</td>
</tr>
<tr>
<td>Diet 5</td>
<td>26.78</td>
<td>6.35</td>
<td>7.35</td>
<td>7.22</td>
<td>11.12</td>
<td>41.18</td>
</tr>
</tbody>
</table>

MC = moist content, NFE = nitrogen-free extract

Growth parameters

Growth parameters were determined using the following formulae:

Weight gain = \( W_1 - W_0 \)

Relative Weight Gain (RWG%) = \( \frac{W_1 - W_0}{W_0} \times 100 \)

Specific Growth \( \left\{ \frac{\ln W_1 - \ln W_0}{T} \right\} \times 100 \)

Where:

\( W_0 \): Mean initial weight (g)

\( W_1 \): Mean final weight (g)

\( T \): Time in 7 days between weightings

Feed conversion ratio (FCR) = feed intake (g)/weight gain (g)

Protein efficiency ratio (PER) = weight gain (g)/protein intake (g)

Net protein utilization (NPU) = \( \frac{(BP_1 - BP_0)/CP}{\times 100} \)

Where:

\( BP_0 \): Initial body protein content (g)

\( BP_1 \): Final body protein content (g)

CP: Protein intake (g)

Sampling was carried out weekly by weighing the whole fish in each replicate.

Statistical Analysis
All analyzed data were tested for significant differences using analysis of variance (ANOVA) test and the means were compared using Duncan multiple range test, all at 5% level of significance.

RESULTS

Growth and feed utilization parameters
The results of the growth response and feed utilization of *C. gariepinus* is shown in Table 3. The results showed that weight gain was significantly (P<0.05) higher in Diet 5 (1.03g) and Diet 2 (0.83g) recorded the least value among all treatments growth performance of *C. gariepinus* fingerlings fed poultry hatchery waste meal based diets were not significantly different (P>0.05). Feed intake by fish fed 100% PHWM was significantly higher (P<0.05) than all other treatments. The least feed intake was recorded in fish fed 75% PHWM and was significantly depressed (P<0.05). The feed conversion ratio (FCR) value for 100% PHWM (1.48) was significantly superior (P<0.05) among all treatments. Similarly, value of 1.77 for 25% PHWM was significantly depressed (P<0.05) compared with fish fed 0% PHWM diet.

The protein efficiency ratio (PER) values for fish fed 75% and 100% PHWM of 2.5 and 2.34 were significantly superior (P<0.05) among all treatments. Similarly depressed (P<0.05) compared with fish fed 0% PHWM diet. The protein efficiency ratio (PER) values for fish fed 75% and 100% PHWM of 2.5 and 2.34 were significantly superior (P<0.05) among all treatments growth performance of *C. gariepinus*. The least feed intake was recorded in fish fed 75% PHWM and was significantly depressed (P<0.05) compared with fish fed 0% PHWM diet. The protein efficiency ratio (PER) values for fish fed 75% and 100% PHWM of 2.5 and 2.34 were significantly superior (P<0.05) among all treatments growth performance of *C. gariepinus*.

Table 3: Growth responses and feed utilization of catfish, (*Clarias gariepinus*) feed poultry hatchery waste meal (PHWM) based diet

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Diet 1 (0% PHWM)</th>
<th>Diet 2 (25% PHWM)</th>
<th>Diet 3 (50% PHWM)</th>
<th>Diet 4 (75% PHWM)</th>
<th>Diet 5 (100% PHWM)</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight gain (g) relative</td>
<td>0.90ab</td>
<td>0.83c</td>
<td>0.97ab</td>
<td>0.93ab</td>
<td>1.03a</td>
<td>0.07</td>
</tr>
<tr>
<td>Relative weight gain (%)</td>
<td>114.70</td>
<td>114.00</td>
<td>115.10</td>
<td>122.90</td>
<td>126.40</td>
<td>8.70</td>
</tr>
<tr>
<td>Specific growth rate (%)/day</td>
<td>1.54</td>
<td>1.54</td>
<td>1.55</td>
<td>2.67</td>
<td>1.67</td>
<td>0.11</td>
</tr>
<tr>
<td>Feed intake (g)</td>
<td>1.41bc</td>
<td>1.41bc</td>
<td>1.43b</td>
<td>1.47b</td>
<td>1.49b</td>
<td>0.03</td>
</tr>
<tr>
<td>Feed conversion ratio</td>
<td>1.57ab</td>
<td>1.70a</td>
<td>1.50ab</td>
<td>1.47b</td>
<td>1.45b</td>
<td>0.12</td>
</tr>
<tr>
<td>Protein efficiency ratio</td>
<td>1.93c</td>
<td>2.00c</td>
<td>2.14b</td>
<td>2.5c</td>
<td>2.34b</td>
<td>0.15</td>
</tr>
<tr>
<td>Net protein utilization</td>
<td>76.30d</td>
<td>83.20e</td>
<td>85.90b</td>
<td>91.00f</td>
<td>86.00b</td>
<td>1.30</td>
</tr>
</tbody>
</table>

N/B: Mean Values with the same superscript on the same rows are not significantly different (P>0.05)

Table 4: Carcass composition of experimental fish (%)

<table>
<thead>
<tr>
<th>Diets</th>
<th>Crude protein</th>
<th>Fat</th>
<th>Ash</th>
<th>Fibre</th>
<th>MC</th>
<th>NFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish (initial) carcass</td>
<td>67.85</td>
<td>7.78</td>
<td>8.37</td>
<td>0.04</td>
<td>10.35</td>
<td>5.62</td>
</tr>
<tr>
<td>D1 (control)</td>
<td>34.48</td>
<td>5.58</td>
<td>6.55</td>
<td>6.59</td>
<td>10.22</td>
<td>36.58</td>
</tr>
<tr>
<td>D2</td>
<td>35.26</td>
<td>6.05</td>
<td>6.35</td>
<td>6.44</td>
<td>10.28</td>
<td>35.62</td>
</tr>
<tr>
<td>D3</td>
<td>33.44</td>
<td>5.78</td>
<td>6.44</td>
<td>6.66</td>
<td>10.88</td>
<td>36.8</td>
</tr>
<tr>
<td>D4</td>
<td>34.59</td>
<td>5.69</td>
<td>6.28</td>
<td>6.35</td>
<td>10.55</td>
<td>36.54</td>
</tr>
<tr>
<td>D5</td>
<td>34.66</td>
<td>5.77</td>
<td>6.37</td>
<td>6.42</td>
<td>10.79</td>
<td>35.99</td>
</tr>
</tbody>
</table>

MC = moist content; NFE = nitrogen – free extract

The results of the analysed carcass composition of fish are shown in Table 4 above. It was observed that the crude protein of the fish (initial) carcass was very high before they were introduced to the diets but after they were introduced to test diets, there was a dramatic drop in the crude protein and increased nitrogen-free extract (NFE) level.

DISCUSSION

It is apparent from the results of this feeding trial that the growth and nutrient utilization of *C. gariepinus* were influenced by the levels of poultry hatchery waste meal inclusion in the diets. The feed intake was significantly low in Diet 4 (1.37) and significantly high in Diet 5 (1.49) which contains 100% PHWM. It is followed by Diet 3 (1.45) which was not significantly different. Diet 1 and Diet 2 each had 1.41g. The crude protein content of Diets 2, 3, 4 and 5 are all lower than that of the control, D1. Similar trend was reported by Mustafa and Huseyn, (2003); Gumus and Aydin, (2013); Falaye et al. (2012); Tabinda and Butt, (2012). The crude protein content of the poultry hatchery waste which was 48.25% (Table 3), is lower than that reported by Obasa et al. (2009) which was 62.82%. Kundu et al. (1986) and Abiola et al. (2012) reported a crude protein content of 42.26% whereas Rasool et al., (1999) reported similar value of 44.25% crude protein content for poultry hatchery waste meal of broilers And Khan and Bhatti, (2001) reported an average of 45.47%. It indicates that there are some factors which affect the crude protein content, i.e. the proportion of egg shells, processing technique, particularly the
temperature and treatment period, etc. (Khan and Bhatti, 2001). The fat content of the waste is very low with a value of 5.45%, but it increased to 6.35% when the waste was used to replace fishmeal completely in Diet 5. This is similar to the fat content of the control diet (6.22%). Therefore, the problem of excess fat accumulation in the fish may not arise because this is lower than the inclusion level of lipids in a normal catfish diet (8%).

The results of this study show that feed intake generally increased as fishmeal (FM) replacement was increased which may be due to increase in the palatability of the diets. This is similar to the finding of Morenike et al. (2010) and Goda et al. (2007), who replaced with poultry by-product to feed to C. gariepinus. Weight gain response was variable among the diets. This was confirmed by the reports of Lin et al. (2012) and Yu (2004) as there was variable weight gain response when poultry by-product meal (PHWM) was fed to tilapia, shrimp and trout which may likely be related to low ash content. Even though the weight gain among the treatments was variable it was appreciable as Diets 1, 3, and 4 are similar with a higher value in Diet 5. The availability of nutrients to fish may vary considerably, depending on a variety of factors including fish species, ingredient quality and processing conditions (Gaylord and Gatlin, 1996).

As confirmed by Pares-Sierra et al. (2012), the feed conversion ratio (FCR) decreased as the level of PHWM increased and had a significant difference (P<0.05) in Diet 5 which contained 100% PHWM. Since the lower the FCR value the better the utilization of the feed, therefore, Diet 5 had the best FCR. A similar trend was reported by Abiola et al. (2012) and Lin et al. (2012). In contrast, Morenike et al. (2010) reported an overall increase in FCR among the diets as the levels of PHWM increased. The feed conversion ratio (FCR) and protein efficiency ratio (PER) were significantly affected by the replacement levels of FM with PHWM (P<0.05). The decrease in FCR among the diets could be explained with processing methods of PHWM, quality of the ingredients, digestibility, the rearing conditions or a combination of all those cases (Gumus and Aydin, 2013).

The relative weight gain (RWG) and specific growth rate (SGR) having these values respectively as follows: (114.7, 1.54; 114, 1.54; 115.1, 1.55; 129, 1.67; 126.4, 1.67) increased as the inclusion level of PHWM increased among the diets which is similar to the report of Lin et al. (2012). This showed that the diets were palatable to the fishes. Protein efficiency ratio (PER) is an important parameter for amino acid balance and protein quality (Hardy, 2000). PER increased among the diets but reduced insignificantly in Diet 5 (2.34). Net protein utilization (NPU), had a similar trend like PER. The PER and NPU values (2.34 and 86 respectively) in Diet 5 were not too low as they were next to the highest values seen in Diet 4 (2.5 and 91 respectively). Obasa et al., (2009) recorded a decrease in both PER and NPU as PHWM inclusion levels increased. The low PER and NPU could be attributed to insufficient amino acids (Leucine and lysine) availability in the diet (FAO, 1957) and feather, connective tissue and skin contents that are considered to be difficult for fish to digest (Hardy, 2000).

CONCLUSION

Problems with fishmeal in the world market led many manufacturers of fish feed to look for alternative sources of protein. The results from this study showed that poultry hatchery waste meal (PHWM) is an acceptable ingredient for the total replacement of fishmeal protein in practical diets for fingerlings of African catfish without impairing the growth. This approach provides alternative protein and calcium sources in catfish diets, reduce cost of fish production in terms of cost of feeds and minimizes the problem of poultry hatchery waste disposal from the hatchery industry.

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