Performance of Clarias gariepinus fed plantain peel meal as replacement for maize

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Abstract: High cost of feeds is a major problem to fish farming in Nigeria. In this study, the growth performance of African catfish (Clarias gariepinus) fed graded levels of plantain peels (PPM) as a replacement for maize was investigated. Five diets were formulated and maize meal replaced at 0 %, 25 %, 50 %, 75 % and 100 % in PPMD1, PPMD2, PPMD3, PPMD4 and PPMD5 respectively. The feeding trial lasted for 56 days. Data collected were subjected to one-way ANOVA test. Results showed that fish on control diet (PPMD1) were significantly (p > 0.05) highest in weight gain(7.34 ± 0.09g) while the least weight gain was recorded among PPMD5 fish. Similar trend was observed in specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER). Packed cell volume (PCV), Haemoglobin (HB), Red blood cell (RBC), Mean corpuscular haemoglobin cell (MCHC), and Lymphocytes (20.67 ± 0.33, 7.77 ± 0.03, 1.80 ± 0.06, 35.57 ± 0.47, and 84.00 ± 0.58 respectively) were significantly highest (p<0.05) in PPMD4. MCV was highest in PPMD1 and lowest in PPMD4. MCH was significantly higher (p<0.05) in PPMD1 and lowest in PPMD3. White blood cells (WBC) was significantly highest (p<0.05) in PPMD3 and Neutrophils was significantly highest (p<0.05) in PPMD5. It was concluded that PPM compares favorably with maize and an optimum inclusion level 25% (PPMD2).

Key words: Maize meal, Energy requirement, Catfish, Growth performance

1. Introduction

Fish is considered as the cheapest animal protein source in most developing countries including Nigeria [1]. Other advantages of fish as dietary component of human diets have been elucidated [2, 3]. Fish supply comes from the capture sector (coastal and inland fisheries) as well as through fish farming.
(aquaculture). Nigeria has a great potential for fish farming development [4, 5]. However, one major problem facing fish farming in Nigeria is high cost of feed which accounts for at least 60% of the total cost of production [6]. Maize, a major source of carbohydrate, is an important cereal grain [7] in fish feed formulation. It has been used as energy source in formulated feeds and a major source of metabolized energy in most compounded diets for catfish species source in formulated feeds and it is a major source of metabolized energy in most compounded diets for catfish species. However, maize meal for animal feed formulation is dwindling in supply and its price very high [8]. This is largely due to competition for maize arising from human consumption, animal and other industrial uses. Thus, the continued inclusion of this important ingredient in fish feed is no longer justified. There is therefore need to explore alternative and cheaper energy sources to replace the expensive cereals in fish feed formulation. One agricultural by-product that has been identified in this direction is plantain peel meal (PPM) which is a by-product of plantain processing.

Plantain is a tropical plant belonging to the family Musaceae and the genus Musa [9]. Plantain peels are by-products of the plantain processing industries. They are normally dumped in landfills, rivers or regulated grounds [10]. Plantain peels constitute an important source of energy, it is quite abundant and readily available since it is of no direct use to man, it can be fully harnessed in the production of food for animals [11]. The peel has the potential of replacing maize in the diet of fish [12]. The abundance of plantain peel could serve as huge benefit for the sustainability of the aquaculture industry, if properly harnessed. The objectives of the study are, therefore, to evaluate the use of plantain peel in the diet of African catfish, Clarias gariepinus with a view to determine its best inclusion level.

2. Materials and methods

2.1 Collection of fish, Experimental Site, Collection of Plantain Peel Samples and Methodology

One hundred and fifty Clarias gariepinus fingerlings were purchased from Afe Babalola University Fish Farm in Ado-Ekiti and transported to the Wet Laboratory of the Department of Fisheries and Aquaculture, Federal University Oye-Ekiti, Ikole Campus, Ekiti State, Nigeria where the research was conducted. The fish were acclimatized for fourteen days following the method of Kahl, (2019). Peels of unripe plantains were obtained from Ikole Ekiti, Ekiti State at different locations and sundried until a constant weight is obtained. The dried sample was grounded into powder and sieved to pass through 2mm mesh after which it was stored in air-tight container until needed for use. The resulting meal was analyzed for proximate and mineral composition using AOAC (2000). Five diets which contained plantain peels meal at 0, 25, 50, 75 and 100% were formulated (Table 1) to contain 40% protein and administered to the experimental fish at 5% body weight. Each treatment was replicated thrice. Fish were
fed twice each day (8.00 and 16.00 hour) for eight weeks during which the weight and nutrient utilization parameters were taken weekly.

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

| Ingredient          | PPMD1 | PPMD2 | PPMD3 | PPMD4 | PPMD5 |
|---------------------|-------|-------|-------|-------|-------|
|                     | 0%    | 25%   | 50%   | 75%   | 100%  |
| Fish meal           | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| Maize               | 10.64 | 7.98  | 5.32  | 2.66  | 0.00  |
| PPM                 | 0.00  | 2.66  | 5.32  | 7.98  | 10.64 |
| Soybean meal        | 30.53 | 30.53 | 30.53 | 30.53 | 30.53 |
| Groundnut cake      | 15.99 | 15.99 | 15.99 | 15.99 | 15.99 |
| Wheat offal         | 4.32  | 4.32  | 4.32  | 4.32  | 4.32  |
| Methionine          | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| Vitamin/Min Premix  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
| Salt                | 0.5   | 0.5   | 0.5   | 0.5   | 0.5   |
| Vitamin C           | 0.02  | 0.02  | 0.02  | 0.02  | 0.02  |
| Starch              | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
| Vegetable oil       | 3.00  | 3.00  | 3.00  | 3.00  | 3.00  |
| Total               | 100   | 100   | 100   | 100   | 100   |

PPMD – Plantain Peel Meal Diet
PPM - Plantain Peel Meal

2.2 Growth performance and nutrients utilization parameters

2.2.1 Growth performance parameters

Fish response to treatments were measured using mean weight gain, average daily growth, specific growth rate, percentage weight gain, survival rate [13].

2.2.1.1 Mean weight gain (MWG)

\[ MWG = W_1 - W_0 \]

Where \( W_1 \) = Finial Weight
\( W_0 \) = Initial Weight

2.2.1.2 Specific Growth Rate (SGR)

\[ SGR = \frac{Log_e(W_1) - Log_e(W_0)x 100/t_2 - t_1x 100}{t_2 - t_1} \]

[14]
Where \( W_1 \) = the final weight, \( W_0 \) = the initial weight, while \( t_2 - t_1 \) = duration between \( W_0 \) and \( W_1 \) (days).

2.2.1.3 Average daily growth (ADG)

\[
ADG = \frac{Mean\ weight\ gain}{Eperiment\ period\ (days)} \quad [15]
\]

2.2.1.4 Percentage Weight gain (PWG)

\[
PWG = \frac{Mean\ Weight\ Gain}{Initial\ Mean\ Weight} \times 100
\]

2.2.1.5 Survival Rate (SR)

\[
SR = \frac{Number\ of\ fish\ stocked - Mortality}{Number\ of\ fish\ stocked} \times 100
\]

2.2.1.6 Feed conversion Ratio (FCR)

\[
FCR = \frac{Feed\ consumed\ (g)}{Weight\ gained\ (g)} \quad [15]
\]

2.2.2 Nutrient Utilization

Nutrient utilization were measured using food conversion ratio, protein efficiency ratio and productive protein valve as described by [16]

2.2.2.1 Feed conversion efficiency (FCE)

\[
FCE = \frac{Weight\ gain}{Feed\ intake} \times 100
\]

2.2.2.2 Protein efficiency ratio (PER)

\[
PER = \frac{Mean\ weight\ gain}{Crude\ protein\ intake}
\]

2.3 Haematological Assessment

At the end of feeding trial, fish blood samples were collected with heparinized bottle. Blood samples were obtained from the caudal vein of fish from each replicate and kept in EDTA bottles for analysis [17]. Haematological examination of the fish was carried out at the end of the experiment using standard haematological techniques [18]. Parameters analyzed include; Haemoglobin, Red blood Cell (RBC), White blood Cell (WBC), Packed Cell Volume (PCV), neutrophils and lymphocytes. The blood indices including mean corpuscular volume (MCV in femtoliters), mean corpuscular haemoglobin (MCH in pictograms per cell), and mean corpuscular haemoglobin concentration (MCHC in grams per decilitre) were calculated below as did [18] while the differentials in the white blood cell were also determined using methods described by [19].

2.3.1 \( MCV \) (fl) = \( PCV \times 10/RBC \)

2.3.2 \( MCH \) (pg) = \( Hb \times 10/RBC \)

2.3.3 \( MCHC \) (g/dl) = \( Hb \times 100/PCV \)

2.4 Statistical Analysis

The data collected were subjected to using one way statistical analysis of variance (ANOVA) and the significant differences in means were determined by applying Duncan’s Multiple Range test. The
tests will use SPSS Software, version 20 (2011). Statistical significance effect on the parameters to be measured will be set at $p \leq 0.05$.

### 3.0 Results

Proximate composition of experimental African catfish fed plantain peel meal as observed from this study shows that moisture content was highest in PPMD 4 and lowest in PPMD 1 (Table 2). Crude protein was highest in PPMD 2 and lowest in PPMD 5. Lipid was highest in PPMD 5 and lowest in PPMD 3. Ash was significantly highest ($p < 0.05$) in PPMD 1 and lowest in PPMD 5.

| Table 2: Proximate Composition of African Catfish Fingerlings Fed Plantain Peel Meal |
|----------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Parameters                            | PPMD 1 (0 %)    | PPMD 2 (25 %)   | PPMD 3 (50 %)   | PPMD 4 (75 %)   | PPMD 5 (100 %)  |
| Moisture (%)                          | 8.96 ± 0.00     | 9.16 ± 0.00     | 10.30 ± 0.06    | 11.60 ± 0.06    | 11.67 ± 0.03    |
| Crude Protein (%)                     | 57.53 ± 0.07    | 57.07 ± 0.24    | 56.33 ± 0.15    | 55.57 ± 0.07    | 55.07 ± 0.03    |
| Ash (%)                               | 11.13 ± 0.37    | 10.83 ± 0.48    | 10.67 ± 0.23    | 10.43 ± 0.19    | 10.20 ± 0.06    |
| Lipid (%)                             | 11.60 ± 0.50    | 11.43 ± 0.62    | 11.78 ± 0.78    | 12.73 ± 0.62    | 12.47 ± 0.03    |
| NFE (%)                               | 10.77 ± 0.19    | 10.51 ± 0.12    | 11.27 ± 0.69    | 10.67 ± 0.37    | 10.60 ± 0.11    |

**NFE** = nitrogen free extract

Mean ± S.E with different superscripts are significantly different at $p < 0.05$

The growth and nutrient utilization of *Clarias gariepinus* fed plantain peel meal as presented in Figure 1 shows that fish fed control diet had the highest feed intake (8.37 ± 0.06) while the lowest was recorded in fish fed 100% maize meal replaced diet. Similarly, fish fed with control diet had the highest weight gain (7.34 ± 0.09). However, the highest feed conversion ratio (1.64 ± 0.04) was recorded in PPMD 4 where maize meal was replaced at 75 % and in fish fed the control diet (1.14 ± 0.01). Specific growth rate was significantly highest ($p < 0.05$) in PPMD 1 (control) and lowest in PPMD 5. Protein efficiency ratio was highest in fish fed control diet (PPMD 1) while PPMD 2 and PPMD 3 fish were not significantly different ($p > 0.05$) in their PER values. The same thing was observed in the fish of PPMD 4 and PPMD 5.

The Packed cell volume (PCV), Haemoglobin (Hb), Red blood cell (RBC), Mean corpuscular haemoglobin cell (MCHC), Lymphocytes were significantly highest ($p < 0.05$) among the fish of PPMD 4. Mean Corpuscular Volume (MCV) was highest in the fish of control diet and lowest in PPMD 4. Results further revealed that the Mean corpuscular haemoglobin (MCH) was significantly highest ($p > 0.05$) in PPMD 1 and lowest in PPMD 3. White blood cell showed significant differences ($p < 0.05$)
across all the treatments but was highest in PPMD 3. Blood differential counts (neutrophils and lymphocytes) showed significant differences (p < 0.05) across the treatments (Figure 2).

![Figure 1: Growth and Nutritional Performance of African Catfish fed Plantain peel meal](image)

**DISCUSSION**

The reduction in the feed intake and average weight gain between the fish in control and other experimental diets could be attributed to the increased crude fibre and palatability of the feed since this is identify as a common difficulty observed when alternative feedstuffs are tried in fish nutrition [20]. Although the feed intake of *Clarias gariepinus* may not be strictly regulated by dietary energy, balance of dietary energy according to [21] is important when formulating catfish feeds. This is true mainly because if dietary energy is too high, catfish may not eat as much, resulting in fewer intakes of essential nutrients. Too high of a dietary energy/protein ratio may lead to higher body fat as was observed in the proximate composition of the fed fish fillet in this study. This may reduce dressed yield and shorten shelf life of frozen products.
The result of this study demonstrated that inclusion of plantain peel meal has significant effect on the growth performance of *C. gariepinus* as was demonstrated in the decrease in weight gain, specific growth rate (SGR) and feed conversion ratio (FCR) as the plantain peel meal was increase in the diets. It has been established that optimal energy/protein ratio enhances growth and survival of fish [22]. The FCR trend in this study is similar to what [23] reported when he used plantain peel to replace maize meal. Although fish consume food to satisfy their energy requirement, excess dietary energy may limit intake of essential nutrients like protein and amino acids [24]. This may be the reason for the continual decrease in the protein efficiency ratio (PER) of the fish at every increase in plantain peal inclusion. The fact that excess energy can lead to growth reduction and hinder digestion by fish may not be unconnected with the control fish having the best FCR.

According to [25], feeding has measurable effects on blood composition of animals. Haematological characteristics helps fish biologist to interpret physiological response by fish. Any deviation from normal response may indicate a disturbance in the physiological process [26]. Although there were notable variances in the haematological parameters in this study, the values obtained are still

![Figure 2: Haematological Parameters of African Catfish fed Plantain Peel Meal](image-url)
within a healthy range as reported by [22 and 27]. It can thus be stated that the experimental diets did not negatively impact the health status of the fish.

**Conclusion**

From the result of this study, it can be concluded that plantain peel compares favorably with maize up to an optimum inclusion level of 25%. Further addition may distort the protein/energy ratio of the diet of *Clarias gariepinus*.

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