Original Research Article

Effect of Substituting Poultry Waste Meal for Maize in the Diet of the African Clariid Catfish, *Clarias gariepinus* (Burchell 1822) Juveniles.

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ABSTRACT

The growth response of *Clarias gariepinus* juveniles of average weight 6.5g fed poultry waste meal (PWM) was studied for 70 days. The poultry waste meal comprised the droppings from the layers pen, some maggots, broken eggs and feeds that fell during the course of feeding. The proximate analysis of PWM had crude protein value of 9.795, crude fibre 8.700, ash 25.174, moisture 10.794, carbohydrate 44.286 and fat 1.250 respectively. Five diet were formulated; which were Diet A (Control: with 0% inclusion level of poultry waste meal, B (25%), C (50%), D (75%), and E with 100% inclusion level (total replacement with poultry waste meal). The water quality parameters were monitored weekly and weights were taken every fortnight. The result showed that the best diet was the Control which gave the best mean weight gain (9.227g), specific growth rate (1.247), protein efficiency ratio, PER (0.692), and the lowest feed conversion ratio (2.003) when compared with the other diets. The lowest growth and nutrient utilization parameters were observed in diet E with total replacement of maize. However, there were no significant differences ($p \geq 0.05$) between the control and all other diets in the values recorded for growth and nutrient utilization, even up to 100% substitution of maize with PWM. The cost of feed production decreased with increase in inclusion levels of PWM in the diets. The results of the study showed that the use of PWM could be considered in the diet of *C gariepinus* even up to 100% substitution level since there was no significant differences ($p \geq 0.05$) among all the diets in terms of growth and nutrient utilization; and considering the huge cost of maize and competition for its use whereas PMW is obtainable at little or no cost.

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Keywords: [poultry waste meal, substitution, maize, Clarias gariepinus, juveniles}

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1. INTRODUCTION

Fish is one of the most highly consumed proteins because it is relatively cheap and has little or no religious or regional bias [1], therefore the demand for it is on the increase even as human population is increasing. Capture fisheries was relied upon in the past to meet fish demand but recent trends all over the world points to a decline in landing from capture fisheries which is an indicator that fish stock have approached or even exceeded point of maximum sustainable yield [2], hence further increase in capture fisheries are not anticipated under the current global condition [3]. With this trend, Aquaculture has become the proposed solution to bridge the fish demand-supply gap.

A major aspect of aquaculture is feeding. Fish nutritionists have demonstrated increasing interest in researches focused on reducing the cost of the most expensive ingredients by alternative nutrient sources such as replacing fish meal or other conventional feedstuffs with either plant protein sources or other unconventional feedstuffs [4, 5, 6]. Maize is one of such expensive and conventional ingredient because there is great competition for its use by both the human food and animal feed industries. For fish culture project, the optimum dietary requirement at a reduced production cost is essential in order to achieve maximum profit, therefore reducing feed cost is a major challenge in aquaculture nutrition. This study therefore is focused on the use of poultry waste meal as a replacement for maize, which is expensive, in the diet of African catfish *Clarias gariepinus* juveniles so as to reduce feed cost.

Poultry waste meal (PWM) is an agricultural waste and a potential feedstuff which could be a source of protein or energy depending on its composition. [7] observed that agricultural wastes' compositions tend to vary as it will depend on the system and type of agricultural activities from which they are obtained and they can be in the form of liquids, slurries, or solids. [7] further stated that these agricultural wastes are the non-product outputs of production and processing of agricultural products that may contain material that can benefit man or can be collected and processed for beneficial use at minimal cost. The poultry waste meal used in this study comprised of left over feeds, broken poultry egg parts and poultry feaces which was found on analysis to have proximate composition similar to the yellow maize.

The African Clariid catfish, *Clarias gariepinus* (Burchell, 1822) is one of the most popularly cultured fish species in Nigeria because of its many aquaculture potentials [8, 9]. Information on the effect of poultry waste meal when incorporated into fish diets are scarce, therefore this study was carried out to investigate the growth and nutrient utilization of the African Clariid catfish *Clarias gariepinus* fed with poultry waste meal.

2. MATERIALS AND METHODS

The study was carried out at the Department of Fisheries and Aquaculture Management, Ekiti State University Ado-Ekiti, Nigeria Research Laboratory.
The dietary ingredients: Fish meal, soybean meal, vitamin premix, bone meal and starch were purchased from Metrovet Veterinary Shop, G.R.A. Ado Ekiti and Mercy Agricultural Business Services, Ado Ekiti.

2.1 Collection and Preparation of Poultry Waste Meal

The poultry waste was collected from Ekiti State University Poultry Farm. The poultry waste comprised of poultry droppings of layers, some maggots, some broken eggs and feeds that fell during the course of feeding. The poultry waste was sun dried at a temperature of 28^{o}C for three days and then grinded to flour using grinding machine. The grinded poultry waste was then taken to the laboratory for proximate composition before being incorporated into the experimental diets.

2.2 Preparation of Experimental Diets

The dietary ingredients were measured as contained in Table 1 with poultry waste meal (PWM) substituted for maize at inclusion levels 0%, 25%, 50%, 75% and 100% for diet A (control), B,C,D and E respectively. Starch was added to act as a binder and it was pelletized with a locally fabricated pelleting machine of 3mm die size. The pellets were sun dried and packed in well labeled air tight containers and stored in a cool and dry place.

Table 1. Gross Composition of Poultry Waste Meal (PWM) Diets (g/100g)

	A (0%)	B (25%)	C (50%)	D (75%)	E (100%)
FISHMEAL (65.5%)	32.00	32.00	32.00	32.00	32.00
SBM (45%)	31.5	31.5	31.5	31.5	31.5
YELLOW MAIZE (10%)	28.5	22.8	17.1	11.4	5.7
PWM (9.8%)	-	5.7	11.4	17.1	22.8
VEG. OIL	2.5	2.5	2.5	2.5	2.5
BONE MEAL	1.00	1.00	1.00	1.00	1.00
*VIT. PREMIX	2.00	2.00	2.00	2.00	2.00
STARCH	2.5	2.5	2.5	2.5	2.5

***Each kg contains: Vit. A: 4,000,000IU; Vit. B: 800,000IU; Vit. E: 16,000mg; Vit. K3: 800mg; Vit. B1: 600mg; Vit. B2: 2,000mg; Vit. B6: 1,600mg; Vit. B12: 8mg; Niacin: 16,000mg; Caplan: 4,000mg; Folic Acid: 400mg; Biotin: 40mg; Antioxidant: 40,000mg; Chlorine chloride: 120,000mg; Manganese: 32,000mg; Iron: 16,000mg; Zinc: 24,000mg; Copper: 32,000mg; Iodine: 320mg; Cobalt: 120mg; Selenium: 800mg manufactured by DSM Nutritional products Europe Limited, Basle, Switzerland.*

Where: SBM = Soybean meal, PWM = Poultry waste meal

2.3 Procurement of Fish

One hundred and fifty juvenile *Clarias gariepinus* of average weight of 6.5g were purchased from Federal Ministry of Agriculture GRA, Ado Ekiti. The fish were starved for 24hours and allowed to acclimate to the new environment after which Coppens was used to feed it for three days prior to the beginning of the actual feeding experiment.

Ten fish were randomly stocked per aquarium in triplicate groups for each treatment and fed twice daily to satiation at 8.00 to 9.00 and 17.00 to 18.00 hours for 70days. Weighing of fish in each aquarium was carried out in batches every fortnight and feed was adjusted to accommodate the increase in body weights of the fish. Faeces and feed remnants were siphoned out every day to prevent fouling.

2.4 Determination of Growth Performance of test fish

Growth performance was determined as follows [10]:

i Weight gain = final weight of fish (W_2)-Initial weight (W_1)

ii Specific growth rate (SGR) = $\underline{\text{Log}_e \text{ final weight} – \text{Log}_e \text{ initial weight} \times 100}$

Rearing period (Days)

iii Protein efficiency ratio (PER) = fish weight gain (g)

Protein consumed (g)

iv Feed conversion ratio (FCR) = weight of feed (g)

Fish weight gain (g)

2.5 Proximate Analyses

The proximate analyses of poultry waste meal (PWM) and that of the fish after the experiment were determined using the method of [11]. Parameters determined were: moisture content, crude protein, lipid, ash, crude fibre and NFE (carbohydrate).

2.6 Cost of experimental diets

The cost of producing 1kg of the different feeds with PWM at different inclusion levels was calculated and compared with the production cost of 1kg of the control diet which has no PWM. Costing was done according to the prevailing market prices of ingredients that were used in diets at the time of the experiment.

2.7 Statistical Analysis

Data on growth parameters were subjected to one - way analysis of variance (ANOVA) to test for significant difference in the means while means which were significantly different were separated using Duncan's multiple range test. Analysis was performed using the SPSS (Statistical Package for Social Sciences) version 21. Significant level was set at $p \geq 0.05$ and values were expressed as Means±SD.

3. RESULTS

3.1 Proximate Composition of Poultry Waste Meal

The result of the proximate composition of poultry waste meal is shown in Table 2. The poultry waste meal had a crude protein content of 9.795, Fat content of 1.250, Crude fibre of 8.700, moisture content of 10.794, Ash content of 25.174 and Carbohydrate of 44.286

Table 2. Proximate Composition of Poultry Waste Meal (%) Dry Weight

FAT	1.250
CRUDE FIBRE	8.700
PROTEIN	9.795
MOISTURE	10.794
ASH	25.174
CARBOHYDRATE	44.286

Laboratory analysis, 2019

3.2 Growth and Nutrient Utilization of the Experimental Fish

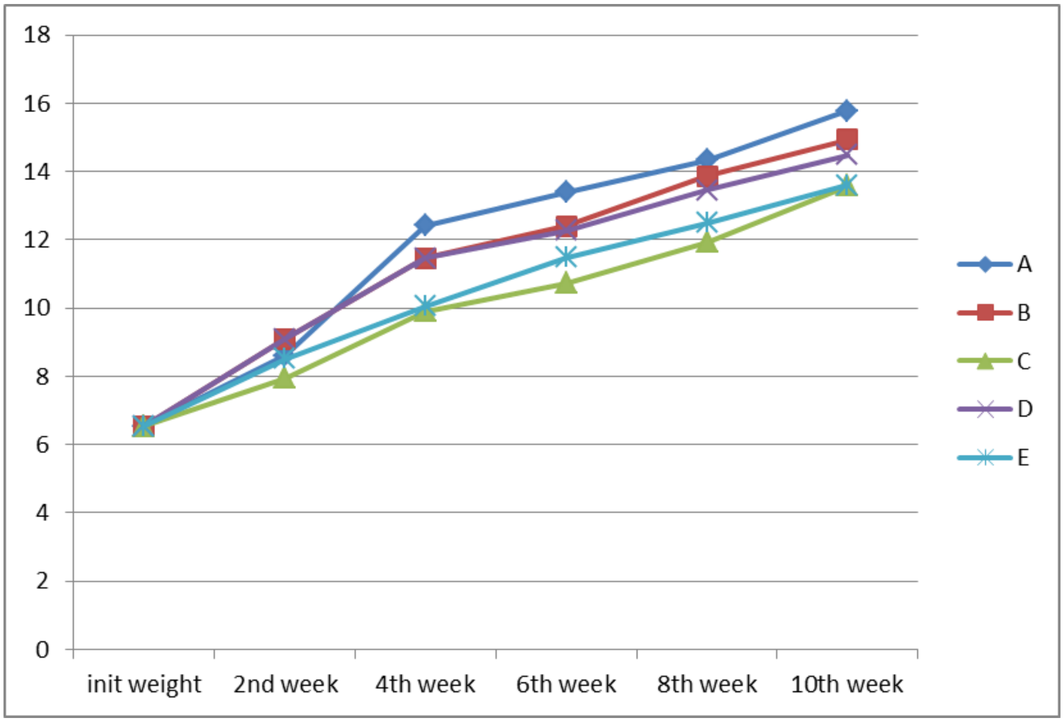
Table 3 shows the growth and nutrient utilization of the experimental fish. Final weight was highest in fish fed with diet A (15.780±2.130) followed by the fish feed with diet B (14.940±0.949) while the least was found in fish fed with diet C (13.597±1.364) Weight gain was highest in fish fed diet A (9.227±2.129) while the least weight gain was found in fish fed with diet C (7.047±1.346).All the other parameters followed the same trends with the highest values recorded in control and the least in C. However, there were no significant differences (p>0.05) between the control and all other diets. For FCR, fish fed with the control had the best value (1.880±4.814), followed by the fish fed with diet B (2.003±0.215). The worst value was recorded in fish fed with diet C (2.430±0.521). However, there were no significant differences (p>0.05) between all the diets in terms of FCR.

Table 3. Growth and nutrient utilization of *Clarias gariepinus* fed with poultry waste meal

	A (Control)	B	C	D	E
Mean initial weight	6.553±0.006[a]	6.557±0.006[a]	6.550±0.000[a]	6.557±0.006[a]	6.553±0.006[a]
Mean final weight	15.780±2.130[a]	14.940±0.949[a]	13.597±1.346[a]	14.477±1.476[a]	13.610±0582[a]
Mean weight gain	9.227±2.129[a]	8.383±0.947[d]	7.047±1346[a]	7.920±1.475[a]	7.057±0.583[a]
Average daily weight gain	0.1318±0.031[a]	0.1198±0.017[a]	0.1007±0.006[a]	0.1131±0.025[a]	0.1008±0.010[a]
Specific growth rate (SGR)	1.247±.0.203[a]	1.183±0.102[a]	1.040±0.148[a]	1.127±0.146[a]	1.047±0.060[a]
Protein efficiency ratio (PER)	0.692±0.169[a]	0.630±0.0701[a]	0.529±0.101[a]	0.594±0.111[a]	0.529±0.044[a]
Feed conversion ratio (FCR)	1.880±4.814[a]	2.003±0.215[a]	2.430±0.521[a]	2.152±0.393[a]	2.373±0.193[a]

Means and standard deviation along the same column followed by same superscripts are not significantly different (p>0.05).

Weight (g)



Weeks

Figure 1: Graph of the weight increase of Experimental Fish

3.3 Carcass Composition of the Experimental Fish

The carcass composition of the experimental fish is given in Table 4. Fish fed with diet B had the highest crude protein value (70.173±0.962) while the fish fed with diet A had the least value (59.195±1.318). There were significant differences ($p<0.05$) between the fish fed diet B and all the other diets in terms of crude protein value while there was no significant difference ($p>0.5$) between the control and diet E. Ash content was highest in fish fed with diet B (5.291±0.004) and the lowest was found in fish fed with diet D (4.856±0.009). In term of ash content, there were significant difference ($p<0.05$) between the control and diet B and D but there was no significant difference ($p>0.05$) between the control and other diets.

Table 4. Carcass composition of experimental fish (% Dry Weight)

	A Control	B	C	D	E
Moisture	$6.828±0.047^{b}$	$5.890±0.045^{a}$	$6.607±0.025^{ab}$	$6.829±0.104^{b}$	$7.150±0.754^{b}$
Crude protein	$59.195±1.318^{a}$	$70.172±0.962^{c}$	$64.083±0.818^{b}$	$64.998±0.123^{b}$	$62.098±2.341^{ab}$
Ether extract	$15.248±0.543^{c}$	$12.260±0.514^{a}$	$14.686±0.675^{bc}$	$13.234±0.320^{ab}$	$14.067±1.115^{abc}$
Ash	$4.998±0.064^{b}$	$5.291±0.004^{c}$	$4.990±0.009^{b}$	$4.856±0.009^{a}$	$5.059±0.075^{b}$
NFE	$13.730±0.756^{d}$	$6.411±0.442^{a}$	$9.684±0.136^{b}$	$10.082±0.348^{b}$	$11.619±0.403^{c}$

Means and standard deviation along the same column followed by same superscripts are not significantly different ($p>0.05$).

3.4 Water Parameters During the Experimental Period

Table 5 shows the result of water quality parameters recorded during the period of the experiment. The temperature and the dissolved oxygen throughout the period of the experiment ranged from 26.120-26.272 and 6.266-7.300mg/litre respectively while pH values ranged between 6.300-6.733.In terms of temperature there were no significant differences (p>0.05) between the control, diet B,C and E and there were no significant differences (p>0.05) between diets C,D and E. For DO, there was no significant differences (p>0.05) between A,C, and E and no significant differences (p>0.05) between diet B and D. For pH, there were no significant differences among all the diets.

Table 5. Water quality parameter during the experiment

Treatment	Temp ^{0}C	DO (mg/l)	pH
A	26.133±0.104^a	6.400±0.100^a	6.300±0.300^a
B	26.120±0.030^a	7.200±0.200^b	6.500±0.360^a
C	26.20±0.057^{ab}	6.633±0.321^a	6.333±0.493^a
D	26.272±0.069^b	7.300±0.100^b	6.633±0.152^a
E	26.200±0.010^{ab}	6.266±0.152^a	6.733±0.208^a

Means and standard deviation along the same row followed by same superscripts are not significantly different (p>0.05).

3.5 Cost of experimental diet

The cost of replacing maize in the diet of *Clarias gariepinus* is shown in Table 6. The cost of the diet decreased with increasing level of inclusion of poultry waste meal

Table 6: Cost of experimental diet

INGREDIENTS	A(₦)	B(₦)	C(₦)	D(₦)	E(₦)
Fish meal	1080	1080	1080	1080	1080
Poultry waste meal	__	7.125	14.25	21.38	28.6
Soya bean meal	143.33	143.33	143.33	143.33	143.33
Yellow maize	79.8	63.84	47.88	31.92	15.96
Vegetable oil	25.00	25.00	25.00	25.00	25.00
Bone meal	1.5	1.5	1.5	1.5	1.5
Vitamin premix	82.5	82.5	82.5	82.5	82.5
Starch	6.25	6.25	6.25	6.25	6.26
Total	1418.41	1409.55	1400.71	1391.88.	1383.14

4. DISCUSSION

This study investigated the effect of substituting poultry waste meal (PWM) for maize in the diet of the African Clariid catfish, ***Clarias gariepinus*** (Burchell 1822) juveniles***.*** The experimental fish species (***Clarias gariepinus****)* readily accepted the experimental diets and showed evidence of good growth as attested to by the final weight and weight gain recorded in the experiment. This is an indication that poultry waste meal could be nutritious and well utilized for conversion to flesh in the diets of fish. This is in agreement with the work of [7] who reported that agricultural wastes may contain materials that can be collected and processed for beneficial use at minimal cost. It is also a common practice in integrated poultry-cum- fish farming that poultry wastes could serve as the main source of food for the fish all through the culture period, bringing about adequate growth at little cost with no adverse effect on the fish health. The result of this study further corroborates the work of [12] who reported that some industrial wastes (biscuit, Indomine® and Gala® wastes) had equal potentials in replacing maize as an energy supplement when incorporated to the *Clarias gariepinus* feed with positive effects on the growth and haematological parameters of the fish.

The result of the proximate analysis of PWM in this study showed that it had crude protein level and other nutrients very similar to that of yellow maize. This is an indication that it could conveniently replace maize in this experiment with no adverse effects on the fish growth as attested to by the result of this study. In nutrition experiments usually, only feed ingredients with comparable nutrients compositions are used for substituting the other so that there will be no deficiency symptoms manifesting in the animal being fed as a result of the substituted ingredient or introduce bias in the results obtained in the experiment. The result of proximate composition of PWM obtained from laboratory analysis in this study however is in contrast to the work of [13] who reported a crude protein value of 28.6% on analysis of poultry waste. The differences in values could be due to collection and processing methods. [7] also reported that agricultural wastes usually tend to vary in composition depending on the constituents.

From the growth and nutrient utilization results obtained in the study, the fish fed the control diet (0% inclusion level of PWM) had the best results. However, there were no significant differences ($p \geq 0.05$) between the results obtained in the control and all the other diets. Considering the high cost of maize in the market and the fact that PMW could be obtained at little or no cost, its incorporation could be a way of converting waste to wealth. Incorporating it in the diet of *Clarias gariepinus* would greatly reduce the cost of feed and consequently the cost of production and increase the profit margin of farmers. Several authors have also worked on the replacement of maize with lesser-used ingredients with varying levels of success [14, 12, 6, 15, 16].

The experimental water condition was maintained at temperature values between 26.12 and 26.27^{0}C, dissolved oxygen values between 6.26 and 7.30 mg/l and pH values between 6.3 and 6.7 5. These values were within the standard values recommended for warm water fish culture and supported good fish production [17, 18].

The result of the carcass analysis also showed that the crude protein for all the fish fed the experimental diets were higher than that of the control which showed that they retained protein in their carcass than the fish fed the maize based diets.

The cost of replacing maize with poultry waste meal shows that the cost of production of 1kg feed reduced as the level of inclusion of poultry waste meal increased. Profitability and viability of a fish farming enterprise depends largely on the total cost of fish feeds as feeding cost represents the most expensive component of fish farming enterprise therefore the more the inclusion level of PWM in this experiment, the more profitable and viable the project would be. This is in line with the findings of [12] who reported that the use of some industrial wastes (biscuit, Indomine® and Gala® wastes) in replacing maize in the diet of *Clarias gariepinus* all reduced total feed cost per kg by at least 30%. Fish farming sector is currently faced with the challenge of inadequate and prohibitive cost of quality fish feeds therefore it is pertinent that the use of alternative sources of nutrients that ordinarily pass as waste and usually discarded such as PWM used in this experiment be explored as it is not competed for like maize. These agricultural wastes could be procured at little or no cost as they are categorized as waste products meant to be discarded.

5. CONCLUSION

This study shows that poultry waste meal could be incorporated into the diet of African catfish *Clarias gariepinus* as there was no significant difference in the growth values recorded for the control and all the other experimental diets even up to 100% inclusion level.

Cost analysis of replacing maize with poultry waste meal showed that the cost of production of 1kg feed reduced as the level of inclusion of poultry waste meal increased. The cost of feed forms the major part of cost of production of fish and maize being high in cost will further bring about a hike in cost of production.

Considering the high cost of maize in both local and international markets and the competition for its use in both human foods and livestock feeds, the use of PMW is highly encouraged as it will reduce the cost of production and make fish farming more profitable. It will also serve as a way of converting waste to wealth.

COMPETING INTERESTS

There is no competing interests.

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