International Journal of Agricultural Technology 2022Vol. 18(4):1539-1550
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of maize cob as replacement for maize (*Zea mays*) on the growth performance and haematological profile of *Clarias gariepinus* fingerlings

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Irabor, A. E., Ekelemu, J. K., Nwachi, F. O. Olawale, J. O. and Pierre, J. H. (2022). Effect of maize cob as replacement for maize (*Zea mays*) on the growth performance and haematological profile of *Clarias gariepinus* fingerlings. International Journal of Agricultural Technology 18(4):1539-1550.

Abstract An experiment was conducted on the performance and haematology of *Clarias gariepinus* fingerlings fed with compounded diets (maize cob meal or MCM) as replacement for maize). Triplicate groups of 30 fish samples with initial average weight of 9.75 g were randomly stocked per dietary treatment and fed with 5 different diets (0%, 20%, 40%, 60% and 80% maize cob meal respectively). The study lasted for eight (8) weeks. There were significant (P<0.05) differences across dietary treatments as inclusion levels of MCM increased. It was observed that 40% inclusion level of MCM had the best mean values for weight gain, feed conversion ratio and survival rate at 25.64 g, 2.21 and 96% respectively. Data on haematological profile revealed that the haematocrit (PCV), haemoglobin (Hb) and White blood cell (WBC) in 60% MCM had the highest mean value (36.67, 12.23 and 6466.7 respectively), while red blood cells (RBC) was highest in 40% MCM (7.20). Conclusively, replacement of maize with MCM up to 40% inclusion level is recommended for optimum performance of *C. gariepinus* fingerlings.

Keywords: *Clarias gariepinus*, Growth, Haematology, Replacement, Treatments

Introduction

The culture of African catfish (*Clarias gariepinus*) is a rapidly harnessed species in aquaculture practice in Nigeria and has contributed significantly to the economy growth and food security of the country (Irabor *et al.*, 2021b). The demand for *C. gariepinus* as a major animal protein source has been on the increase due to rise in population and fish farming has the potential to bridge the gab between fish demand and supply (Nwachi and Irabor, 2015; Irabor *et*

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al., 2021a). Also contributing to the significant reduction of importation, wild stock pressure and rural poverty (Obiero *et al*., 2019).

Amidst the potentials, catfish fish farming is faced with a major challenge which is the high cost of feed ingredients especially protein and energy sources such as fish meal, soyabean and maize (Irabor *et al.,* 2022). This challenge threatens the productivity and sustainability of catfish culture. Alternatively, sourcing for available, cheap but effective feed ingredients e. g. plant products or waste is now a major concern to farmers and local feed producers (Irabor *et al.,* 2021a).

Generally, maize cob usually considered as waste have been reported to be a significant energy source due to its high carbohydrate content (45 - 55%) and other nutritional characteristics making it a potential substitute for the expensive energy source (maize) (Cetinkaya *et al.,* 2020; Njideka *et al.,* 2020; Xue *et al.,* 2020; García-Alanis *et al.,* 2021). Also, maize cob is non-toxic, readily available in good quantity and since it is considered as waste, it is gotten almost for free (Pezhhanfar and Zarei 2021; Girelli *et al.,* 2020).

Although, partial or total replacement of the expensive feed ingredients is key to the reduction of cost of production but there is need to ensure the required nutrients is available in the substituting ingredient since the growth of fish is proportional to the feed utilization which is a function of the balanced nutrient composition of the feed (Irabor *et al.,* 2021b).

Therefore, this study evaluated the performance and haematological profile of *C. gariepinus* juveniles fed varying levels of maize cob meal as partial replacement for maize.

Materials and methods

Study location

This research was carried out at the Department of Fisheries Teaching and Research Farm, Delta State University, Asaba Campus located on Latitude 6^0 20^1S and Longitude 6^0 73^I E.

Duration of study

The study lasted for a period of 6weeks from October to December, 2021.

Feed formulation

Five experimental diets, containing graded levels of maize cob as replacement for maize (0%, 20%, 40%, 60% and 80%) were formulated. The ingredients and percentages of inclusion were shown in Table 1.

Table 1. Percentage composition of diet

Ingredients	0% MC	20% MC	40% MC	60% MC	80% MC
MCM	0.00	3.60	7.20	10.8	14.4
Fish meal	40.0	40.0	40.0	40.0	40.0
Soya beans	12.0	12.0	12.0	12.0	12.0
Groundnut cake	8.00	8.00	8.00	8.00	8.00
Maize	18.0	14.4	10.8	7.20	3.60
Wheat bran	10.5	10.5	10.5	10.5	10.5
Bone meal	2.00	2.00	2.00	2.00	2.00
Vitamin premix	1.00	1.00	1.00	1.00	1.00
Lysin	1.00	1.00	1.00	1.00	1.00
Methionine	0.70	0.70	0.70	0.70	0.70
Salt	0.30	0.30	0.30	0.30	0.30
Binder	1.00	1.00	1.00	1.00	1.00

Legends: MCM: Maize cob meal

Source of experimental fish and acclimation

A total of four hundred and fifty (450) fingerlings of *C. gariepinus* were purchased in good condition from a notable farm in Asaba for the study. The fingerlings were acclimatized for one week in culture tank, after which were randomly distributed in 30 per tank into fifteen (15) experimental tanks (MCM $0\%_{A\text{-}C,}$ MCM $20\%_{A\text{-}C,}$ MCM $40\%_{A\text{-}C,}$ MCM $60\%_{A\text{-}C}$ and MCM $80\%_{A\text{-}C}$) and fed twice daily (07:30am and 18:30pm) with the formulated feed at 5% body weight for eight (8) weeks.

Growth parameters

Body weight gained, Specific Growth Rate and Feed Conversion Ratio were all determined using the procedures as described by Irabor *et al.* (2021b).
Body weight gained = final weight – initial weight

$$\text{Specific Growth Rate (SGR)} = \frac{[\text{In}(W_t) - \text{In}(W_I)]}{t} \times 100$$

Where: In (W_t) = final weight, In (W_I) = initial weight, t= duration of culture.

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Total weight of feed fed to fish}}{\text{Total weight of fish weight gained by fish}}$$

Water quality analysis

The water quality parameters such as dissolved oxygen, temperature and pH were observed weekly using the methods as dscribed by Saboe *et al.* (2020).

Haematological analysis

At the end culture period, about 2.3 ml of blood samples was collected from experimental fish using a 2.5ml syringe and hypodermic needles, then introduced into heparinized Ethylene Diamine Tetra-acetic Acid (EDTA) anticoagulant tubes and properly labeled for easy identification then subjected to haematological analysis.

The packed cell volume (PCV), haemoglobin (HB) concentration, Red Blood Cell (RBC) and White Blood Cell (WBC) count were determined in the departmental haematology lab.

Haemoglobin estimation: Cyanmethaemoglobin method was used where 2ml of blood samples was taken from the EDTA tube with the aid of a pipette and mixed with 4ml Drakin's solution. After which the test tube was taken into a photo-calorimeter for reading, then final haemoglobin result was calculated from;

$Hb = \frac{T\ x\ C\ x\ DF}{A\ x\ 100}$ (Kone *et al.*, 2019)

Where: T = Test Absorbance, A = Standard Absorbance, C = Concentration of cynamethaemoglobin, DF = Dilution Factor

White Blood Cell (Leucolytes): Using a 20ul pipette, blood sample was sucked up into a test tube and mixed with already prepared dilute solution which helps to make visible the white blood cells for easy identification and counting.

$WBC = \frac{N\ x\ DF\ x\ 10^2}{A\ x\ A}$ (Kone *et al.*, 2019)

Where: N = Number of Cells Counted, DF = Dilution Factor, A = Area Chamber counted, D = Depth of Chamber

Red Blood Cell (Erythocyte): A solution of formal-citrate was used for the red blood cell count (RBCC) where the blood samples were diluted into a shellback pipette added 4ml of modified Drabkin's fluid to give a final solution of 1 in 20l. The diluted samples were then mixed and loaded into the haemocytometer. After the cell's sedimentation, the number lying on 5 of the 0.04mm^2 area were counted by charging the Neubauer's chamber, placed under a microscope and counted. The final value was expressed as the number of cells per liter.

$RBC = \frac{N\ x\ DF\ x\ 10^2}{A\ x\ A}$ (Kone *et al.*, 2019)

Where: N = Number of Cells Counted, DF = Dilution Factor, A = Area Chamber counted, D = Depth of Chamber

Packed Cell Volume (PVC): Using a Microhaematocrit centrifuge by the wintrobe's and Westergreen's method with commercially available haparined capillary tubes of 75mm. blood sample was drawn by capillary action into microhaematocrit tubes then synthetic sealant was used to seal one end. Sealed tubes were centrifuged in a microhaemotocrit centrifuge at 1200g for 10minutes and placed in a chart where final reading for PCV using a Microhaematocrit reader was obtained.

Statistical analysis

The data obtained from this research were analyzed using analysis of variance (ANOVA) and means separated using the Duncan's multiple range tests (SPSS version 25).

Results

Results of the physicochemical parameters (temperature, pH and dissolved oxygen) were presented in table 2. The highest temperature and pH reading were observed at 60% MCM (27.42 ^{o}C and 6.47, respectively), while the lowest values were observed at 0% MCM (27.01 ^{o}C and 6.47, respectively). Dissolved oxygen was higher at 20% inclusion level, but lowest at 60% MCM. Although, there was a variation in the mean values of the parameters as inclusion levels increased but all parameters were within the acceptable standards.

Table 2. Mean values of water parameters for the five treatments

Parameters	**0% MCM**	**20% MCM**	**40% MCM**	**60% MCM**	**80%**
Temperature (^{o}C)	27.01	27.03	27.23	27.42	27.11
pH	6.43	6.25	6.25	6.47	6.23
DO (Mg/1)	4.67	4.74	4.63	4.35	4.45

The result of the proximate analyses of maize cob meal was presented in Table 3. Maize cob was observed to contain high level of crude fibre (33.36%) which makes it a good energy source. The mean values for crude protein, moisture, ether extract, ash and nitrogen free extract were 4.24%, 5.98%, 4.34%, 2.52% and 0.74%.

Table 3. Proximate composition of maize cob meal

Parameters	Percentage (%)
Moisture	5.98
Crude protein (CP)	4.24
Crude Fibre (CF)	33.36
Ether Extract (EE)	4.34
Ash	2.52
Nitrogen Free Extract (NFE)	0.74

Result of the proximate composition of the experimental diets was shown in Table 4. At 40% MCM inclusion level, the highest crude protein (40.43%) was observed while the least mean value (35.51%) was recorded at 80% MCM inclusion level. Crude lipid, moisture content, total ash and NFE values (5.23%, 9.86%, 4.79% and 35.75%, respectively) were observed to be higher at 0% MCM, while the lowest mean values (4.18%, 7.63%, 3.59% and 33.57%, respectively) were observed at 80%. At 80% inclusion level of MCM, crude fibre was higher with mean value of 9.89%, while the least mean value (3.90) was observed at 0% MCM inclusion level.

Table 4. Proximate composition of compounded feeds

Parameters	0% MCM	20% MCM	40% MCM	60% MCM	80% MCM
Crude protein (%)	40.21	40.06	40.43	39.08	35.51
Crude lipid (%)	5.23	5.12	4.61	4.40	4.18
Crude fibre (%)	3.90	4.78	5.46	7.75	9.89
Moisture content (%)	9.86	9.04	8.58	7.96	7.63
Total ash (%)	4.79	4.52	4.26	3.87	3.59
NFE	35.75	34.79	34.38	33.76	33.57

Legends: CP: Crude Protein, CF: Crude Fat, CFr: Crude Fibre, DM: Dry Matter, MC: Moisture Content, NFE: Nitrogen Free Extract

At 40% MCM inclusion level, the highest mean values for specific growth rate and mean weight gained which was 2.48% and 25.64 g respectively, while the least mean values (1.60 and 12.74 g, respectively) were observed in 80% MCM. The optimum FCR (2.21) was observed at 40% MCM inclusion level, while the worst mean value (2.99) was observed at 80% MCM inclusion level. The highest percentage survival rate (96%) was observed at 40% MCM, while the lowest percentage value (59%) was observed in 80% MCM.

Table 5. Growth performance of fish fed experimental feeds

Parameters	0% MCM	20% MCM	40% MCM	60% MCM	80% MCM
IW (g)	9.76 ± 0.92	9.75 ± 0.09	9.75 ± 0.09	9.76 ± 0.09	9.75 ± 0.09
FW (g)	31.08±0.4^{c}	31.49±0.6^{b}	35.39±0.21^{a}	25.84±1.0^{d}	22.49±0.3^{e}
BWG (g)	21.32±0.93^{c}	21.74±0.93^{b}	25.64±0.93^{a}	16.08±0.93^{d}	12.74±0.93^{e}
TFI/Fish (g)	59.36±0.4^{a}	58.24±0.6^{b}	56.56±0.2^{c}	45.92±0.21^{d}	38.08±0.21^{e}
ADFI/Fish (g)	1.06±0.11^{a}	1.04±1.39^{ab}	1.01±1.43^{b}	0.82±1.12^{c}	0.68±1.06^{d}
FCR	2.78±0.16^{d}	2.68±0.25^{c}	2.21±0.58^{e}	2.86±0.9^{b}	2.99±0.23^{a}
SGR (%)	2.23±0.12^{b}	2.25±0.22^{b}	2.48±0.03^{a}	1.87±0.41^{c}	1.60±0.24^{d}
SR (%)	96	92	96	74	59

Data expressed as mean ± SD (standard Deviation). Values in the same column with the same alphabet as superscript are not significantly different (*P* > 0.05).
Legends: TFI: Total feed intake, ADFI: Average daily feed intake; SGR: Specific Growth Rate, FCR: Feed Conversion Rate, SR: Survival Rate.

The haematological profile result showed that at 80% MCM, PCV, HB and WBC mean values (36.00, 12.23 and 6466.7, respectively) were highest, while the least mean values (31, 10.33 and 4700, respectively) were observed at 0% MCM. The RBC count had the highest mean value (5.900) at 40% MCM inclusion, while at 80% MCM inclusion level, the lowest mean value (4.567) was observed.

Table 6. Haematological profile of *Clarias gariepinus* fingerlings fed experimental feed

Parameters	0% MCM	20% MCM	40% MCM	60% MCM	80% MCM	SEM	Sig.
PCV	31.00^{e}	33.00^{d}	34.33^{c}	36.00^{b}	36.67^{a}	1.064	0.001
HB	10.33^{d}	11.67^{bc}	11.43^{c}	11.97^{b}	12.23^{a}	0.367	0.001
WBC	4700^{e}	4733.33^{d}	4760^{c}	5633.33^{b}	6466.7^{a}	272.03	0.000
RBC	4.867^{c}	4.800^{d}	5.900^{a}	5.200^{b}	4.567^{e}	1.023	0.051

a-d; mean within the row with different superscript differs significantly ($p<0.05$).
Legends: PCV: Packed Cell Volume, HB: Haemoglobin, WBC**:** White Blood Cell, RBC**:** Red Blood Cell

Discussion

The effect of the experimental diets (varying inclusion levels of maize cob meal) fed to *Clarias gariepinus* fingerlings revealed significant findings. Diets with 20% and 40% inclusion level of maize cob meal promoted better growth than the other test diets (60% - 80%) probably due to their ability to meet the essential amino acid requirement of the fish. Nogales-Mérida *et al.* (2019) reported that protein requirements of fish are considered to be the sum of the requirements essential for individual amino acids. The low values of live weight gain observed in this study as dietary levels of processed maize cob meal increased could be due to several factors such as the lower feed intake and components which was reported to have the ability to cause marked weight changes (Lilianna *et al.*, 2020).

The result showed maize cob meal inclusion in diets had significant effect on SGR, FCR and CF of *Clarias gariepinus* fingerlings, especially significantly increased weight gain in comparison with control. Although increased quantity of maize cob (40%, 60% and 80%) was most favorable for other growth indices of *Clarias gariepinus* fingerlings, especially FCR which was topmost at 60% inclusion level. Thus, digestibility increased and in turn the energetic benefits enhanced the growth, this confirms Doan *et al.* (2018) who reported an increased growth in Nile tilapia when fed increased level of xylooligosaccharide derived from corncob. In contrast, Kakwi and Olusegun (2020) observed significantly decreased growth performance in *Cyprinus carpio* fed diet containing *Mucuna pruriens* seed especially as inclusion level increased. Although, most reports have been given in respect to the effect of additives on the growth performance of fish species but there is need to consider fish species, size, the dose of additive, fish physiological status and ambient culture conditions (Hoseinifar *et al.*, 2010).

Among the various treatments, crude protein was efficiently utilized by *C. gariepinus* fingerlings, although less efficient at higher inclusion levels, which could be related to anti-nutritional factors and fibre levels in the diets (Mariana and Maira, 2017). The same was observed by Alegbeleye *et al.* (2017), who reported inclusion of toasted lima bean and boiled pigeon pea seed meals at levels of 10-20% and 15-30% respectively without adverse effects or loss in weight in *C. gariepinus*. The least growth performance was obtained in 80% MC which contained the highest proportion of processed maize cob (80%). Similar results were obtained with higher inclusion level for pigeon pea meal (Kari *et al.*, 2020); Lima bean (Alegbeleye *et al*., 2005); Pawpaw seed meal (Irabor *et al.*, 2016); Peanut (Yusuf *et al.*, 2016) and Faba bean (Azaza *et al*., 2009) in *C. gariepinus* diets.

Blood parameters play an important role in identifying any problem with fish (Muttappa *et al.*, 2015). In this study, WBC (leucocytes) increased across treatments; however, this increase was significant. The increased WBC count following feeding of maize cob diet demonstrates the immune-stimulatory effects and anti-infection properties of maize cob. Similarly, Omeje *et al.* (2019) reported significant difference in WBC for *Oreochromis mossambicus* fed diet containing pawpaw seed meal. Also, significant increase in WBC of rainbow trout and Asian sea bass fed with maize cob were reported by Božović *et al.* (2004) and Menon and Rao (2012).

The haemogolobin content was significantly higher in treated groups than control, suggesting increased oxygen supply which is beneficial to fish health. This finding contrast Irabor *et al.* (2018) and Omeje *et al.* (2019) who recorded low haemogolobin content in *Oreochromis mossambicus* after feeding with pawpaw seed meal diet. The values obtained for RBC showed slight significant differences across dietary treatments which was in line with the report on *Oreochromis niloticus* (Millet *et al.,* 2005; Rezaei *et al.,* 2009) where RBC was affected at 6% maize cob inclusion level. Similar to the trend observed in RBC, PCV was increased at different inclusion levels of maize cob. This contrasts the finding of Kakwi and Olusegun (2020) who found significant decrease in PCV of *Cyprinus carpio* fed *Mucuna pruriens* seed diets. The reason for different results might be attributed to differences in the effect of plants and immune system reaction.

On the basis of observed results, partial replacement (40%) with maize cob in the diet of *Clarias gariepinus* fingerlings showed no inhibition in feed intake; also, an appreciable growth performance and digestibility index. Although there was significant increase in the blood parameters which were observed as the inclusion level increased but this has no negative impact on the fish.

An optimum replacement of maize with maize cob meal at 40% inclusion is appropriate to reduce cost of production and maximize profit while ensuring the fish is in good health.

Acknowledgements

We wish to appreciate the workforces of the Department of Fisheries for their inestimable assistance all through the research period. Also, we appreciate the laboratory technologist for their significant contributions to the work.

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(Received: 16 January 2022, accepted: 30 June 2022)