



EFFECTS OF MAIZE BRAN DIETS ON THE GROWTH AND NUTRIENT UTILIZATION OF TILAPIA (*Oreochromis niloticus*)

¹FALAYE, A. E. & ²A. OMOIKE

1. Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria
2. Department of Biological Sciences, Bells University of Technology, P.M.B. 1015, Ota, Nigeria

* Correspondence: dromoike@yahoo.com, +2348062099220

ABSTRACT

Tilapia (Oreochromis niloticus Trewavas) fingerlings were fed 30 % crude protein isonitrogenous diets with maize bran replacing different proportion 0, 33.3, 66.7 and 100% of the whole maize in the diet and were observed for growth response over time. Fish meal and groundnuts cake were the main dietary protein sources and mineral/vitamin premix was added and the pelletized experimental diets stored in air-tight polythene bags. The fingerlings were fed for 49 days. Acclimatized tilapia fingerlings, with mean weight of 8.19 g, were stocked in four aerated glass aquaria tank measuring 47 x 28 x 32 cm at the rate of 15 per aquarium. Each experimental diet was assigned to a tank and fed to the fish twice daily and adjusted weekly later. Findings indicated increasing maize bran intake resulted in better weight gains and higher specific growth rates of 0.22, 0.25 and 0.25 per day respectively. The increase in growth from the feeding diets containing 66.7% and 100% of the maize replaced with maize bran were significantly higher ($P < 0.05$) than those of other diets. Fish fed with diets where whole maize was replaced 100% by maize bran, gave the best overall performance in terms of weight gain, food conversion efficiency and specific growth. The replacement of maize with maize bran is economical with no side effects as tilapia feeds.

Keywords: protein efficiency, fish growth performance, digestibility

INTRODUCTION

In many developing regions of the world, the awareness on the need for adequate protein in human diets has greatly increased, the consumption of fish has been widely acknowledged as a rich source of dietary protein (Akinrotimi *et al.*, 2007). Intensification of fish production through aquaculture in Nigeria is however greatly hampered by inadequate supply of balanced diets (Falaye, 1992). In view of the scarcity and escalating costs of most conventional animal feed ingredients, it has become necessary to search for cheaper alternative nutrient sources to enhance fish culture development in the country.

There is a need to supply cultured species with adequate diets to supply their needed nutrient requirements both qualitatively and quantitatively in order to achieve faster growth and high fish yield. The use of cheaper feed processes has shown potentials in terms of their nutrient supply as well as reduction in feeding costs. (Falaye, 1992). Cruz and Landencia, (1978) reported on the profitable and beneficial use of rice bran and other farm by-products as ingredients in Nile tilapia rations. Maize (*Zea mays*) is produced in most parts of Nigeria, popular in human diet and livestock feed, it's also used for different purposes (Falaye *et al.*, 2012); it is considered the most valuable cereal crop in Sub Saharan Africa, the

plant is economically viable as edible and non edible products useful to both man and livestock, and is within the reach of both rich and poor (IITA, 2009).

Maize is a staple cereal food which is widely grown in Nigeria, when whole maize grain is dehusked and grated; it yields maize bran which is easily and cheaply obtained as a by-product. Oyenuga, (1968) determined the composition of the maize bran, and results show that it contains valuable nutrients which could be beneficially used for production of animal feed. Cruz and Landencia, (1978) have reported on the incorporation of rice bran and other agricultural by-products as ingredients in rations for the Nile tilapia (*Oreochromis niloticus*). Maize bran is widely used in the feeding of poultry and livestock in many States in Nigeria, but information on its utilization in fish feeding in Nigeria is scanty, therefore the research investigates the substitution of maize bran for whole maize in fish diets and their effects on the growth and nutrient utilization performance of tilapia (*Oreochromis niloticus*) fingerlings.

MATERIALS AND METHODS

The experimental diets

Consisted of isonitrogenous (30%) protein) rations with the maize component replaced at four levels (0, 33.3, 66.7 and 100%) by maize bran. The

maize bran was collected from a commercial feed producer in Ibadan, Nigeria. Fish meal and groundnuts cake were the main dietary protein sources and mineral/ vitamin premix was added as quoted by suppliers (Roche Nigeria Limited). The diets were prepared in the form of pellets following the methods described by Wee and Ng, (1986), oven-dried at 70 °C in a Gallenkamp Oven for 18 hours, and stored in air-tight polythene bags kept in a deep freezer at a temperature of 8 °C until used.

Experimental tank

The glass aquaria tanks measuring 47 x 28 x 32cm were used for the experimental system. The tank water was aerated by means of 'Rena' air pump connected to rubber tubing and thoroughly washed stones which were suspended in the water.

Experimental procedure

The tank water was changed twice weekly; water quality remained stable throughout the experimental period, with average readings of temperature, dissolved oxygen, and pH at 25°C, 8 mg/l and 6.8 respectively. Sixty fingerlings of *Tilapia*, with mean weight of 8.19 g, procured from the University of Ibadan fish farm and stocked in the four aquaria at the rate of 15 fingerlings per aquarium. The fish were acclimatized for 48 hours prior the commencement of the feeding trial. Each of the experimental diet was assigned to a tank and fed to the fish twice daily in equal rations and were adjusted weekly on the basis of average weight of the fish. Each diet treatment was triplicated. Debris was siphoned from the experimental tanks daily and dead fish were counted, weighed and removed. The duration of the experimental study was 49 days. All experimental diets and samples of fish carcass before and after the feeding trial were analyzed for their proximate composition according to methods of AOAC (1990). Moisture was estimated by oven-drying at 105°C for 24 hours. Crude protein and crude lipid were determined using AOAC (1990). Fish growth and nutrient utilization parameters were calculated for Specific growth rate (SGR), Food conversion ratio (FCR), Gross Feed Conversion Efficiency, Protein Efficiency Ratio (PER) Crude Protein Intake (g), and Apparent Net Protein Utilization (ANPU) as follows:

$$\text{Specific Growth Rate (SGR \% per day)} = \frac{\text{Log } W_f - \text{Log } W_i}{t(\text{days})} \times 100$$

Where, Log W_f = logarithm of the fish final weight gain

Log W_i = logarithm of the fish initial weight

t = experimental period in days

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Feed Intake (g)}}{\text{Weight gain (g)}}$$

(Burel *et al.*, 2000)

$$\text{Gross Feed Conversion Efficiency (GFCE)} = 1 \times \frac{100}{\text{FCR}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Wet body weight gain (g)}}{\text{Crude protein fed}}$$

$$\text{Protein Intake} = \frac{\text{Feed Intake} \times \text{Percentage protein in diet}}{100}$$

$$\text{Apparent net protein utilization (ANPU\%)} = \frac{P_2 - P_1}{P_1} \times 100$$

Where, P_1 = initial protein in fish carcass at the beginning of the experiment

P_2 = final protein in fish carcass at the end of the experiment

PI = protein intake (g of protein in 100g of diet/fish) (Ali, 2001).

RESULTS

The experimental diet percentage composition is presented in Table 1. All test diets were acceptable and actively fed upon by the fish while no pathological symptoms resulting from nutritional deficiency were observed (Table 2). Findings revealed that crude fibre and metabolizable energy progressively increased as the level of maize bran added to the diet increased. There were however, only slight variations in the crude protein content of the feeds.

The growth performance and nutrient utilization data for the fish trial is presented in Table 3. There was an increase in mean weight gain as the amount of maize bran increased from 0% to 100% (diet 4) with the highest weight gain by fish fed with diet 4. Significant difference ($P < 0.05$) occurred between diets 2, 3, and 4, with 0.26% per day in diets 1 and 4 respectively. There were changes in fish body composition at the end of the feeding trials, tissue protein, lipid, fibre and ash levels increased as the level of maize bran increased in the diets (Table 4). In terms of food conversion efficiency, weight gain, specific growth rates and protein deposition, *O. niloticus* fingerlings supplied diets 4 containing 33.3% maize bran (100% replacement of whole maize) exhibited optimum performance with Fish

mortality due to dietary treatment was low and occurred only among fish fed with diet 1 (13.3%) and 4 (6.7%) respectively.

Table 1: Percentage composition of the experimental diets

| Component | 1 (0%) | 2 (33.3%) | 3 (66.7%) | 4 (100%) |
|------------------------|---------------|---------------|---------------|---------------|
| Fish meal | 9.48 | 9.48 | 9.48 | 9.48 |
| Groundnut cake | 21.96 | 21.96 | 21.96 | 21.96 |
| Blood meal | 9.02 | 9.02 | 9.02 | 9.02 |
| Maize bran | 0 | 11.03 | 22.03 | 33.03 |
| Yellow maize | 33.03 | 22.03 | 11.03 | 0 |
| Brewer's grain | 12.00 | 12.00 | 12.00 | 12.00 |
| Oil | 6.00 | 6.00 | 6.00 | 6.00 |
| Vitamin/Mineral Premix | 6.00 | 6.00 | 6.00 | 6.00 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 |

Key: Figure in parenthesis represents percentage of maize replaced by maize bran diets.

Table 2: Proximate composition (% by weight) of the experimental diets for *Oreochromis niloticus* fingerlings

| Proximate Component | DIETS | | | |
|---------------------|-------|-------|-------|-------|
| | 1 | 2 | 3 | 4 |
| Moisture | 12.13 | 11.85 | 12.07 | 12.20 |
| Crude protein | 26.22 | 31.26 | 29.49 | 29.58 |
| Ether extract | 9.35 | 11.05 | 10.12 | 9.97 |
| Ash | 13.53 | 12.29 | 13.01 | 12.57 |
| NFE ¹ | 34.67 | 29.09 | 30.69 | 30.85 |
| Gross Energy | 3.80 | 3.99 | 3.87 | 3.87 |

Key: Nitrogen Free Extract (NFE) calculated as 100- (Moisture + Protein + Ash + Crude Fibre).

Table 3: Proximate fish carcass composition (% by weight) before and after feeding trial

| Component | Initial | DIETS | | | |
|---------------|---------|-------|-------|-------|-------|
| | | 1 | 2 | 3 | 4 |
| Moisture | 80.07 | 77.18 | 75.57 | 74.61 | 72.60 |
| Crude protein | 18.31 | 21.00 | 22.31 | 23.15 | 25.00 |
| Ether extract | 0.53 | 0.72 | 0.80 | 0.84 | 0.90 |
| Crude fibre | 0.00 | 0.03 | 0.04 | 0.06 | 0.07 |
| Ash | 0.10 | 1.08 | 1.28 | 1.35 | 1.47 |
| Gross Energy | 2.84 | 2.94 | 3.19 | 3.26 | 3.30 |

Table 4: Nutrient utilization, growth and survival of fish fed different levels of maize bran

| Parameters | DIETS | | | |
|---|--------------------|--------------------|--------------------|--------------------|
| | 1 | 2 | 3 | 4 |
| Initials Weight (g) | 8.35 | 7.79 | 8.49 | 8.12 |
| Final Weight (g) | 10.42 | 9.94 | 11.21 | 10.92 |
| Weight gain (%) | 24.79 ^a | 27.60 ^a | 32.04 ^b | 34.48 ^b |
| Mean Weight gain (g) | 2.07 ^a | 2.15 ^a | 2.72 ^b | 2.80 ^b |
| Food intake (g/fish) | 20.23 | 18.48 | 21.42 | 20.02 |
| Specific growth (%/day) | 0.45 ^a | 0.36 ^a | 0.57 ^b | 0.60 ^b |
| Protein intake (g) | 5.30 | 5.78 | 6.32 | 5.93 |
| Protein Efficiency ratio | 0.39 | 0.37 | 0.43 | 0.47 |
| Food Conversion ratio | 9.77 | 8.60 | 7.88 | 7.15 |
| Gross efficiency of food conversion (%) | 10.22 | 11.63 | 12.69 | 13.99 |
| Apparent Net Protein Utilization (%) | 12.46 | 13.70 | 16.48 | 20.98 |
| Survival (%) | 86.67 | 100 | 100 | 93.33 |

Figures on the same row having the same superscripts are not significantly different ($P > 0.05$)

DISCUSSION

The water quality parameters recorded during this experimental study were adequate and within range for the culture of *O. niloticus*, as defined for warm water fish species (Boyd, 1981).

The proximate composition of feeds which contained maize bran diets was similar to those of diets containing whole maize grain. The slight variation in the crude protein values was probably due to lack of homogeneous mixture of the ingredients during diet preparation. The increased level of crude fibre over control diet associated with increasing maize bran content in the diets did not cause deleterious effects on the fish. This is apparently because the values (4.46 to 4.83%) were within crude fibre levels as recommended for tilapia (Anderson, 1984) for tilapia. Also, the crude protein of the diet adequately meets the requirements of tilapia as recommended (Wang *et al.*, 1985; Teshima *et al.*, 1986; Falaye and Arogunjo, 1989). Falaye *et al.*, (2012) concluded in their report that cowpea hull could be used as total substitution for maize in the diet of *Clarias gariepinus* as it enhances rapid growth, sound health, and economic profitability. Also, that replacement of up to 30% fishmeal by chicken offal meal enhances growth performance of *C. gariepinus* fry (Falaye *et al.*, 2011).

The feed consumption and positive response of the fish to these experimental diets showed that maize bran is acceptable as a dietary ingredient for feeding tilapia fingerlings. It is of interest to note that better weight gain and specific

growth were achieved at high inclusion level of maize bran compared to low incorporation levels of the test ingredients. This could be due to the fingerlings better conversion and utilization of the diet as a result of its high fibre content.

It is important to note the elevated levels of body protein observed in fish treated with the maize bran diets. This is also reflected by their apparent net protein utilization. This could have been caused by a protein sparing action whereby non-protein energy was utilized by the fish, with a consequent deposition of the spared protein in the body tissues. The superior growth and nutrient utilization resulting from the use of maize bran, in place of whole maize has economic significance considering that the latter has become expensive; being competed for as food by humans and livestock in many developing countries such as Nigeria. This is important in aquaculture particularly as the costs of fish feeds currently accounts for 40 to 60 % of the variable costs of fish farming ventures (Niamat and Jafri, 1984). Maize bran which is mostly discarded as a processing waste will in no doubt supply dietary energy much more cheaply than whole profitable use of agro-produce (Lu and Keven, 1975; Chvapil *et al.*, 1980; Edwards 1980; Falaye, 1990) In a similar feeding trial with Nile tilapia, Cruz and Landencia (1978) recorded the highest weight gain and best food conversion efficiency with a ration containing rice bran and fish meal. It was observed that the use of corn gluten as a substitute for fish meal in diets of tilapia (*Oreochromis niloticus*) fry and sub-adult obtained a better feed efficiency using

67% of corn gluten meal than in diets containing 30% of gluten feed dietary protein (Wu *et al.*, 1997 cited by Heuze *et al.*, 2012); whereas Channel catfish (*Ictalurus punctatus*) and hybrid catfish (*Ictalurus punctatus* x *Ictalurus furcatus*) fingerlings could be fed on corn gluten feed up to 50% in the feed of Channel Catfish and 30% in hybrid Catfish to enhance growth performance and nutrient efficiency (Robinson *et al.*, 2001; Li *et al.*, 2012, cited by Heuze *et al.*, 2012). Corn gluten meal have highly increased fish quality, yielding good carcass and less fat fish (Robinson *et al.*, 2001, cited by Heuze *et al.*, 2012)

On the basis of the appreciable growth and nutrient utilization achieved with maize bran in this feeding trial, it is suggested that feeds formulated for *O. niloticus* fingerlings may be replaced with as much as 66.7 to 100% maize bran, the level that gave optimal fish performance.

CONCLUSION

The study on the use of maize bran as a replacer for whole maize have shown that higher amount of maize bran as replacement produced best result, therefore, the total replacement of whole maize with maize bran diet is economical and growth effective as tilapia feeds, as cowpea hull is readily available with no indication of any adverse effects noticed or recorded during this research.

REFERENCES

- Akinrotimi, O.A., Gabriel, U.U., Owhonda, N.K., Onukwo, D.N., Opara, J. Y., Anyanwu, P. E. and Cliffe, P. T. (2007). Formulating an environmentally friendly fish feed for sustainable aquaculture development in Nigeria. *Agric Journal* 2(5):606-612.
- Ali, M. Z. (2001). Dietary protein and energy interactions in African catfish *Clarias gariepinus* (Burchell, 1822). PhD Thesis, Department of Aquaculture, University of Aquaculture, Stirling, United Kingdom. 274.
- Anderson, J. (1984). Digestible energy and carbohydrates in the nutrition of tilapia (*Oreochromis niloticus* Ph.D Thesis, University of Aston in Birmingham.
- AOAC (Association for Official Analytical Chemists) (1990). Official methods of analysis of the association of official analytical chemists. 15th Edition. K. Heltich (Editor). Association of Official Analytical Chemists Inc. Arlington, V. A. 1298.
- Boyd, C. E. (1981). Water quality in warm water fish ponds Auburn University Agricultural Experimental Station Publication USA. 117 - 360.
- Burel, C., Boujard, T., Tulli, F. and Kaushik, S. J. (2000). Digestibility of extruded pea, extruded lupin and rapeseed meals in rainbow trout (*Oncorhynchus mykiss*) and turbot (*Psetta maxissa*). *Aquaculture* 188: 285-298.
- Chvapil, M., Ulreich, J. B. and Hunter, B. (1980). Complementation of predigested proteins: A nutritionally and economically advantageous methods of the by-product utilization. *Journal of Nutrition* 110(7). 1319 –1320.
- Cruz, E. M and Landencia, I. L. (1977). Protein requirements of *Tilapia mossambica* fingerlings. *Kalikasan. Philipp. J. Biol.*, 6(2):177-182pp.
- Edwards, P. (1980). A review of recycling organic wastes into fish wish emphasis on the tropics. *Aquaculture* 21: 261-275.
- Falaye, A. E. (1990). Evaluation of the chemical and nutrient composition of cocoa husk (*Theobroma cacao*) and its potentials as a fish feed ingredients. *Nigerian Journal of basic and Applied Sciences* 4 (1 & 2): 157 – 164.
- Falaye, A. E. and Arogunjo, p. (1989). A. of varying dietary protein levels on the growth and utilization performance of tilapia, (*Oreochromis niloticus*). Proceedings of the 4th Annual Conference of the Nigerian Association for Aquatic Sciences 84 - 92.
- Falaye, A. E. (1992). Utilization of agro-industrial wastes as fish feedstuff's in Nigeria. Proceedings: 10th Annual Conference of the Fisheries Society of Nigeria (FISON), Abeokuta, Nigeria: 16-20 November, 1992: 47 - 57.
- Falaye, A. E, Omoike, A., Ajani, E. K. Kolawole, O.T. (2011). Replacement of fishmeal using poultry offal meal. In: Practical Feeds for Fry of the African Catfish (*Clarias gariepinus*) *The Israeli Journal of Aquaculture - Bamidgah, IIC.63.2011.542*, 6 pages
- Falaye,A.E., Omoike, A. and Olasebikan, O.B. (2012). Replacement of maize using cowpea (*Vigna unguiculata*) hull meal in practical feeds of African Catfish (*Clarias gariepinus*) fry *International journal of Plant, Animal and Environmental Sciences*, 2(3) 178-182
- Heuze, V.,Sauvant, D., Tran, G., Lebas, F., Lessire, M. and Renaudeau D. (2012). Corn gluten feed.

Feedipedia.org. A programme by INRA, CIRAD, AFZ and FAO. <http://www.feedipedia.org/node/714>

IITA, (2009). Maize, International Institute of Tropical Agriculture, Moniya, Nigeria www.iita.org

Lu, J. D. and Kevern, N. R. (1975). The feasibility of using waste materials a supplementary fish feed. *The Progressive Fish Culturist* 37 (4): 241 -244.

Niamat, R. and Jafri, A. K. (1984). Growth responses of their siluroid *Heterpneustes fossilis* Bloch, fed. *Aquaculture* 37: 223-229.

Oyenuga, V. A. (1968). Nigeria's food and feeding stuffs. Their Chemistry and nutritive value. Ibadan University Publishing Co. Ltd., Ibadan, Nigeria.

Teshima. S., Kanazawu, A. and Uchiyama, Y. (1986). Effect of several protein sources and other factors on the growth of *Oreochromis niloticus*. *Bull. Journal Soc. Sci. Fish.* 52(3): 525 - 530.

Wang, K. Takechi, W. and Watanabe, T. (1985). Effects of dietary protein levels on growth of *Tilapia nilotica*. *Bull. Journal Soc. Sci. Fish* 51: 133 - 140.

Wee, K. C. and Ng, L. T. (1986). Use of cassava as energy source in pelleted feed for the tilapia, *Oreochromis niloticus* L. *Aquaculture Fish Management* 17: 129- 138.