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Utilization of stunted tilapia as replacement for imported fishmeal in the diet of Clarias gariepinus fingerlings

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Abstract
Absolute replacement of imported fishmeal with stunted tilapia fishmeal (Low-Value Tilapia LVT) in the diet of *Clarias gariepinus* fingerlings was carried out. Freshly collected low-value tilapia was processed into tilapia fishmeal at the NIOMR fish processing plant. Feeding trial was conducted in a flow-through system. Data were generated for total weight gain (TWG), specific growth rate (SGR), feed conversion ratio (FCR), hepatosomatic index (HSI), spleensomatic index (SSI) condition factor (CF) and carcass analysis. Results obtained was not significantly different ($P > 0.05$) in feed conversion ratio (FCR) between fishes fed control diet (C) containing imported fishmeal based diet and fishes fed T_2 diet containing whole tilapia fishmeal based diet. Feed conversion ratio (FCR) was best in fishes fed T_2 diet. However, no significant difference ($P > 0.05$) was observed in their growth performance. Hepatosomatic index and spleensomatic index values obtained for fishes fed control diet (C) and fishes fed T_2 diet were 1.008, 1.025 and 0.108, 0.178 respectively. Condition factor of fishes fed control diet C, and T_2 were however not significantly different ($p > 0.05$). Carcass composition analysis revealed that there was no significant difference in the crude protein contents of fishes fed with control diet (C) and low value tilapia based diet. It can be concluded that value addition of stunted tilapia (low-value tilapia LVT) as fishmeal has a great potential of replacing imported fishmeal in the aqua feed industry.

1. Introduction

Fisheries have always played a very significant socio-economic role in many countries and communities. As a subsistence produce, fish is a vital resource towards poverty reduction and food security for most poor households (Cinner *et al.*, 2009).

Fish feed in aquaculture represents between 60–80% of the variable cost of fish production. Fish meal is the most expensive of all the ingredients and critical to good quality fish feed production. For this reasons, the cost of fish feeds has gone beyond the reach of many farmers. In addition, when obtained locally, millers have complained of fish meals mixed with bones and other useless materials which makes it highly substandard. For the purpose of nutritional and economic benefits, previous researchers have made attempts at increasing the use of nonconventional plant and animal materials to replace conventional feed ingredients like fishmeal and maize in fish feed formulation (Falaye, 1988; Fagbenro, 1992; Olatunde, 1996, Baruah *et al*., 2003; Eyo, 2004). However, none has proven to be an efficient replacement for the imported fishmeal thus the need to find an inexpensive alternative that will measure up comparatively with the imported fishmeal becomes imperative.

Unfortunately, Tilapia which is the third most important cultured fish group in the world has not found a good economic value despite its high proliferation rate, ease of cultivation and high protein content. According to Akande (1990) and Eyo (1993), fresh water fishes such as low value or stunted Tilapias (LVT) could be economically utilized to produce acceptable high-protein fishery products for human consumption, and fish-meal for animal feeds. Large quantities of cichlids such as tilapia are landed from freshwaters of Africa in short periods and often glut the market, consequently much remain unsold and spoil as a result of poor handling, processing and poor consumer acceptability of fish nature. Thus, recycling stunted tilapias into dry fish-meals using various fish processing equipments and relevant low-level (artisanal) technologies will encourage and enhance value addition of stunted tilapia to the aquaculture industry in Nigeria and beyond. Thus, the objective of this study is to process low-value tilapia into tilapia fishmeal and to use this tilapia fishmeal as a total replacement for Danish imported fishmeal in the diet of *Clarias gariepinus* fingerlings.

2. Materials and Methods

Fresh stunted tilapia (low-value tilapia) fishes were collected from Makoko fish market Fig 1 in Yaba Local Government Area, Lagos State and transported in a frozen iced chest boxes to the Nigerian Institute for Oceanography and Marine Research (NIOMR) Lagos for processing into Tilapia fishmeal using the NIOMR compact fishmeal plant (Denmark, type FR100). Danish imported fishmeal was also purchased and together with other feed ingredients formulated and compounded as the control (C) diet in the feeding trial.

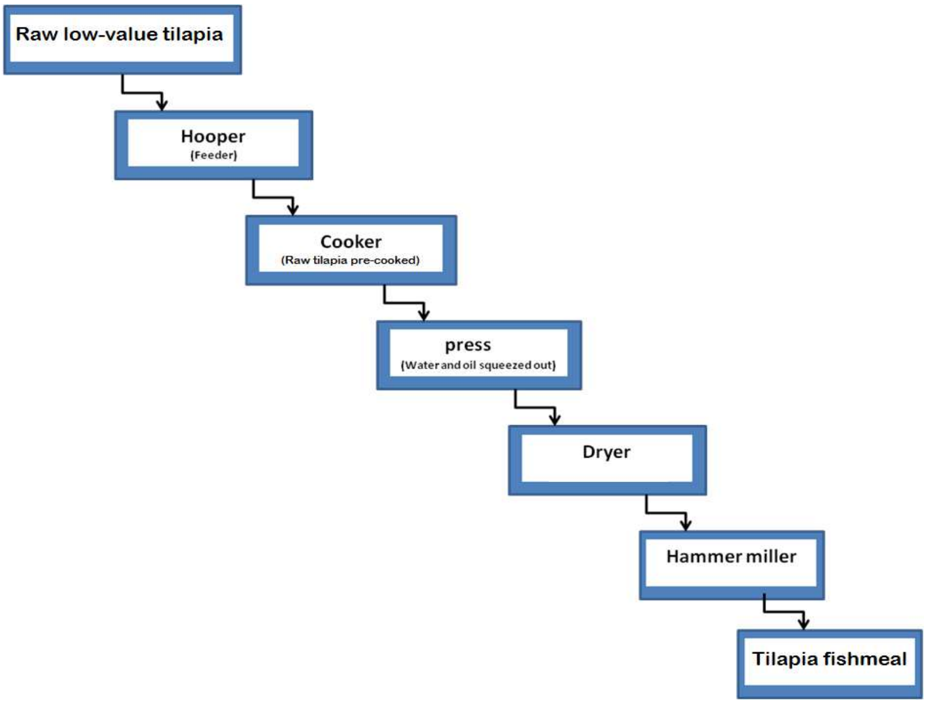

Fig 1. *Flow Chart Describing NIOMR Fish Processing Plant for LVT (Denmark, type FR100).*

2.1. Crude Protein Composition, Dry Matter and Ash Content of Imported Fishmeal, De-Boned Tilapia Fishmeal and Whole Tilapia Fishmeal

Analyses of crude protein for Danish imported fishmeal and whole tilapia fishmeal contents were carried out in triplicates at the chemistry department of the Nigerian Institute for Oceanography and Marine Research (NIOMR) generally following AOAC (1995) procedure

2.1.1. Formulation of Experimental Diets

Two (2) diets (40% crude protein) were formulated contained 100% Danish imported fishmeal as (control C) and 100% whole low-value tilapia fishmeal based diets as (T_2). These were manually mixed thoroughly with other ingredients. The diet mixture was then pelleted through a 2-mm hand-pelleting machine to form a model-like strands which was mechanically broken into pellets of suitable size for *Clarias gariepinus* fingerlings. The pelleted diets were sun-dried at 30-31^{o}C and stored in polythene bags.

2.2. Collection and Acclimatization of Experimental Fish

One hundred and twenty six mixed-sex fingerlings of *Clarias gariepinus* of the same brood stock with mean weight (6.1±0.36) were utilized for this experiment.

The fingerlings were acclimatized to laboratory *conditions* for 7 days before the commencement of feeding trial. The experiments were conducted in a flow through system plastic tanks of (64 x 35 x 44cm). After acclimation, fingerlings were randomly distributed into the tanks at 21 fingerlings/tank. The fishes were then fed to satiation thrice daily for a period of 8 weeks using 5% body weight between (9:0h, 13:0h and 17:0h). The length and corresponding weight of the fish were recorded on a bi-weekly basis as this helped in adjusting fish feed ration.

2.2.1. Determination of Growth Indices

The Mean Growth Rate (MGR), Relative Growth Rate (RGR), Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Condition Factor (K), Hepatosomatic index (HSI) and Spleensomatic index (SSI) were calculated.

2.2.2. Hepatosomatic Index (HSI) and Spleensomatic Index (SSI)

At the end of the feeding trial, 5 fishes were randomly selected from each of the experimental tanks per treatments and weighed individually, after which they were dissected and the liver and spleen removed and weighed individually.

2.3. Statistical Analysis

All data resulting from the experiment were presented as means ± SD and analyzed by one way analysis of variance (ANOVA) using the SPSS (statistical Package Computer, Software 2004 version Chicago Illinoise, USA). Duncan's multiple range test for least significant difference were used to compare differences among individual means. Differences were regarded as significant when $P < 0.05$ (Zar, 1999).

3. Results

3.1. Growth Performance of *C. Gariepinus* Fed Diet C and T_2

The mean cumulative weight gain of the experimental fishes *Clarias gariepinus* fed different diets for 8 weeks. The initial weight of the fish at the point of commencement of feeding trial was 6.1 ± 0.36 for (C and T_2) while the final weight of fishes were 37.4 ± 0.16 and 54.0 ± 0.02 for C and T_2 respectively.

The group of fish fed whole tilapia fishmeal based diet (T_2) had the highest percentage weight gain (54.0 ± 0.02). While the groups of fishes fed imported fishmeal based diet (C) recorded the least percentage weight gain (37.4 ± 0.16). The groups of fishes fed diet of whole tilapia fishmeal had the highest SGR value (1.69), while the least SGR value was obtained from fish fed control diet (1.41) Table 1.

3.2. Chemical Composition

The chemical composition of Danish imported fishmeal (C) and whole tilapia fishmeal (T_2) were 70% CP and 63.0% CP crude proteins respectively. Moisture content for Danish imported fishmeal and whole tilapia fishmeal were12% and 13.5% respectively. Ash content for Danish imported fishmeal and whole tilapia fishmeal were 12.5% and 20.0% respectively.

Table 1. *Feed Utilization of C. gariepinus Fed C and T_2*

Parameters	Imported fishmeal (C)	Whole tilapia (T_2)
Feed conversion ratio (FCR) g/d††	2.1 ± (0.77)	1.82 ± (0.85)
Specific growth rate (SGR)%	1.41	1.69
Relative growth rate (RGR)%	513.1	785.2
Condition factor (K)	0.985± (0.071)	0.987± (0.186)
Hepatosomatic index (HSI) ††	1.008	1.025
Spleensomatic index (SSI) ††	0.108	0.178

††Condition factor, hepatosomatic index and spleensomatic index are presented as means with the standard deviation in brackets

3.3. Carcass composition of *C. Gariepinus* Fed C and T_2 Diets at End of Experimental Period

The carcass proximate composition of *C. gariepinus* fed C and T_2 diets after 8 weeks of feeding is presented in Table 4. For the control (C) diet, the moisture was 25.8%, crude protein 52.15%, ether extract 7.0%, crude fibre 1.8% and ash 6.0% and for treatment two (T_2), the moisture content was 25.46%, crude protein 54.75%, ether extract 8.0%, crude fibre 2.2% and ash 11.0%.

Table 2. *Hepatosomatic index (HSI) of C. gariepinus fed C and T_2 diets*

Treatments	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	HSI
C	5	0	1.01	1.01	5.04	1.0084	0.0009	
T_2	5	0.12	0.97	1.09	5.13	1.0254	0.0581	1.025

C – Control diet (Imported fishmeal based), T_2– Treatment 2 (Whole Tilapia based)

Table 3. *Spleensomatic index (SSI) of C. gariepinus fed C and T_2 diets.*

Treatments	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	SSI
C	5	0.03	0.09	0.12	0.54	0.1079	0.0124	0.108
T_2	5	0.1	0.13	0.23	0.87	0.178	0.036	0.178

C – Control diet (Imported fishmeal based), T_2– Treatment 2 (Whole Tilapia based)

Table 4. *Carcass composition of C. gariepinus fed C and T_2 diets at end of experimental period.*

Sample ID	Crude Protein	Ash	Ether extract	Crude Fibre	Moisture
(C)	52.15	6	7.0	1.8	25.8
(T_2)	54.75	11	8.0	2.2	25.46

C – Control diet (Imported fishmeal based), T_2– Treatment 2 (Whole Tilapia fishmeal based)

4. Discussion

The nutritional quality of treatments containing Whole Tilapia fishmeal as compared by Duncan's multiple range test for least significant difference in this study were adequate. Although final body weight and growth rate were higher in fish fed the diet containing whole tilapia fishmeal. However, no deleterious depression in growth was observed in fishes fed Danish imported fishmeal based diet. Secondly, one of the most common difficulties observed when alternative sources of feedstuffs are used in fish diets is acceptance and palatability by the fish (Domingues *et al.*, 2003, Rodriguez *et al*., 1996 and Adewolu, 2008).

In the present investigation, all the experimental diet treatments (C and T_2) were accepted by *C. gariepinus* fingerlings, indicating that absolute replacement of fish diet containing Danish imported fishmeal with whole tilapia fishmeal did not affect the palatability of the diets. This might be due to the processing technique employed in this study that does not denature the proteins necessary for good aroma and palatability owing to the adjusted minimal processing temperature of low-value tilapia by the NIOMR fishmeal processing plant.

Feed conversion ratio (FCR) is an important economy indicator in feed production. FCR is a marker of how efficiently an animal utilizes feed, therefore minimizing feed wastage. Low FCR is usually desired in feed production. In general, the FCR observed in this study revealed that feed utilization were best in fishes fed with whole tilapia fishmeal based diets. FCR of fishes fed control diet containing Danish imported fishmeal based diet were also adequate with fishes fed whole tilapia fishmeal having the best FCR.

These value supports the results by other researchers that evaluated alternative dietary protein sources to fish meal. Muzinic *et al*., (2006) reported FCR range of 1.70-1.78 when turkey meal was used at various replacement levels in diets for Sunshine bass which agrees with the results obtained in this study for *C. gariepinus fingerlings* fed whole tilapia fishmeal based diet. Rawles *et al*., (2006) also reported an FCR range of 1.58-1.72 when poultry blood meal was used to replaced fishmeal in diet for hybrid striped bass. There was no significant difference ($p > 0.05$) between fishes fed with diet containing whole tilapia fishmeal based diet and fishes fed with diet containing imported fishmeal based.

The whole body proximate composition of *C. gariepinus* fishes fed diets containing imported fishmeal and whole tilapia fishmeal at the end of experimental period did not also differ significantly ($p > 0.05$). This might be due to the near constant protein content of the experimental diets.

The Hepatosomatic index (HSI) is often used as an indicator of condition and nutritional status of fish (Rueda-Jasso *et al.*, 2003). The absolute replacement of imported fishmeal with whole tilapia fishmeal resulted in a fairly constant HSI and SSI, which could have been influenced by the dietary lipid content. The fairly constant values obtained in the HSI and SSI was expected because ether extract from the results of the whole body proximate composition of *C. gariepinus* fed control diet containing imported fishmeal and treatment T_2 diet containing whole tilapia fishmeal based diet at the end of experimental period were fairly constant.

HSI and SSI values observed in this study were lower than the values of 2.05-2.43 reported by Rawles *et al.*, (2006) after substituting imported fishmeal with poultry blood meal in commercial diet of hybrid striped bass. High HSI value, increases the probability of fish developing fatty liver problems (Gaylord and Gatlin 2000; Lee *et al.*, 2002; Rueda-Jasso *et al.*, 2003). The result obtained in this study is in agreement with the result obtained by Olokor and Raji (2011) who reported that fish fed with Tilapia based fish feed had the highest final mean weight gain when compared with the imported fishmeal based diet. The exponent b value of 2.64 and 2.32 recorded for fishes fed with diets containing imported fishmeal and whole tilapia fishmeal exhibited a negative allometric growth. This finding is closely similar to the findings of Entsua – Mensah *et al*., (1995) that recorded b values of 2.919. it also support the findings of Fafioye and Oluajo (2005) who also reported b values of 3.04. Pauly and Gayannilo (1997) reported that b values may range from 2.5 to 3.5 which support the result of this study. Condition factors (CF) obtain for fishes fed with diets containing imported fishmeal and whole tilapia fishmeal were 0.985 and 0.987 respectively. Salzen (1958) cited by Fagade and Olaniyan (1974) recorded a condition factor of 1.0 for *Ethmalosa finbriata* (maximal length 15.0 cm). However, the fairly constant values obtained for the mean condition factor of *C.*

gariepinus fed with diets containing imported fishmeal and whole tilapia fishmeal in this research could be as a result of the experimental fishes subjected to the same culturing conditions throughout the experimental period.

5. Conclusion

In conclusion, the results of this study supports the conclusion of Olokor and Raji (2011) that low- value tilapia fishmeal can be used as a total replacement for the imported fishmeal in the diet of *C. gariepinus* without any negative effects on the growth and feed efficiency. Furthermore, utilizing whole tilapia fishmeal based diet in this study proved to be even better than the imported fishmeal based diet in the culture of *C. gariepinus*.

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