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Full Length Research Paper

Yeast single cell protein in the diet of *Oreochromis niloticus* (L) fingerlings: An economic evaluation

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Six isonitrogenous diets (30% protein) were prepared, D_0, D_{IO}, D_{20}, D_{30}, D_{40} and D_{50}. Diet Do the control diet) consist of fishmeal as the protein source. Diets D_{10} to D_{50} had fish meal replaced systematically with yeast single cell protein (SCP) in the order 10, 20, 30, 40 and 50%, respectively. Trial feeding was carried out with these feeds on *Oreochromis niloticus.* The cost benefit evaluation of these diets was carried out. Result showed that the 50% yeast SCP substituted diet had the lowest profit index, the, least expenditure as well as the best sales, net profit and cost-benefit ratio.

Key word: microbial protein, *Oreochromis niloticus*, feeding, cost benefit, aquaculture.

INTRODUCTION

The cost of feeding has long been recognized as the major cost in aquaculture (De Silva, 1989; Dabrowskii, 1993; Tacon, 1993; Chamberlain and Hopkins, 1994; Anupama, 2000; Sogbesan et al., 2004). For example, Falaye (1992) documented that feed cost claims about 60% of the recurrent cost of fish farming venture and this often minimized the profit margin of fish farmers and negate economic viability of the aquaculture industry.

Fishmeal, which constitutes about 50-75% by weight in most aqua feeds, is an important ingredient in aquaculture diets. Though it has high protein quality and good palatability, it however still remains the most expensive ingredient in fish feed formulation. The cost attached to this ingredient has a lot to do with its rare availability, consumption by man and competition from other livestock industry (Misra et al., 2003; Sogbesan et al., 2004). Hence, partial or total replacement of fishmeal protein with alternate sources of protein such as SCP could be, of considerable economic advantage especially if the ingredient has good nutrient profile and is associated with moderate reduction in feed efficiency (Sogbesan et al., 2004). Utilization of some of the unconventional protein sources in fish feeds may result in a slight reduction in fish performance but can still be more cost effective than standard, expensive protein such as fishmeal (FM). Therefore, economic evaluation of such protein sources for fish species like tilapia is necessary. However, only a few studies have considered both economic and biological evaluation of dietary protein sources for tilapia. These studies demonstrated that sources like brewery waste (OduroBoating and Bart-Plange, 1988), cotton seed meal (CSM) (El-Sayed, 1990), corn gluten meal (Wu et al., 1995) and animal by-product meal (Rodriguez-Serna et al., 1996; El-Sayed, 1998) can be used as total fishmeal replacers for tilapia despite the fact that they produced lower biological performance.

In Nigeria, there is a recent surge in commercial aquaculture production. However, feeds remain the major challenge to the growth of the industry. This is because most of these farms use imported feeds from Europe, thereby resulting in high production costs. Local on-farm feeds production, which could have mitigated this situation, has been hamstrung by the prohibitive cost of fishmeal, which is considered the first ideal protein source for fish. There is therefore, the need for a search for alternative protein sources for Nigerian aquafeeds. Such alternatives must satisfy the nutritional needs of the fish species, and as well minimize production cost so as

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Abbreviations: SCP, Single cell protein; **FM,** fishmeal; **CSM,** cotton seed meal; **FCR,** feed conversion ratios; **PER,** protein efficiency ratio.

Table 1. Cost of experimental diet.

Diet component	Do	D_{IO}	D_{20}	D_{30}	D_{40}	D_{50}
Wheat bran	66.67	66.67	66.67	66.67	66.67	66.67
Fish meal	1112.00	1001.00	889.00	778.00	667	556
SCP	-	103.30	206.21	308.84	441.57	470.28
Palm oil/codliver oil	233.30	233.30	233.30	233.30	233.30	233.30
Bone meal/oyster shell	50.00	50.00	50.00	50.00	50.00	50.00
Salt (Sodium chloride)	40.00	4.00	4.00	4.00	4.00	4.00
Methionine	-	66.67	13 3.00	199.50	266.00	332.50
Vitamin/mineral premix (poultry)	20.00	20.00	20.00	20.00	20.00	20.00
Binder (garri)	15.00	15.00	15.00	15.00	15.00	15.00
Corn starch	457.74	347.74	238.94	131.46	23.07	-
Cost of each diet	₦ I,958.74	₦ I,907.62	₦ I,856.12	₦ I ,806.77	₦ I,756.61	₦ I,747.45

to optimitize the production process. The implication is that while a feedstuff may be evaluated in terms of its biological value (feed conversion ratios (FCR), protein efficiency ratio (PER), digestibility, etc), it cost effectiveness remains a critical factor. Zeitoun et al. (1976) in their analysis pointed out that when economic parameters dictate lower dietary protein levels, those purported to give maximum growth may be more desirable. It is thus evident that the economic analysis of a feedstuff is imperative before adjudging it a suitable ingredient for fish feeds.

This study is therefore, aimed at evaluating the economic viability of partially replacing fishmeal with a microbial protein source (yeast single cell protein (SCP)) in the diet of *Oreochromis niloticus.*

MATERIALS AND METHODS

Six isonitrogenous diets were prepared for this experiment namely, diets Do, D_{IO}, D_{20}, D_{30}, D_{40}, D_{50}. Each of the experimental diets had 30% protein. Diet Do was prepared from fishmeal alone which also served as the control diet. Diets D_{10} to D_{50} had the fishmeal component of the diet substituted with yeast SCP in graded level from 10 to 50%. The costs of the experimental diets were based on current market prices.

Cost benefit analysis

The economic evaluation of substituting fishmeal with yeast SCP in the culture of *O. niloticus* was determined. The incidence of cost was done using the method of Vincke (1969).

Incidence of cost = Cost of feed / Weight of fish produced

A second method of comparison is the profit index (Miller, 1976).

Profit Index = Weight or value of fish produced / Cost of feed
Net Profit = Sales - Expenditure

Cost benefit ratio (CBR) = Total sales / Total expenditure

The biological value (BV) was calculated from the net protein utilization (NPU) and digestibility data.

BV = NPU / Apparent protein digestibility coefficient *(*ADC*)* (Thonney, 1981 and Thonney et al., 1984).

Statistical analysis

Cost-benefits evaluation of the experimental diets were subjected to analysis of variance (ANOV A) based on Wahua (1999). Means differences were determined using Duncan Multiple Range Test, Significance was recorded at P>0.05.

RESULTS AND DISCUSSION

The cost of experimental diets based on current market prices of feed ingredients indicated that fishmeal was the most expensive component in the diets (Table 1). The highest cost was recorded for diet Do (₦ I,958.74), while the least cost was D_{50} (₦ I,747.45). The cost gradually declined with increase in the replacement level of SCP. Cost benefit evaluation of the diets revealed that Diet Do had the highest incidence of cost based on the current market prices of the feed ingredients (₦ 124.68), while D_{50} had the least (₦ 98.58) Table 2. The least profit index was recorded in Do (₦ 8.02) while the highest profit index was D_{50} (₦ 10.14). The highest expenditure was incurred with diet Do (₦ I,958.71) while the least expenditure (₦ I,747.45) was recorded for diet D_{50}: Expenditure declined with increase in the amount of fishmeal replaced by SCP. The highest sale was made with diet D_{50} (₦ 3,546.00) while the lowest sales were diet D_{30} (₦ 3,060.00). Net profit was highest with diet D_{50} (₦ I,798.55) while, the lowest values were observed with diet Do (₦ 1,183.29). Cost-benefit ratio was highest with diet D_{50} (₦ 2.30) while the least was diet Do (₦ 1.60). The result of the cost benefit ratio followed the same trend with sales and net profit. The biological values range between 0.42 to 0.57.

The cost of the diets decreased as the quantity of fishmeal was being replaced by yeast SCP as observed by Sogbesan et al., (2004), that fishmeal constitutes about 50-75% by weight in most aquafeeds. He further reported that the partial or total replacement of fish meal

Table 2. Cost-benefit evaluation of experimental diets**.**

Parameter	Do	D_{IO}	D_{20}	D_{30}	D_{40}	D_{50}
Incidence of cost	124.68^{a}	114.02^{b}	116.88^{b}	118.90^{b}	106.78^{c}	98.58^{c}
Profit indices	8.02^{b}	8.77^{b}	8.55^{b}	8.47^{b}	9.3 7^{b}	10.14^{c}
Expenditure	1958.71^{a}	1907.62^{b}	1856.12^{b}	1806.77^{c}	1756.61^{c}	1747.45^{c}
Sales	3142.00^{c}	3345.00^{c}	3176.00c	3060.00^{c}	3300.00^{c}	3546.00^{c}
Net profit	1183.29^{c}	1437.38^{b}	1319.38^{b}	1253.39^{b}	1543.39^{b}	1798.55^{a}
Cost benefit ratio (CBR)	1.60^{b}	1. 75^{b}	1.71^{b}	1.69^{b}	1.88^{b}	2.03^{b}
Biological value	0.57^{a}	0.48^{a}	0.52^{a}	0.42^{a}	0.50^{a}	0.54^{a}

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

protein with alternative sources of protein could be of considerable economic advantage. Tacon (1993) noted that since fishmeal has become the most expensive protein commodity in aquaculture feeds; many attempts have been made to partially or totally replace fishmeal with less expensive locally available protein sources. The incidence of cost and profit indices was higher than those of Sogbesan et al. (2004) for hybrid catfish. The best cost benefit ratio and net profit were recorded for diet D_{50}. The main objective of any business enterprise including aquaculture is to make profit. Since cost of feed has been one of the major constraints in aquaculture development, the provision of an alternative ingredient such as yeast SCP that will reduce the feeding cost becomes imperative.

The economic evaluation of feeding *O. niloticus* fingerlings with experimental diets showed that D_{50} recorded the best net profit as well as the highest cost benefit ratio than those fed with the control (Do). The results of this study therefore indicate the possibility of rearing *O. niloticus* fingerlings, with diet in which fishmeal could be substituted with 50% yeast SCP to give the best profit margin as well as growth performance. These findings are similar to those of Sogbesan et al. (2004) who fed maggot meal to hybrid catfish. Also Abdelghany et al. (2002) reported that the best net profit was obtained when *O. niloticus* are fed with 25% protein pelleted feed. This compares well with the results of this work where 30% crude protein pelleted feed in which 50% of the fishmeal component was replaced with yeast SCP, gave the best net profit. According to Zeitoun et al. (1976) and De Silva, (1989) lower dietary protein level than those purported to give maximum growth may be more desirable and cost effective when economic parameters dictates. The findings in this study however, is that the most cost effective diet also gave the best growth performance in *O. niloticus.* The cost-benefit evaluation revealed that the diet D_{50} had the lowest incidence of cost, the highest profit index, the least expenditure, the best sales, and highest net profit and cost-benefit ratio. This is an indication that replacing fishmeal with 50% SCP in the diet of *O. niloticus* fingerlings could give good economic returns to the fish farmer. Thus, farmers could overcome the financial challenges arising from high production costs, and this will contribute to the long-term sustainability of aquaculture in Nigeria.

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