REPLACEMENT OF FISHMEAL WITH YEAST (*Saccaromyces cerevisiae*) IN THE DIET OF *Oreochromis niloticus* FINGERLINGS

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ABSTRACT

A feeding trial was carried out to study the effect of replacement of animal protein (fishmeal) with single cell protein - yeast (*Saccharomyces cervisiae*) on the growth, carcass composition and feed utilization of Nile tilapia (*Oreochromis niloticus*) fingerlings, mean weight of 7.92 ±0.08g. Four is nitrogenous diets were prepared including the control diet to contain as protein source (0%, 20%, 40% and 60% yeast levels). The results showed significant difference (P< 0.05) in the growth parameters and carcass composition for the test diets. However, tilapia gave best performance in terms of feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER) values between 20 - 40% inclusion levels of bakers' yeast beyond which there was decline in growth and feed utilization.

Key words: Yeast, *Oreochromis niloticus*, Fishmeal

INTRODUCTION

Abundant supplies of feed stuffs are available and farmers and hobbyist are now able to prepare their own feed from locally available ingredients. Nutrition is one of the most important factors that influence the ability of fish to attain proper growth and reproduction. Protein is considered as most important component of fish diet (Steffens, 1981). The research for unconventional sources for suitable, cheap and available protein concentrates is a continuous affair. Fish meal, soybean meal, fish hydrosylate, skin milk powder, legumes and wheat gluten are excellent sources of protein. A possible supplement which has not been exploited by farmers is the nutritional yeast (Hardy and Tacon, 2002). Yeasts are a rich source of protein and B-complex vitamins. Yeast based diets has been reported in diets for tilapia without impacting weight gain (Craig and Mclean, 2005). Similarly, Lunger *et al* (2006) reported replacement of fish meal with 25% yeast without any negative effect on the growth (Gohl, 1991). In addition they are considered a cheaper dietary supplement as they are easily produced on an industrial level from a number carbon-rich crude protein content. (Ballerini and Thonor, 1980). The nutritive value of yeast values differs according to its type. *Candida sp, Hansenula sp, pitchia sp* and *sacchromyces sp* are of special importance as components in fish feeds. Lysine content in yeast varies according to yeast strain and ranges between 4.1% in *Torulopsis Candida* (Ballerini and Thonon, 1977) to 8.4 % of dietary protein in *sacchromyces sp* (Schulz and Oslage, 1976). Methionine content as percentage of dietary protein ranges from 0.9 in *Candida trapicalis* (Ballerini Thonon 1980) to 1.9% in *pichia aganobii* (Ohkouchi *et al.*, 1980). The present study aims at evaluating the effect of graded level inclusion of yeast (*Sacchromyces cerevisiae*) on growth performance, carcass composition and feed utilization in *Oreochromis niloticus* fingerlings.

MATERIAL AND METHODS

Formulation of Diet

Proximate analysis of feedstuffs and the yeast were carried (Table 1 and 2) on which the formulation was done using Pearson square method. Four diets were formulated at crude protein level of (35% CP) containing three levels of yeast substitution (20%, 40%, and 60%) and the control diet with 0% yeast having 100% fishmeal (Table 2. The diets are designated as D1 (Control diet), D2 (20 % yeast), D3 (40 % yeast), D4 (60 % yeast). The feed stuffs used were fishmeal, maize meal, baker's yeast and vitamin- mineral premix. The diets were formulated using the Pearson Square method fixing yeast at 0, 20, 40 and 60 % as protein source.

Table 1: Chemical composition of Yeast used for the Feeding Trial

Proximate composition (%)	
Crude protein	59.38
Crude fibre	0.00
Lipid	5.76
Moisture	1.59
Ash	5.45

Table 2: Diet Formulation and Proximate compositions of Diets

Diet composition (%)	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**
Yeast	0.00	20.00	40.00	60.00
Maize	36.47	28.79	21.11	13.43
Fish meal	58.53	46.21	33.89	21.56
Vitamin premix	5	5	5	5
Total	100.00	100.00	100.00	99.99
Proximate Composition (%)				

Crude protein	35.99	35.27	35.23	34.84
Crude Lipid	14.10	10.65	10.07	9.09
Crude fibre	7.08	5.11	7.12	2.79
Ash	19.00	15.0	8.00	8.00
Moisture	10.50	9.64	10.8	7.0
NFE	13.33	24.33	28.78	38.28

Experimental procedure

A total number of 200 Nile tilapia fingerlings (*Oreochromis niloticus)* of mean weight 7.92 ± 0.08 were obtained from the Department of Water Resources, Aquaculture, and Fisheries Technology, Old Research Farm Centre of the Federal University of Technology Minna, Nigeria where the experiment was conducted. The fish obtained were apparently healthy and free of any infection. The fish were randomly distributed in aquaria (60 X 60 X 30 cm) tank. Each aquarium was filled with 20 litres bore hole fresh water. The aquaria were covered with screen nets to safeguard against loss of fish. They were fed with commercial catfish feed of size 2mm for one week acclamation period. The fingerlings were then randomly distributed into four equal treatments. Each treatment in triplicate and each aquarium were assigned ten fishes. The fishes were bulked weighed at the commencement of the feeding trial, fortnightly and at the end of the study. They were fed 3% body weight throughout the experiment twice daily between the hours of 10.00 and 16.00. The uneaten diets were siphoned 30 minutes after feeding, dried and removed from total feed fed to establish actual feed taken by the fishes. The faecal matters were siphoned daily before feeding and stored in a refrigerator for digestibility analysis.

Experimental Analysis

At the commencement of the feeding trial six fishes were sacrificed for the initial and similar number were also used for the final carcass analysis per treatment. there were analysed for their crude protein, crude lipid, moisture content and total ash using standard methods as described by AOAC (2000). Fortnightly, fishes were weighed and the record was used to compute for various growth and feed utilization parameters like mean weight gain (g) which is the difference between mean final weights (g) - Mean initial weight (g). The Specific Growth Rate (SGR % / Day) which is the average percentage weight change per day between any two weightings within the experimental period in accordance with Brown (1957). It is expressed as SGR (% / Day) = [(LnW2 - LnW1) / (T2 - T1) X100]; Where W1 is the initial fish weight (g) at time T1 (day) and W2 is the final fish weight (g) at time T2 (day) and Ln (as natural logarithm). The Food Conversion Ratio (FCR) is defined as the weight of feed fed in dry weight per fish live weight gain and was calculated as FCR = Feed fed (g dry weight)/Live weight gain (g). The Protein Utilisation was determined from the Protein Efficiency Ratio (PER) which is the fish weight gain per gram of crude protein fed. PER gives an indication of the efficiency of protein utilization (Osborne *et al.*, 1919) while the Apparent Net Protein Utilisation (ANPU) was expressed as the percentage of ingested protein that is retained by deposition in the carcass (Bender and Miller (1953), Miller and Bender (1955) mathematically as ANPU (%) = (P2 - P1) / Total protein consumed (g) X100; Where, P1 is the protein in fish carcass (g) at the beginning of the study and P2 is the protein in fish carcass (g) at the end of the study. The Apparent Digestibility Coefficient (ADC) was evaluated according to Maynard *et al* (1979) and Bondi (1987) using Acid insoluble Ash (AIA) as internal indicator as reported by Church and Pond (1988).

$$\% \text{ ADC} = 100 - \left[\frac{100 \text{x} \% \text{AIA in diets x } \% \text{ Nutrients in Feaces}}{\% \text{AIA in feaces x } \% \text{ Nutrient in diets}} \right]$$

Statistical analysis

Results of carcass composition, the evaluation of biological parameters, and all other data obtained were subjected to one way analysis of variance (ANOVA) using Turkey's test (Steel and Torrie, 1980) at 5% probability level. Multiple parameter means comparison of treatments was according to Duncan multiple range tests (Duncan, 1955). All statistics analyses including regression were executed using the software Minitab Release 14 and graphical analyses were plotted with Microsoft Excel Window 2007.

RESULTS AND DISCUSSION

Table 3 shows the results of the feeding trial on the utilization of yeast by *Oreochromis niloticus* fingerlings. During the study fishes accepted the diets and fed actively on them. There were no significant difference (P>0.05) among diets 1 to 3 which were significantly (P<0.05) higher than diet 4. The specific growth rate (SGR) showed no significant difference (P< 0.05) between diets 2 and 3 however, diet 4 gave the lowest SGR value (Table 3). The feed conversion ratio (FCR) also showed insignificant difference (P>0.05) between diets 1, 2 and 3 which were significantly (P<0.05) lower than diet 4 which gave the highest FCR value. The protein efficiency ratio (PER) did not show significant difference (P>0.05) between diets 2 and 3 which were significantly lower than diet 1. Moreover, the PER value for diet 4 was the lowest. On the carcass compositions there were no significant differences (P< 0.05) in crude protein, lipid, ash and moisture among diets 2,3 and 4 (Table 4).

There were significant differences (P<0.05) in the Apparent digestibility coefficient (ADC %) of the treatments. There is significant difference (P<0.05) in the protein, ash, and lipid. Diet 1 (0% yeast) is highest in protein digestibility (85.37 %) followed by diet 2 (20% yeast) while die 4 gives the lowest value (64.48%) the lipid digestibility was highest for die 1 (69.24%) while diet 4 gives the lowest value (42.25 %). The dry matter digestibility is highest for diet 1 while the lowest value was obtained for diet 4 (41. 67 %). The ash digestibility was highest for diet 1 (33.33 %) while diet 3 gave the least value (2.50 %) (Table 5)

Table 3: Mean growth parameters Nile Tilapia (*Oreochromis niloticus*) fed yeast based Diets for 56 days.

Growth parameters	Diet 1	Diet 2	Diet 3	Diet 4
Mean Initial Body weight (g)	7.92 ± 0.08^a	7.79 ± 0.11^a	7.83 ± 0.07^a	7.95 ± 0.07^a
Mean Final Body weight (g)	21.00 ± 3.19^a	20.13 ± 0.00^a	20.07 ± 3.50^a	9.39 ± 0.22^b
Mean weight gain (g)	13.08 ± 3.25^a	12.21 ± 0.00^a	12.24 ± 3.47^a	1.44 ± 0.28^b
Specific Growth rate (SGR) (% Day)	1.17 ± 0.01^b	1.70 ± 0.01^a	1.68 ± 0.02^a	0.30 ± 0.01^c
Feed Conversion ratio (FCR)	1.70 ± 0.01^a	1.79 ± 0.01^a	1.79 ± 0.01^a	15.46 ± 0.01^b
Protein efficiency ratio (PER)	4.91 ± 2.76^a	3.60 ± 3.75^b	3.74 ± 2.86^b	0.50 ± 0.18^c

Table 4 Carcass Composition of Nile Tilapia (*Oreochromis niloticus*) fed yeast based Diets

Chemical Composition (%)	Initial	Diet 1	Diet 2	Diet 3	Diet 4
Crude Protein	$55.79^a \pm 0.09$	$55.08^a \pm 0.09$	$52.21^b \pm 0.09$	$52.64^b \pm 0.09$	$52.93^b \pm 0.09$
Crude Lipid	$6.83^a \pm 0.35$	$6.08^b \pm 0.36$	$5.99^b \pm 0.36$	$5.97^b \pm 0.36$	$5.97^b \pm 0.36$
Ash	$15.27^{ac} \pm 0.25$	$17.49^b \pm 0.25$	$22.13^a \pm 0.23$	$19.39^a \pm 0.25$	$20.24^a \pm 0.25$
Moisture	$8.93^a \pm 0.07$	$8.12^b \pm 0.07$	$6.81^c \pm 0.07$	$5.89^c \pm 0.07$	$5.98^c \pm 0.07$
NFE	$13.18^c \pm 0.01$	$13.23^c \pm 0.01$	$12.86^c \pm 0.01$	$16.11^a \pm 0.01$	$14.88^b \pm 0.01$

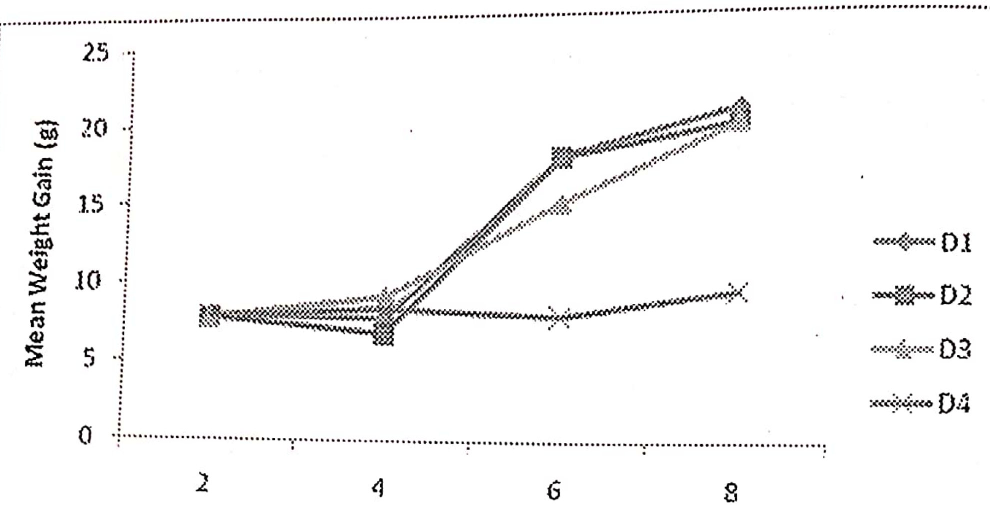

Fig. 1: Growth Response of *Oreochromis niloticus* fed graded levels of Yeast for 8 weeks

Table 5: Apparent Digestibility Coefficient (ADC %) of *Oreochromis niloticus* fed with Yeast based diets

ADC (%)	D1	D2	D3	D4
Dry matter	66.66 ± 0.01[a]	57.78 ± 0.01[b]	41.96 ± 0.01[c]	41.67 ± 0.01[c]
Lipid	69.24 ± 0.01[a]	44.58 ± 0.01[b]	68.38 ± 0.01[a]	42.25 ± 0.01[c]
Crude protein	85.37 ± 0.01[a]	77.49 ± 0.01[b]	68.00 ± 0.01[c]	64.48 ± 0.01[d]
Ash	33.33 ± 0.01[a]	11.46 ± 0.01[b]	2.50 ± 0.01[d]	6.25 ± 0.01[c]

Data on the same row carrying different superscripts differed significantly from each other ($P < 0.05$)

The results indicated utilization of yeast by *Oreochromis niloticus* up to 40 % inclusion level. However, figure 1 showed the growth response curve which showed that even though 40% inclusion level of yeast gave good performance in terms of the mean weight gain (MWG), specific growth rate (SGR) as well the feed conversion ratio (FCR) *Oreochromis niloticus* appears to tolerate optimum of 20% inclusion level of yeast as there was decline in the growth beyond this level. The decline in growth beyond the optimum tolerant level is agreement with (Angela *et l.* 2007; Rumsy *et al.* 1991) who reported reduced growth and feed intake in rainbow trout fed brewery dried yeast at 25% and above. Even though there were no significant difference in the MWG and SGR values for diet 2 and 3, diet 3 apparently gave a higher value for protein efficiency ratio (PER) which is an indication of utilization of muscle development. Olvera-novoa *et al.*, (2002) reported replacement of animal protein up to 65% with a mixture of plant protein including 30% torular yeast, in tilapia fry diet without adverse effect on the fish performance and culture profit. This result is also similar to report from other species of juvenile carnivorous fish in which fishmeal was replaced using yeast – based products of 30 – 50% without negative impact (Beck *et al*., 1976, Rumsey *et al*., 1990, Oliva –Teles and Goncalves, 2001).

Diet 4 gave the least performance in terms of weight gain as reflected in the poor feed conversion ratio, specific growth rate and protein efficiency ratio. Poor utilization of yeast at a high inclusion level has been reported by Lunger *et al.* (2007) despite supplementation with taurine in the diet of juvenile cobia. On the carcass compositions, the crude protein, lipid, ash and moisture contents were significantly not different (P>0.05) between diet 2, 3 and 4. The result is in agreement with the results of Olvera-Novoa *et al*., (2002) who reported no significant difference in carcass composition when substituting animal protein with a mixture of plant feed stuffs including 25, 30, 35, 40 and 45% of protein with torular yeast (*Candida utilis*) in the Diet of *Oreochromis niloticus* fry.

CONCLUSION AND RECOMMENDATIONS

In conclusion, this study showed the possibility of replacing the expensive protein source (fishmeal) with yeast (SC) in tilapia fingerlings' diets, up to 40% inclusion level in the practical diet of *Oreochromis niloticus* fingerlings without any negative effect on the growth of the fish. However, further studies should be done to improve on the anti-nutritional factor in the yeast, which limits its utilization at a high inclusion level.

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