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Utilization of Baker's Yeast (*saccharomyces cerevisiae*) in the diet of juvenile African Catfish (*clarias gariepinus*).

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ABSTRACT

A total of 150 juvenile Clarias gariepinus of mean weight (17.14g) were randomly distributed in triplicate of 7 fish per tank. Graded levels of Baker's yeast were mixed with commercial feed (COPPENS) at 0% (Diet 1), 2% (Diet 2), 4% (Diet 3), 6% (Diet 4) and 8% (Diet 5). Mean weight gain was significantly different with the highest MWG recorded by fish on Diet 3 (174.80g) and least on Diet 1 (116.85g). The least feed conversion ratio (0.56) was recorded in Diet 3 and the highest Diet 1 (0.71). The protein efficiency ratio was highest in Diet 3 (4.28) and least in Diet 1 (3.35) while the highest gross profit of (#1889.0) was recorded in Diet 3. There was no significant difference (P>0.05) in haemoglobin, PCV, Red blood cell, White blood cell, MCH and MCV across the test diets. The result of the organ analysis showed no significant difference (P>0.05) in spleen, kidney, heart, large intestine, stomach, bile, lungs and fat, while liver, small intestine and air sacs showed significant difference (P<0.05). The study showed that inclusion of Baker's yeast at all levels of inclusion positively enhanced growth performance and feed utilization without any adverse effect on the fish growth and performance, though the best result was recorded at 4% inclusion.

Keywords: *Saccharomyces cerevisiae, Baker's yeast, diet, Clarias gariepinus.*

INTRODUCTION

Protein is an essential component of diet and constitutes a major part of the animal's body hence protein cannot be compromised in the choice of ingredients for feed formulation and preparation (Zeitler *et al;* 1984). Single cell proteins, including yeast and bacteria, have been viewed as promising substitutes for fishmeal in fish diets. Researchers have evaluated the nutritional value of yeast (*Saccharomyces cerevisiae*) in Lake Trout (Rumsey *et al*., 1990), Rainbow Trout (Rumsey *et al*., 1991) and Sea Bass (Olivia-Teles and Goncalves, 2001) by comparing growth performance, feed efficiency and nitrogen retention. Based on these studies, yeast could replace up to 20-50% of fish meal protein without adversely affecting growth of these species. Yeast is a rich source of protein and B-complex vitamins. It has been used as supplement in animal feed to compensate for the amino acid and vitamin deficiencies of cereals, and is recommended as a substitute for soybean oil in diets for fowls (Gohl, 1991). In addition, they are considered as a cheap dietary supplement as it is easily produced on an industrial level from a number of carbon-rich substrate by-products such as citrus-pulp, molasses, paper industry waste and fruit waste (*Candida utilis*), as well as from hydrocarbons (*Candida lipolytica).* Apparently, sulphur amino acid deficiency restricts the use of yeast, though there

may also be other factors limiting the use in salmon, such as its high carbohydrate and nucleotide content (Rumsey *et al*., 1991).

The aim of the present study was to investigate the growth and nutrient utilisation performances of *Clarias gariepinus,* the proximate and haematology composition of the fish fed graded levels of Baker's yeast.

MATERIALS AND METHODS

Experimental Procedure

The experiment was carried out at the Experimental Unit of the Department of Marine Sciences, Faculty of Science, University of Lagos. The Baker's yeast was purchased from a store at Itafaji market in Lagos. Five experimental diets in triplicates were used for the experiment. Fifteen mini-plastic tanks (52.5 X 33.5 X 21cm) were used; the tanks were cleaned, disinfected with formalin and allowed to dry for 24 hours after which dechlorinated water was added to each.

Preparation of Test Ingredient

The Baker's yeast, (20g of Baker's yeast dissolved in 60ml of water) was mixed with the Coppens feed for this study. The essence of dissolving it in water was to allow the yeast to be evenly distributed in the Coppens feed. Different inclusion levels of the baker's yeast were added at 2%, 4%, 6% and 8% for diet II, III, IV and V respectively. Diet I was the control diet which contained no Baker's yeast. Dietary composition of Coppens feed in percentage (%) and chemical composition of *Saccharomyces cerevisiae* were recorded in Tables 1 and 2 respectively. A total number of 150 juvenile (*Clarias gariepinus)* was purchased from Fuard Farms at Cele-Egbe area of Ikotun, Lagos. The fish were apparently healthy and free from infection; they were acclimatized for 2 weeks in mini-plastic tanks and were covered with net of mesh size 3mm to prevent the fish from jumping out of the tanks. The fish were sorted, weighed and randomly stocked into the experimental chamber at the rate of seven (7) fishes per tank with weight range 17.00-17.14g. They were starved overnight before the commencement of the feeding trials.

Feeding Trials

The fish were fed to satiation by hand twice daily (9.00am and 4.00pm) throughout the experimental period. The fish were weighed on weekly basis using a digital scale Camry EK 5055 max. 5kg/ 11 1b= 1g/ 0.05 Oz, and water was changed every other day and replaced with dechlorinated water. Fish were monitored daily for mortality. Dead fish were removed, counted and recorded. Survival rate was determined from the number of fish at the end of 8 weeks duration of the experiment relative to the number stocked.

Proximate Analysis

Proximate composition analysis of fish carcass after the experiment was carried out according to the Association of Analytical Chemists Method (A.O.A.C., 2000).

Haematology Analysis

Blood samples of fish taken at random from each tank were collected in a 2ml syringe and heparin bottles for Haematological assay. Haemoglobin (Hb), Packed Cell Volume (PCV), Red blood cell (RBC), White blood cell (WBC), Lymphocytes and Monocytes were analysed according to the method of Joshi *et al* (2002).

Statistical Analysis

All the data collected throughout the experimented period were subjected to analysis of variance (ANOVA) and Duncan's multiple range tests. Comparison among the treatments was carried out and the level of significance among treatments was determined.

GROWTH AND NUTRIENT PARAMETERS

(1) Mean Weight Gain (MWG)

$$MWG = \frac{\text{Average Weight Gain}}{\text{Number of days}}$$

(2) Feed Conversion Ratio (FCR)

$$FCR = \frac{\text{Feed Intake (g)}}{\text{Weight Gain (g)}}$$

(3) Specific Growth Rate (SGR)

$$SGR = \frac{(\text{Loge } W_2 - \text{Loge } W_1)}{} \times 100\%$$

(4) Protein Efficiency Ratio (PER)

$$PER = \frac{\text{Mean Weight Gain of Fish}}{\text{(g) Protein intake (g)}}$$

(5) Gross Profit (GP)

GP = Net Profit Value (N) – Investment Cost Analysis

(6) Net Profit Value (NPV)

NPV = Mean Weight Gain x Total number of Fish (n) x Cost per kg

(7) Profit Index (PI) PI

$$= \frac{\text{Value of fish}}{\text{Cost of feeding}}$$

(8) Incidence of cost (IC)

$$IC = \frac{\text{cost of fish}}{\text{kg of fish produced}}$$

Cost Analysis

The cost was based on the current prices of feed ingredients in the experimental locality (Nigeria) as of the time of the experiment. The economic evaluations of the diet were calculated from the method of Aderolu and Oyedokun (2008).

RESULTS

Proximate composition of the experimental feed and the commercial yeast used in this study is shown in Table 1 and 2 respectively.

The mean body weight gain; feed intake and feed conversion ratio of catfish juvenile fed graded levels of yeast over the experimental period of 8 weeks is presented in Table 3. Results showed that the highest value of mean weight gain(MWG) 174.80g was reported in diet III (4% yeast inclusion level) which was significantly different ($P<0.05$) from the other four diets, while the lowest value of 116.85g was from the diet I. In terms of specific growth rate (SGR), the highest and lowest values were recorded as 3.75 in diet III and 3.19 in the diet I respectively. The best feed conversion ratio (FCR) value was recorded in diet III (0.56), which was significantly different from all others ($P<0.05$). The highest value of protein efficiency ratio (PER) was recorded in diet III (4.28) which is not significantly different ($P<0.05$) from the value obtained for diet IV (3.80). Incident cost (IC) had the highest and lowest values recorded in diet I (0.19) and diet III (0.15) respectively (Table 3.0).

The result of the haematological analysis is shown in Table 4; level of Haemoglobin, Packed Cell Volume and Red Blood Cells were lowest in diet III compared to other diets but with no significant difference ($P>0.05$). White blood cell count is lower in the fish fed the yeast diets compared to the control diet. Table 5 shows the proximate composition of the fish carcass on completion of experiment, while Table 6 shows the effect of graded levels of yeast on some organs in the fish.

Table 1: Chemical Composition of Coppens Feed

Composition	Percentage (%)
Crude protein	42
Carbohydrate	13
Crude fibre	1.5
Ash	9
Calcium	1.6
Phosphorus	1.1
Lysine	2.8
Methionine	0.9
Copper sulphate (mg/ kg)	5
Selenium (mg/ kg)	0.3

Table 2: Chemical Composition of *Saccharomyces cerevisiae*

Composition	Percentage (%)
Dry matter	93
Crude protein	44.4
Crude fat	1
Crude fibre	2.7
Calcium	0.12
Phosphorus	1.4

Table 3: Growth Performance and Nutrient Utilisation of *Clarias gariepinus* fish fed diets with Graded Levels of Baker's Yeast (*Saccharomyces cervisiae*)

Parameters	Diet I	Diet II	Diet III	Diet IV	Diet V
Average Initial Weight (g)	17.13	17.05	17.09	17.27	17.27
Average Final Weight (g)	133.99^{c}	168.33^{b}	191.90^{a}	191.49^{b}	145.76^{c}
Average Feed Intake (g)	83.17^{b}	101.42^{a}	97.21^{ab}	96.04^{ab}	87.54^{ab}
Mean Weight Gain (g)	116.85^{c}	151.29^{b}	174.80^{a}	152.22^{b}	128.49^{c}
Specific Growth Rate	3.19^{c}	3.55^{b}	3.75^{a}	3.54^{b}	3.31^{c}
Feed Conversion Ratio	0.71^{a}	0.67^{a}	0.56^{b}	0.63^{ab}	0.68^{a}
Protein Intake	34.93^{b}	42.60^{a}	40.83^{ab}	40.34^{ab}	36.77^{ab}
Protein Efficiency Ratio	3.35^{b}	3.57^{b}	4.28^{a}	3.80^{ab}	3.50^{b}
Profit Index	0.017^{c}	0.026^{a}	0.028^{a}	0.024^{ab}	0.019^{bc}
Net Profit Value	1193.5^{c}	1838^{a}	1991.6^{a}	1738.2^{ab}	1367.6^{bc}
Investment Cost Analysis	75.77^{c}	94.38^{a}	102.68^{a}	93.41^{ab}	81.65^{bc}
Incidence of Cost	0.19^{a}	0.18^{a}	0.15^{b}	0.17^{ab}	0.18^{a}
Gross Profit	1117.7^{c}	1743.6^{a}	1889.0^{a}	1644.8^{ab}	1286^{bc}

Values are the mean of the triplicate groups of fish. Mean values with different superscripts in each row were significantly different in the Duncan test ($P<0.05$).

Table 4: Haematological parameters of the fish fed diet containing baker's yeast (*Saccharomyces cerevisiae*).

	Diet I	Diet II	Diet III	Diet IV	Diet V
Haemoglobin (Hb)	9.70	9.90	8.77	9.03	9.23
Packed cell Volume(PCV)	0.30	0.31	0.27	0.29	0.29
Red Blood Cells (RBC)	6.00	6.33	5.33	6.00	5.67
White Blood cells (WBC)	16667	15000	12667	15667	14667
Lymphocytes	0.70^{ab}	0.75^{a}	0.71^{ab}	0.65^{b}	0.66^{b}
Monocytes	0.31^{ab}	0.25^{b}	0.30^{ab}	0.34^{a}	0.32^{ab}
MCHC	0.032^{ab}	0.032^{ab}	0.033^{a}	0.031^{b}	0.032^{ab}
MCH	1.62^{a}	1.58^{a}	1.68^{a}	1.51^{a}	1.66^{a}
MCV	5.06^{a}	4.90^{a}	5.08^{a}	4.83^{a}	5.28^{a}

Table 5: Proximate Composition (% Dry matter) of the fish carcass

Composition	Diet I	Diet II	Diet III	Diet IV	Diet V
Crude Protein (%)	68.57	54.60	67.12	55.13	67.35
Ash (%)	6.00	6.00	6.00	6.00	6.00
Ether Extract (%)	25.00	26.00	23.00	27.00	23.00
Dry Matter (%)	25.30	29.13	29.92	30.27	27.33

Table 6: Result of Organ Analysis of fish fed graded levels of yeast.

	Diet I	Diet II	Diet III	Diet IV	Diet V
Liver	0.015^{a}	0.015^{a}	0.009^{b}	0.010^{b}	0.012^{ab}
Spleen	0.012^{a}	0.013^{a}	0.010^{a}	0.011^{a}	0.010^{a}
Kidney	0.005^{a}	0.004^{a}	0.003^{a}	0.004^{a}	0.004^{a}
Heart	0.002^{a}	0.002^{a}	0.001^{a}	0.002^{a}	0.002^{a}
Small Intestine	0.007^{b}	0.007^{b}	0.008^{b}	0.013^{ab}	0.016^{a}
Large Intestine	0.006^{a}	0.006^{a}	0.005^{a}	0.006^{a}	0.006^{a}
Gonad	0.014^{a}	0.058^{a}	0.014^{a}	0.027^{a}	0.035^{a}
Stomach	0.008^{a}	0.007^{a}	0.007^{a}	0.008^{a}	0.006^{a}
Bile	0.003^{a}	0.003^{a}	0.003^{a}	0.004^{a}	0.004^{a}
Air sacs	0.016^{a}	0.011^{ab}	0.010^{b}	0.008^{b}	0.014^{ab}
Lungs	0.030^{a}	0.027^{a}	0.027^{a}	0.028^{a}	0.025^{a}
Fat	0.011^{a}	0.006^{a}	0.012^{a}	0.015^{a}	0.008^{a}

DISCUSSION

Single cell proteins, including yeast, have been viewed as promising substitutes for fishmeal in fish diets. Researchers have evaluated the nutritional value of yeast *Saccharomyces cerevisiae* in Lake Trout (Rumsey *et al*., 1990) and Rainbow Trout (Rumsey *et al*., 1991) by comparing growth performance and feed utilisation. Based on these studies, yeast could replace up to 25-50% of fishmeal protein without adversely affecting growth of species.The following authors also got improved weight

gain,feed conversion ratio and growth when they fed yeast to chicken (Angel *et al.,*2001; Zhang *et al.,* 2005).

Baker's yeast (*Saccharomyces cerevisiae*) has been recognised as a potential replacement for fishmeal (Oliva-Teles and Goncalves, 2001). In the present study, the inclusion of graded levels of baker's yeast improved growth and feed utilisation. These results agree with that obtained with hybrid striped bass (Li and Gatlin, 2003; Li and Gatlin, 2004 and Li and Gatlin, 2005). Similar results were obtained when *S. cerevisiae* was added to fish diet of Israeli carp (Noh *et al*., 1994) and Nile tilapia (Lara-Flores *et al*., 2003).

The improved fish growth and feed utilisation may possibly be due to the improved nutrient digestibility. In this regard, Lara-Flores *et al.,* (2003) found that the addition of yeast improve diet and protein digestibility which may explain the better growth and feed efficiency recorded with yeast supplements.

Result in this present study reported that diet III (4% inclusion level) provided the best results in terms of Weight Gain, Feed Conversion Ratio, Specific Growth Rate, Protein Efficiency Ratio and apppears to be more digestible compared to other diets. Fish fed with diet I (control diet) showed the highest body moisture content over all other diets while diet IV exhibited the lowest value. Highest crude protein content was obtained in diet I (control diet) while diet IV showed the highest value of ether extract. However, all diets had the same value for ash content. Accordig to Ebrahim and Abou-seif (2008) chemical analysis of fish carcass at the end of their experiment showed that, dry matter, crude protein, body fat and body ash content were slightly fluctuated among all the experimental diets without significant differences. These results took the same trend of those results obtained by Olvera-Novoa *et al*, (2002)

A high level of haemoglobin, packed cell volume and red blood cell was observed in diet III (4% inclusion level), while the highest value of white blood cell was observed in diet I (control diet). Several workers (Oyofo *et al.,* 1989; Newman, 1994; Spring *et al.,* 2000) reported that *S. cerevisiae* improved the efficacy of the immune system, improved intestinal lumen health, increased digestion and absorption of nutrients, which resulted in better performance.

In conclusion, the present study indicates that baker's yeast positively enhanced growth performance and feed utilisation of african Catfish *Clarias gariepinus* without any adverse effect on the fish health.

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