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# Wheat Bran Grown Brewers Yeast (Saccharomyces cerevisioe) as Feed for Clarias gariepinus Fingerlings: Carcass Analysis and Growth Performance

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**Abstract**
A trial feed was prepared by inoculating and growing brewer's yeast (Saccharomyces *cerevisiae)* in wheat bran. The biomass so produced was dried and used to replace fish meal in the diet of Clarias gariepinus at varying levels (0%, 15%, 30%, 45% and 60%) respectively. The analysis of the fish carcass revealed that the diet $D_5$ with 60% substitution of fishmeal with brewer's yeast had the highest protein (50.91) followed by $D_1$ (fishmeal only) 45.51. In growth performance, the fishmeal diet gave better results in Mean Weight Gain (MWG) – 1.27; and Percentage Weight Gain (PWG) – 27.79. However, the 60% substituted diet showed superiority in Specific Growth Rate (SGR) 4.00 and Nitrogen Metabolism (Nm) – 44.73. the results therefore are indicative of the fact that wheat bran grown , Brewers yeast can serve as fishmeal replacers at 60% substitution level without adverse effect but improvement on the fish carcass protein and growth performance.
**Keywords:** Brewers yeast wheat bran feeding trial, *Clarias gariepinus*, carcass composition, growth.

## INTRODUCTION

One of the problems facing fish farmers in Nigeria is the high cost of feed. Consequently many local fish farmers use bread crumbs and other carbohydrate sources to feed their fish. The result is poor growth and fish with a lot of fat deposits in their tissues.

Fish nutritionists and technologists globally are also seeking for alternative sources of protein to replace fishmeal which has been the main source of protein in fish feed production. This is due to the fact that fishmeal satisfies all the amino acid and other nutritional requirements in fish feed. However due to its high cost, it is becoming less profitable on daily basis for the fish farmer to depend in fish feed manufactured with fishmeal, since the ulterior motive of any fish farmer is to make profit.

Aquaculture is fast developing and expanding in Nigeria. This rapid expansion along with improvement in fish culture techniques have increased the demand for fishmeal and fish oil as the major dietary components, due to their unique nutritive quality.

The story of aquaculture in Nigeria is fast becoming the story of catfish culture and the hope of fish supply depends on its development and culture. Aquaculture therefore remains the only viable alternative if fish culture is to be one means of providing animal protein to the fast increasing population.

The sharp-tooth African catfish (*Clarias gariepinus*) is a successful aquaculture species in Nigeria. The species is widely accepted by fish farmers and consumers because of some biological reasons. These include fast growth rate, ease of artificial propagation, accepting artificial feeds, tolerance to a wide range of environmental conditions and disease resistance. Other factors which endear this fish to the people include its low caloric value, low carbohydrate content, high protein quality, low fat content, easy and quick to prepare and above all, it tastes good. Consequently the demand for *C. gariepinus* in Nigeria is unprecedented. No matter the quantity supplied into the market, it is readily purchased.

*C. gariepinus* are found throughout Africa and the Middle-East. They live in rivers and swamps, fresh water lakes and man-made habitats such as oxidation ponds or urban sewage systems. The African sharp-tooth catfish was introduced all over the world in the early 1980's for aquaculture purposes, so is found in countries far outside its natural habitats.

Wheat bran is a by-product of the dry milling of common wheat into flour. It is one of the major agro-industrial by-products used in feeding fish (WMC 2008).

The food composition of wheat bran includes;

- A high protein quantity
- Low fat content and high carbohydrate content
- It is rich in Vitamin B which plays an important role in nervous system, enzymes and strengthening of the immune system, health and production of hormones.
- It is also important in minerals especially potassium, calcium, phosphorus, iron, magnesium, and manganese.
- It is rich in non-soluble fibres used as a dietary supplement.

Fuller (2004) observed that wheat bran is suitable for livestock feeding and very palatable to most

classes of animals. Hertramp and Paidad-Pascual (2000) noted that the high fibre content of wheat bran limits its use to herbivorous and omnivorous fish and recommended extrusion and inclusion rates between 3 and 5%. The nutrient digestibility of wheat bran in *Oreochromis niloticus* was found to be relatively high for protein (75-84%) but generally much lower than the digestibility of fishmeal and other sources. (Ribeiro *et al* 2011). Akrain *et al* (1992) used wheat bran as substrate and cultured *Aspergilus terreus* and obtained the biomass that contained 32.88% crude protein. Also, the amino acid profile revealed that it contained sufficient amount of all essential amino acids except lysine which was deficient. Jamu and Anyila (2003) investigated to select the most efficient strain of yeast cultures for the production of high quality single cell protein with *Saccharomyces cerevisiae*. El-Sayed, (2013) indicated that wheat bran is one of the major ingredients used by Tilapia farmers in sub-Saharan Africa. Nile tilapia fingerlings were fed cereal brans (maize, wheat, and rice bran) at 1.5% body weight. It was observed that growth obtained with wheat bran was intermediate between that from maize bran (highest) and rice bran (lowest). However, wheat bran was more profitable (Lit; *et al*. 2006). The value of a feed stuff is based not only on its chemical composition but also on the amount of the nutrient or energy the fish can absorb and use (NRC 2002). Gokeek *et al* (2008) noted that one of the major problems rocking fish farmers is the need to obtain a balance between rapid growth of fish and optimum use of the supplied feed. Unconventional sources of feeds have been used effectively in feeds for a variety of fish species (Bureau *et al* 2002). However, some constraints to the use of wheat bran have been observed. Choct and Annison (1992) observed that wheat bran contains pentosans which are thought to have anti-nutritional activities in poultry and results in depressed growth and poor nutrient utilization. Also wheat bran has been reported to have a high phytase activity (Cavalcanti and Behnke 2004). However, the phytase activity may be considerably reduced when wheat bran is processed into pellets since heat treatment destroys phytase. Wheat bran contains a very heat-stable lipase that causes hydrolytic rancidity which is more active in finely ground bran. However, wheat bran contains low fat and no health problems associated to rancidity have been reported in livestock (Allen and Hamilton 1994).

The objective of this work is to improve the protein content of wheat bran by using it as a substrate for the growth of the yeast *Saccharomyces cerevisiae* and harvesting the product for use in fish feed. This is aimed at replacing fishmeal in fish feed production. The level of substitution at which the wheat bran enriched feed ingredient brings about optimum growth and digestibility was also investigated.

**Use of wheat bran and brewers yeast in fish feed production**

The study of unconventional protein source production from agro-industrial wastes is under focus in recent times. Agricultural residues rich in carbohydrate can be utilized in fermentation process to produce microbial protein which can be used to upgrade animal feeds. Agricultural residue such as wheat bran comprise mainly of lignin, cellulose and hemicelluloses. Their direct utilization ratio as animal feed stock is therefore very low. However, thorough appropriate hydrolysis, this lignocellulosic biomass could be transformed into fermentable sugar as cultural substrate for growth of micro-organisms. Yeasts are common micro-organisms which can grow on agricultural wastes.

## MATERIALS AND RESEARCH METHODOLOGY

**Feed Production**

In this work wheat bran was used as a substrate for the culture of brewers yeast, (Saccharomyces cereviciae). The biomass obtained was, dried and analysed (Table 1). This was used to replace fish meal at various levels of substitution. Diet D1 had fish meal as the main protein source and served as the control diet $D_2$, $D_3$, $D_4$ and $D_5$ had fish meal substituted at 15%, 30%, 45% and 60% respectively by the wheat bran grown brewers yeast. This was used as trial feeds in the culture of the African catfish (Clarias gariepinus) fingerlings.

**Experimental Procedure**

The experiment was carried out in twenty outdoor tanks in the Department of Biology, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt. The dimension of the tanks were 40cm x 83cm x 50cm and three-quarter ($^3/_4$) filled with clean tap water after proper cleaning. Three hundred and fifty (350) *C. gariepinus* fingerlings of initial weight and length of 23.1g and 14cm respectively were obtained from a nearby fish farm and stocked. These were left to acclimate for a period of five days and distributed into the twenty (20) plastic experimental tanks. Four tanks where used for a particular treatment (feed) and there were five different feeds. The experimental design was complete randomization with five (5) treatments and four (4) replicates.

Water quality was monitored by changing the water every other day to provide a fresh water environment for the fish. There was only marginal difference in temperature in all treatment during the study. pH values were slightly above 7.0 and dissolved oxygen was high in all treatments and low ammonia content.

The fish were fed and libitum twice daily, morning and evening. Weights and lengths were taken once every week, using top load weighing balance and measuring board respectively.

.**Determination of growth and nutrient utilization parameters (Brown 1957)**

1. Mean weight gain (MWG) = $(W_2 - W_1)$g
   Where:-
   $W_1$ = Initial mean weight (g)
   $W_2$ = Final mean weight (g)
2. **Daily growth rate (DGR) =** $\frac{\text{Increase in weight per day}}{\text{Body weight of fish}}$
3. **Nitrogen metabolism (Nm) =** $\frac{(0.549)(b-a)h}{2}$ where: a = initial wt of fish
   b = final wt of fish
   h = exp. period in days
   0.549 = exp. constraint.
4. **Percentage weight gain (PWG)%** = $\frac{\text{Mean weight gain}}{\text{Mean fish weight}} \times \frac{100}{1}$
5. **Specific growth rate (SGR) %**. This was calculated according to Brown (1957). Therefore;
   SGR % = $\frac{\log W_2 - \log W_1}{T_2 - T_1} \times \frac{100}{1}$

$W_1$ = Initial weight (g)
$W_2$ = Final weight (g)
$T_1$ = Beginning of experiment
$T_2$ = End of experiment
$Log_e$ = Natural logarithm

**RESULT**

TABLE 1: Proximate analysis of protein enriched wheat bran and ordinary wheat bran

| Sample | Moisture Content % | Ash % | Fat % | Protein % | Crude Fiber % | Carbohydrate % |
|---|---|---|---|---|---|---|
| Protein Enriched Wheat Bran (A2) | 5.79 | 20.76 | 0.03 | 27.98 | 9.90 | 39.54 |
| Ordinary Wheat Bran (B2) | 10.69 | 7.11 | 2.69 | 20.83 | 12.23 | 46.45 |

TABLE 2: Weekly increase in weight of *C. gariepinus* (g) during the experimental period.

| Weeks/ Diets | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $D_1$ | 3.30 | 3.35 | 3.84 | 4.50 | 4.81 | 5.25 | 5.43 | 6.10 | 4.57 |
| $D_2$ | 3.36 | 3.55 | 3.70 | 3.90 | 4.07 | 4.31 | 4.51 | 5.00 | 4.05 |
| $D_3$ | 3.00 | 3.20 | 3.40 | 3.70 | 3.98 | 4.05 | 4.18 | 4.51 | 3.75 |
| $D_4$ | 3.10 | 3.30 | 3.50 | 3.70 | 4.03 | 4.16 | 4.28 | 4.60 | 3.83 |
| $D_5$ | 3.34 | 3.45 | 3.98 | 4.61 | 5.15 | 5.23 | 5.43 | 6.25 | 3.90 |

TABLE 3: Weekly increase in length of *c. gariepinus* (cm) during the experimental period

| Weeks/ Diets | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Mean |
|---|---|---|---|---|---|---|---|---|---|
| $D_1$ | 70 | 76 | 80 | 80 | 90 | 90.5 | 100 | 109 | 86.94 |
| $D_2$ | 60 | 65 | 71 | 74 | 80 | 95 | 99 | 100 | 80.50 |
| $D_3$ | 69 | 73 | 79 | 82 | 85 | 91 | 94 | 95.5 | 83.56 |
| $D_4$ | 80 | 89 | 92 | 92 | 98 | 111 | 105 | 109 | 97.00 |
| $D_5$ | 90 | 94 | 96 | 99 | 100 | 112 | 117 | 120 | 103.50 |

TABLE 4: Proximate analysis of experimental feeds/diets

| Sample Identity | Moisture % | Ash % | Fat % | Crude Fibre % | Protein % | NFE |
|---|---|---|---|---|---|---|
| $D_1$ | 3.12 | 11.90 | 4.81 | 4.88 | 21.46 | 53.83 |
| $D_2$ | 3.59 | 14.43 | 5.65 | 6.00 | 17.61 | 52.72 |
| $D_3$ | 2.19 | 17.09 | 6.98 | 7.00 | 21.58 | 45.20 |
| $D_4$ | 2.45 | 6.71 | 8.61 | 3.57 | 16.39 | 62.26 |
| $D_5$ | 5.72 | 15.61 | 6.20 | 7.87 | 14.26 | 50.34 |

TABLE 5: Proximate analysis of faecal collection

| Sample Identity | Moisture % | Ash % | Fat % | Crude Fibre % | Protein % | NFE |
|---|---|---|---|---|---|---|
| $D_1$ | 2.69 | 32.91 | 1.35 | 14.76 | 9.85 | 38.44 |
| $D_2$ | 2.47 | 29.02 | 1.60 | 12.48 | 18.00 | 42.66 |
| $D_3$ | 3.12 | 26.09 | 0.51 | 11.67 | 14.19 | 44.42 |
| $D_4$ | 3.70 | 24.72 | 0.73 | 11.36 | 10.48 | 50.01 |
| $D_5$ | 2.01 | 23.54 | 0.75 | 10.58 | 12.56 | 41.56 |

TABLE 6: Analysis of fish carcass before and at the end of experiment

| Sample Identity | Moisture % | Ash % | Fat % | Crude Fibre % | Protein % | NFE |
|---|---|---|---|---|---|---|
| $D_0$ | 8.42 | 19.73 | 10.95 | 1.89 | 39.26 | 19.75 |
| $D_1$ | 1.51 | 25.12 | 9.55 | 2.26 | 45.51 | 16.05 |
| $D_2$ | 1.09 | 22.31 | 8.82 | 2.53 | 40.23 | 25.01 |
| $D_3$ | 3.40 | 29.60 | 9.59 | 3.75 | 43.66 | 10.00 |
| $D_4$ | 2.06 | 26.94 | 8.96 | 2.97 | 37.44 | 21.63 |
| $D_5$ | 2.48 | 24.00 | 9.51 | 2.47 | 50.91 | 10.63 |

$D_0$ – before experiment
$D_1$ – $D_5$ – at the end of experiment

Table 7: Growth and Nutrient utilization parameters

| PARAMETERS ANALYSED | EXPERIMENTAL DIETS | | | | |
|---|---|---|---|---|---|
| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | $D_5$ |
| Mean Weight Gain (MWG) g | 1.27 | 0.69 | 0.75 | 0.73 | 0.56 |
| Mean Daily Growth Rate (MDGR) g/day | 0.07 | 0.06 | 0.12 | 0.06 | 0.09 |
| Percentage Weight Gain (PWG) % | 27.79 | 17.04 | 20.00 | 19.06 | 14.36 |
| Specific Growth Rate (SGR) % | 3.70 | 2.40 | 2.40 | 2.40 | 4.00 |
| Nitrogen Metabolism (Nm) | 43.04 | 25.21 | 23.21 | 23.06 | 44.73 |

## DISCUSSION

The proximate analysis of the wheat bran grown brewers yeast gave an increase in crude protein value (27.98%) compared with the ordinary wheat bran (20.83%). This value is however lower than that obtained by Akram et al (1992) when wheat bran was as substrate in the culture of Aspergillus terreus (32.88%).

The analysis of the experimental feeds indicated that diet $D_3$ (30%) fishmeal substitution with brewers yeast had the highest crude protein value (21.58%) followed by diet $D_1$ (control). (21.46%) and then $D_2$ (17.61%). Also $D_3$ had the highest ash content (17.09%) followed by $D_5$ (15.61%). $D_1$ had the lowest fat content (4.81%) while $D_4$ had the highest (8.62%). $D_5$ had the highest crude fibre content (7.87%) while the lowest was $D_2$ (5.10%). The percentage crude fibre followed the order $D_5$ (7.87) > $D_3$ (6.96) > $D_2$ (5.10) > $D_1$ (4.88) > $D_4$ (3.57).

There was no consistency in the crude protein present in the faeces with the levels of substitute of fishmeal with yeast protein. However, the least protein level obtained from faeces of $D_1$ (fishmeal) is an indication that fishmeal protein was to a larger extent utilized by the fish and metabolized into fish flesh or used to generate energy and had little left to be sent out of the body as faeces. This was also buttressed by the high values obtained in Nm (Table 7). The ash and crude fibre content of the faeces decreased with increasing level of substitution of fish meal with brewery yeast.

The ash content in the faeces followed the order; $D_1$ (32.91) > $D_2$ (27.99) $D_3$ (26.09) > $D_4$ (24.72) > $D_5$ (23.54). The crude fibre content of the faecal material also followed the order $D_1$ (14.76) > $D_2$ (12.48) > $D_3$ (11.67) > $D_4$ (11.36) > $D_5$ (10.58).

Examination of the fish carcass analysis before and after the experiment (Tables 4 and 7) indicated that the moisture and fat content before the experiment was higher than all the treatments at the end of the experiment.

The ash and crude fibre contents of the fish carcass were higher for all the treatments than before the start of the experiment. With the exception of $D_4$ (34.44) the crude protein content of the fish carcass at the end of the experiment were higher than that before the experiment (39.26). $D_5$ (60% substitution) had the highest carcass protein (50.91) followed by $D_1$ (fish meal only) - 45.51 (Table 6). It could be deduced from this that 60% replacement of fishmeal with brewers yeast could produce Clarias gariepinus with good protein yield in the carcass which suggest that this level of substitution did not result in lower quality protein.

The growth and nutrient utilization parameter Table 7 indicated that Mean Weight Gain (MWG) is highest for $D_1$ (1.27) and lowest for $D_5$ (0.56) and the trend is $D_1 > D_3 > D_4 > D_2 > D_5$. These values are lower than those recorded by Bob-Manuel 2013a) using commercial cat fish feeds for *C. gariepinus* finger lings which ranged between 24.43 – 57.63g.

The MWG values are also lower than those observed for *O. niloticus* fed increased levels of yeast scp which ranged between 0.22 and 2.64 (Bob-Manuel 2013b).

The values of the Mean Daily Growth Rate (MDGR) range between 0.06 to 0.12. These values ash comparable to those observed by Bob-Manuel (2013b) but higher than those recorded by Bob-Manuel and Alfred. Ockiya (2011). The highest PWG recorded was 27.79 while the lowest was 14.36. Those values exceed those of Bob-Manuel and Alfred-Ockiya (2011) but lower than those of Bob-Manuel (2013b) Nwanna (2003) Sotolu and Faturoti (2008). The Specific Growth Rate (SGR) range between 2.40 to 4.00. These valued are closely related to those observed by Bob-Manuel (2013b) but higher than those of Bob-Manuel and Alfred-Ockiya (2011), Nwanna (2003) and Ogunji *et al* (2008). In this work the highest Nm was observed for $D_5$ (44.77) followed very closely by $D_1$ (43.04). The Nm follow the trend $D_5 > D_1 > D_2 > D_3 > D_4$. These Nm values are closely correlated with those of Bob-Manuel (2013b) as well as Sotolu and Faturoti (2008) but higher than those of Bob-Manuel *et al* (2011).

The results obtained from the carcass analysis as well as some of the growth parameters are indicators to the fact that at the 60% level of substitution wheat bran grown brewers yeast could be used as fishmeal replacer without adverse effect on the growth and carcass composition of *Clarias gariepinus* fingerlings. Further investigation is required.

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