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ORIGINAL ARTICLE

EFFECT OF SACCHAROMYCES CEREVISIAE ON THE SURVIVAL RATE AND GROWTH PERFORMANCE OF CLARIAS GARIEPINUS (BURCHELL, 1822)

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Abstract

This study evaluated the efficacy of including Saccharomyces cerevisiae, Brewer's yeast in the diet of Clarias gariepinus. Two hundred and twenty-five C. gariepinus sourced from Fisheries and Aquaculture Research Farm, Federal University Wukari, were used for the study. The fish were conditioned for 14 days, distributed into the experimental tanks consisting of 45 fish per treatment in three replicates in a completely randomised design model and were fed for 84 days. Five experimental diets were formulated with brewer's yeast replacing fishmeal at 0% 25%, 50%, 75%, and 100% inclusion levels. The fish were fed 5% of their body weight twice daily. Growth parameters such as mean weight gain, specific growth rate, and survival rate were evaluated. The water quality parameters were monitored and recorded throughout the period of experiment. The results showed significant (p<0.05) differences on the feed intake (911.67g/day – 1120.33g/day), weight gain (401.7g – 459.0g), and specific growth rate (0.80g/day - 0.88g/day) of C. gariepinus. This apparently suggested that S. cerevisiae is a potential economical and nutritious feed ingredient for fish. Based on this finding, it was concluded that Saccharomyces cerevisiae can be included in fish diet up to 75% without impacting negatively on the growth performance of Clarias gariepinus.

Keywords: African catfish, Brewer's yeast, Performance characteristics, Production cost, Survival rate.

Introduction

As the world's population grows, there is a greater need for high-quality, high-quantity protein, which must be produced (Ayimbila and Keawsompong, 2023). Fish species can be obtained by either aquaculture; intentional rearing of fish, or by capturing of fish in the wild i.e. from sea, ocean and many more. In Nigeria, the use of aquaculture as a source of fish food has become more popular lately, especially as the catch from the wild is decreasing as a result of many causes, including fishing pressure and climate change (Ogunji and Wuertz, 2023).

According to Awe (2017), African catfish (Clarias gariepinus), is the most widely farmed fish in Nigeria. Its biological characteristics include disease resistance, the potential for high stocking densities, and a quicker rate of growth. In aquaculture, nutrition plays a pivotal role, accounting for 60 to 80% of total production costs (Ragasa et al., 2022). Recent advancements in fish nutrition have led to the creation of balanced commercial diets that enhance fish growth and health (Rombenso et al., 2022). The formulation of species-specific diets has significantly supported the expansion of the aquaculture industry, enabling it to meet the rising demand for affordable, safe, and high-quality fish and seafood products (Joshi et al., 2021). As previously noted by Miles and Chapman (2016), aquaculture is one area where Nigeria's fisheries potential may be utilized; however, the growth and development of this industry would mostly depend on a number of factors. Among these are, availability of reasonably priced and high-quality feed materials for compound feed formulation, since supplement feed increases fish yields in ponds more than feeding them only natural (aquatic) food. Over the years, fishmeal was the preferred protein source in fish feed but the cost and other environmental concerns have necessitated the need for alternative protein sources (Aragão et al., 2022) particularly in developing countries. In an attempt to lower feeding costs, the high cost of animal protein for fish feed has sparked research in a number of possible sources of protein for both human consumption and animal feed. Brewer’s yeast is used as a flavour in the food industry, and as feedstuff for pigs, ruminants, poultry and fish (Mwaipopo et al., 2023). Brewer's yeast contains between 40 to 56% crude protein, making it a source of protein. It also has nucleic acids, vitamins, minerals, and the B-complex vitamins in abundance (Mwaipopo et al., 2023). Brewer’s yeast contains various immuno-stimulating compounds such as β-glucans and mannan oligosaccharides (White et al., 2012).

The natural occurrence of numerous yeast species in the gastrointestinal tract of healthy fish has been well described, and yeast have been reported to be an important part of the microbiota of the fish gut (Navarrete and Tovar-Ramıŕ ez, 2014). Recent studies have shown the beneficial effect of administered dietary Saccharomyces cerevisiae in fish (El-Naby et al., 2024; El-Bab et al., 2022 and Xu et al., 2021). Yeast supplemented diets stimulated growth performance, blood biochemistry, survival rate, and non- specific immune responses in Uronema marinuminfected olive flounder, Paralichthys olivaceus (Harikrishnan, et al., 2011). Similarly, dietary administration of probiotic S. cerevisiae P13 at a minimum level of 105 CFU/kg enhanced growth, innate immune responses and disease resistance of grouper, Epinephelus coioides (Chiu et al., 2010). Hence, Brewer’s yeast, which is readily available and cheaper is a potential substitute for highly expensive protein source ingredient in fish feed. Therefore, this study assessed the efficacy of Brewer’s yeast on growth performance and survival rate of Clarias gariepinus.

Materials and Methods

The experiment was conducted at the Department of Fisheries and Aquaculture Research Farm, Federal University Wukari, Nigeria. Wukari Local Government Area lies along Latitude 7° 52' 47.86"N and Longitude 9° 46' 37.66"E covering an area of 4,308 km^2 with an elevation of 189m above sea level (Magomya and Ataitiya, 2023).

The Brewer’s yeast (Saccharomyces cerevisiae) used for the experiment was obtained from reputable source in Wukari.

Experimental Diet

Five experimental diets were formulated to contain different level of S. cerevisiae as replacement for fishmeal at 0% (control), 25%, 50%, 75% and 100% as Diets 1, 2, 3, 4 and 5 respectively. Other feed ingredients in the experimental diets were fixed as presented in table 1. The formulated feed was pelletized by forcefully passing the feed through a locally made die disc of 2mm sizes and sun dried for 5 – 6 hours.

Table 1: Composition of Experimental Diets

Ingredient (kg)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Fishmeal	0.231	0.173	0.115	0.058	-
Brewer’s yeast	-	0.058	0.116	0.173	0.231
Soybean meal	0.231	0.231	0.231	0.231	0.231
GNC	0.231	0.231	0.231	0.231	0.231
Maize	0.276	0.276	0.276	0.276	0.276
Methionine	0.005	0.005	0.005	0.005	0.005
Lysine	0.005	0.005	0.005	0.005	0.005
Bone meal	0.005	0.005	0.005	0.005	0.005
Premix	0.010	0.010	0.010	0.010	0.010
Salt	0.0025	0.0025	0.0025	0.0025	0.0025

Oil	0.0025	0.0025	0.0025	0.0025	0.0025
Total (kg)	1.00	1.00	1.00	1.00	1.00

Diet 1: 0% Brewer's yeast (control); Diet 2: 25% Brewer's yeast; Diet 3: 50% Brewer's yeast; Diet 4: 75% Brewer's yeast and Diet 5: 100% Brewer's yeast; GNC: Groundnut cake

Experimental Fish

Two hundred and twenty-five C. gariepinus with an average weight of 80±15g were harvested from the culture tanks of the Department of Fisheries and Aquaculture Research Farm, Federal University Wukari and conditioned for 14 days and fed commercial diets during this period.

Experimental Design

The experimental fish were distributed randomly to five experimental tanks such that each treatment had 45 fish with three replicates of 15 fish in a completely randomized design.

Experimental Procedure

Chemical analysis of the diet sample was carried out following the AOAC (2000) approved standard procedures.

The fish were fed experimental diets at 3% body weight twice a day for 84 days. Water quality parameters such as ammonia, disso1ved oxygen, nitrite, pH, and temperature were monitored and recorded weekly. Mortality in each tank of the different treatments were recorded and removed with a scoop net daily and fish were selected randomly from each replicate and weighed weekly using a table scale and meter board for the length. Growth parameters and nutrient utilization such as weight gain (WG), relative weight gain (RWG), specific growth rate (SGR), feed conversion ratio (FCR), protein intake (PI), protein efficiency ratio (PER) as well as Survival rates were monitored and calculated using the following formula by Sveier et al. (2000).

Weight gain (g) $= W_2 - W_1$

SGR $= \frac{\ln W_2 - \ln W_1}{T_2 - T_1} \times 100$

FCR $= \frac{\text{Quantity of feed fed (g)}}{\text{Weight gain (g)}}$

Survival Rate (%) $\frac{\text{Number of fish that survived}}{\text{Total number of fish stocked}} = \text{X } 100$

Where;

W_1 = initial weight of fish,

W_2 = final weight of fish and

P_1 = initial protein content in fish

P_2 = Final protein content in fish T

= duration of experiment (day).

Statistical Analysis

Data obtained were analyzed using analysis of variance of SPSS statistical package 23.0. Duncan Multiple Range Test of the same statistical package was used to separate the mean differences.

Results

Nutritional Composition of Saccharomyces cerevisiae

The nutritional composition of brewer's yeast (S. cerevisiae) is shown in table 2. The result showed 93% dry matter, 44.7% crude protein, 2.7% crude fiber, 1.0% crude fat and mineral contents of 0.12% and 1.4% for calcium and phosphorus respectively. This implies that brewer's yeast has the potential of replacing major protein source ingredients and can be included in fish diet as substitute for fishmeal, which is one of the major protein sources in fish feed.

Table 2: Nutritional composition of brewer's yeast (Saccharomyces cerevisiae)

Parameters	Percentage (%)
Dry matter	**93.0**
Moisture	**7.0**
Crude protein	**44.4**
Crude fat	**1.0**
Crude fibre	**2.7**
Calcium	**0.12**
Phosphorus	**1.4**
NFE	**34.0**

Proximate Composition of the Experimental Diets

The nutrient composition of the experimental diets is presented in table 3. There was significant ($p<0.05$) differences in nutrient composition of the experimental diets. Diet 1 had significantly, ($p<0.05$) the highest moisture content (11.38%), followed closely by diet 2 (11.02%), diet 3 (10.99%), diet 4 (10.66%) and diet 5 (10.42%) which had the lowest moisture content. Meanwhile, crude protein significantly ($p<0.05$) increased from diet 1 to diet 5 (34.50%, 35.30%, 36.23%, 37.07% and 37.83%). The crude fiber (5.59%, 4.89%, 4.17%, 3.44% and 2.75%) and crude fat (7.16%, 6.20%, 5.29%, 4.40% and 3.48%) significantly ($p<0.05$) decreased with increase in brewer's yeast inclusion. The ash content and nitrogen free extract (NFE) were significantly ($p<0.05$) highest in diets containing brewer's yeast. This implies that the feeding value increases follow the level of inclusion.

Table 3: Proximate Composition of Experimental Diets on Dry-Matter Basis

Parameters (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Moisture	11.38 ± 0.04^{a}	11.02 ± 0.05^{b}	10.90 ± 0.03^{b}	10.66 ± 0.12^{c}	10.42 ± 0.01^{d}
Crude protein	34.50 ± 0.06^{d}	35.30 ± 0.34^{c}	36.23 ± 0.10^{b}	37.07 ± 0.06^{ab}	37.83 ± 0.14^{a}
Crude fat	7.16 ± 0.01^{a}	6.20 ± 0.10^{b}	5.29 ± 0.03^{c}	4.40 ± 0.06^{d}	3.48 ± 0.03^{e}
Crude fiber	5.59 ± 0.04^{a}	4.89 ± 0.03^{b}	4.17 ± 0.11^{c}	3.44 ± 0.01^{d}	2.75 ± 0.11^{e}
Ash	9.18 ± 0.01^{c}	9.36 ± 0.07^{b}	9.51 ± 0.05^{b}	9.74 ± 0.07^{a}	9.89 ± 0.03^{a}
NFE	43.58 ± 0.09^{d}	44.26 ± 0.32^{c}	44.80 ± 0.25^{bc}	45.36 ± 0.09^{b}	45.36 ± 0.09^{a}

Means in the same row with different superscripts differs significantly (□< 0.05).

Growth Performance Characteristics of C. Gariepinus Fed Diets With S. Cerevisiae

Table 4 shows the performance characteristics response of experimental fish. There was significant ($p<0.05$) differences among means of performance characteristics across the treatment diets. Feed intake of the fish fed diet 5 (1120.0g) was significantly ($p<0.05$) highest and different from diet 1 (911.67g), 2 (895.33g), 4 (986.0g) and diet 3 (830.0g) which was significantly ($p<0.05$) lowest. The weight gain of the fish was significantly ($p<0.05$) highest in diet 4 (459g) followed by diet 2 (422.7g), diet 1 (420.6g), diet 3 (411g) and diet 5 (401.7g). The feed conversion ratio (FCR) was significantly ($p<0.05$) highest in diet 5 (2.80) while the lowest FCR was observed in diet 3 (2.02). Conversely, the specific growth rate of the fish was significantly ($p<0.05$) highest in diet 4 (0.88g/day) and different from diet 3 (0.80g/day), and diet 5 (0.81g/day).The gain in length was highest in diet 4 (9.70mm) but not significantly (p>0.05) different from diet 1 (8.16mm) and diet 3 (8.44mm). The survival rate was highest in fish fed diet 5 (76.00%) but not significantly (p>0.05) different from diet 4 (71.63%).

Table 4: Growth Performance Characteristics of Fish Fed Diets with S. Cerevisiae

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Feed intake (g/day)	911.67 ± 0.88^{c}	895.33 ± 2.73^{d}	830.0 ± 2.89^{e}	986.0 ± 0.58^{b}	1120.33 ± 3.18^{a}
Initial weight (g)	103.7±0.15	107.3±0.51	110.0±0.40	101.6±0.42	105.3±0.25
Final weight (g)	524.3 ± 0.21^{b}	530.0 ± 0.10^{ab}	521.0 ± 0.09^{bc}	560.0 ± 0.11^{a}	507.0 ± 0.15^{bc}
Weight gain (g)	420.6 ± 0.11^{b}	422.7 ± 0.20^{ab}	411 ± 0.10^{b}	459 ± 0.10^{a}	401.7 ± 0.10^{c}
FCR	2.18 ± 0.02^{b}	2.12 ± 0.008^{b}	2.02 ± 0.008^{c}	2.11 ± 0.04^{bc}	2.80 ± 0.00^{a}
Specific growth rate (g/day)	0.84 ± 0.02^{ab}	0.83 ± 0.05^{ab}	0.80 ± 0.10^{b}	0.88 ± 0.12^{a}	0.81 ± 0.05^{b}
Initial length (mm)	14.01 ± 0.10^{a}	14.03 ± 0.06^{a}	12.03 ± 0.31^{b}	13.83 ± 0.61^{ab}	14.00 ± 0.39^{a}
Final length (mm)	22.17 ± 0.20^{b}	21.33 ± 0.08^{a}	20.47 ± 0.16^{b}	23.53 ± 0.33^{b}	21.57 ± 0.16^{b}
Length gain (mm)	8.16 ± 0.17^{ab}	7.30 ± 0.11^{b}	8.44 ± 0.18^{ab}	9.70 ± 0.22^{a}	7.57 ± 0.19^{b}
Survival rate (%)	69.4 ± 5.77^{b}	69.43 ± 5.77^{b}	64.97 ± 5.77^{c}	71.63 ± 5.77^{ab}	76.00 ± 5.77^{a}

Means in the same row with different superscripts differs significantly (□< 0.05).

Discussion

Since protein is the one nutrient needed in the greatest quantity for growth and development and is also the most expensive element in diet composition, it is given top attention in all animal nutritional studies. The crude proteins from the five diets were within the requirements (40 50%) recommended for C. gariepinus in tropics (FAO, 2023) which was in line with previous study of Oso et al., (2011). The research also supported the conclusions of Audu et al. (2004) who investigated the impact of substituting fishmeal diets with varying quantities of ensiled parboiled beni seed (Seasamum indicum) and brewer's yeast (Saccharomyces cerevisiae) on growth responses and food utilization of the Nile Tilapia.

Fibre has been documented to support and promote digestion in the feed at minimal level (Oso et al., 2011). The results obtained in this study was in agreement with Fasakin et al. (2000), who reported that relatively low fibres and high protein contents in the fish diets produced better utilization as evidenced by fish growth and feed conversion ratio in this study.

In this current study, it was found that low moisture content of the experimental diets including control was below 20% and this corresponds with the theoretical range of moisture content in all low moisture food. All the diets, however, were seemingly suitable to be utilized as feedstuff in fish production. It is well recognized that the most significant indices for assessing how fish react to experimental diets and that weight gain and length increase are highly trustworthy markers of growth (Huang et al., 2023). The weight gain recorded in all the treatments indicated that the fish responded positively to all the diets and that the protein content of brewer's yeast enhanced the growth of fish. This observation was in line with the report of Fagbenro et al. (2006) as well as Osoi et al., (2011). Compared to the other experimentally prepared diets, the fish given diet 4 (75% brewer's yeast) exhibited a higher specific growth rate, which bestowed upon it superior growth and feed utilization efficiency.

Conclusion

Overall, the study indicates that brewer's yeast could serve as a viable alternative to fishmeal in fish feeding, providing a high-protein and cost-effective feedstuff. Conclusively, adding brewer's yeast in fish feed may enhance feed utilization promote growth and survival of Clarias gariepinus

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