



INFLUENCE OF YEAST-BASED COMMERCIAL PROBIOTIC ON GROWTH PERFORMANCE, NUTRIENT UTILIZATION AND BODY COMPOSITION OF THE AFRICAN CATFISH (*Clarias gariepinus*) FINGERLINGS

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ABSTRACT

The study was carried out for three (3) months to determine the influence of a commercial probiotic which is a mono- strain probiotic consisting of live *Saccharomyces cerevisiae* at 4.125×10^6 cfu per 100ml, on growth, nutrient utilization and body composition of *Clarias gariepinus* fingerlings. At a stocking density of ten (10) fish per tank, fish fingerlings (7.6–7.9g) were randomly dispersed into five treatment groups with three repetition per group, consisting of fifteen plastic tanks (80L). The probiotic was administered in the culture water of the treatment groups; 0mls (control, T0), 0.5ml (T1), 1.0 (T2), 1.5 (T3), 2.0 (T4) ml probiotic/tank (80L capacity). Water quality parameters were regularly monitored. The growth performance, nutrients utilization and body composition of *C. gariepinus* fingerlings among probiotic treatments groups were significantly increased ($P < 0.05$) with increasing dosage of the probiotic. The best Mean Weight (121.3g), Mean Weight Gain (113.5g), Percentage Mean Weight Gain (1456.5%), Feed Conversion Ratio (0.92g) and Protein Efficiency Ratio (2.6), was recorded in probiotic treatment group T4 (2.0ml). Similarly, the highest increase in carcass crude protein (69.9g/Kg), moisture (10.34), ash (15.26g/Kg) and dry matter (29.46g/Kg) was recorded in treatment group T4 (2.0ml). Probiotic (Antox[®]) is recommended for administration in *C. gariepinus* fingerlings culture water at 2.0mls per 80L.

Key words: Probiotic, *Clarias gariepinus*, growth performance, carcass composition

INTRODUCTION

The African catfish, *Clarias gariepinus* is of great economic importance to aquaculture in Nigeria because of their high market price, fast growth rate, ability to withstand adverse conditions especially low dissolved oxygen content, ability to practice aquatic and aerial respiration and resistance to parasites and diseases. African catfish production accounts for 85% total aquaculture production in Nigeria (Bolorunduro, 2016). One of the major challenges to increase fish production in the developing world, including Nigeria, is the improvement of production efficiency, which is hampered by high cost of imported feeds (FAO, 2020). African catfish feed constitutes over 60% of cost of production because it is mainly imported (AU-IBAR, 2013). The local feeds has low digestibility, poor feed conversion efficiency with majority of them sinking to the bottom and are equally expensive (AU-IBAR, 2013). To address the challenge of low feed conversion efficiency and growth through better food digestibility and nutrient uptake, probiotics could be employed.

A probiotic is “any microbial cell provided via the diet or rearing water that benefits the host fish, fish farmer or fish consumer, which is achieved, in part at least, by improving the microbial balance of the fish” (Llewellyn *et al.*, 2014). Similarly, Verschuere *et al.* (2000) defined aquatic probiotics as “Live microorganisms that have a beneficial effect on the host by modifying the

microbial community, associated with the host, by ensuring improved use of the feed or enhancing its nutritional value, by enhancing the host response towards disease, or by improving the quality of its ambient environment”. The probiotics contain multiple strains of bacteria like *Bacillus acidophilus*, *B. subtilis*, *B. licheniformis*, *Nitrobacter* sp., *Aerobacter* sp. and *Saccharomyces cerevisiae* (Ramasamy and Venkatasamy. 2015; Prokash *et al.*, 2019).

Even when yeast (*Saccharomyces cerevisiae*) makes up less than 1% of the total microbial isolates in the host, it can make a significant physiological contribution beyond that of probiotic bacteria; in fact, yeast cell sizes can be a hundred folds bigger than those of bacteria (Gatesoupe. 2007). Yeast is non-pathogenic, lacks plasmid-encoded antibiotic resistance genes, and is bile and acidic pH resistant (Abu-Elala *et al.*, 2013). Overall, yeast has been injected directly to water, utilized as a supplement in micro particulate diets, and fed live food (rotifers or *Artemia*) as a possible vehicle to transfer yeast into the guts of fish larvae (Tovar-Ramirez. *et al.*, 2010). There is paucity of information on the use of live yeast (*Saccharomyces cerevisiae*) as water additive in tank rearing of the African catfish fingerlings. This study was therefore designed to evaluate the efficacy of adding different concentration of commercial probiotic consisting of live *Saccharomyces cerevisiae*, to culture tanks on growth,

nutrients utilization and body composition of *Clarias gariepinus* fingerlings.

MATERIALS AND METHODS

Formulation of experimental diets

The ingredient/proximate composition of the experimental diet is presented in Table 1. The basal feed comprising standard amounts of fish meal, yellow maize, soybean meal, vegetable oil, salt, vitamin premix and starch, was formulated according to Pearson square method with pre-determined values of 42% protein content. All the feed ingredients were integrated into computing the required quantities to make up 100 units of the feed. All dietary ingredients were milled to a 3 mm particle size. The ingredients were thoroughly mixed, then hot water was added until stiff dough was formed. The dough was placed into a grinder for thorough mixing and extruded in a pelletizing machine through 2.0 mm diameter strand in a commercial feed mill. The pellets were dried at ambient temperature (27-30°C) and stored in airtight jars at room temperature.

Proximate composition of experimental diets were determined according to AOAC method (1990): dry matter (DM) after drying in an oven at 105°C until constant weight; crude protein by Kjeldahl digestion and distillation after acid digestion; crude lipid by petroleum ether extraction in a Soxhlet apparatus; ash by incineration in a muffle furnace at 550°C for 8 to 12 hrs (Table 1).

One hundred and fifty (150) fingerlings of *Clarias gariepinus* were obtained from the hatchery unit, Department of Biology, Ahmadu Bello University Zaria, Kaduna State Nigeria. They were acclimated for two weeks in a concrete tank during which they were fed 3% of their body weight with coppers pelleted fish feed (42% crude protein) twice daily, morning (8:00am) and evening (5:00pm). Furthermore, fish were also fed 3% of their body weight twice daily, morning (8:00am) and evening (5:00pm) with the experimental diet throughout the research period. The probiotic was administered daily in the culture water of the treatment groups; 0mL (control, T0), 0.5mL (T1), 1.0 mL (T2), 1.5 mL (T3), 2.0 mL (T4), using Unitract® 1 mL Tuberculin (TB) syringes (Clinicare, Mumbai, India).

The physico-chemical parameters (water pH, temperature, electrical conductivity and dissolved oxygen) were determined using LaMotte fresh water aquaculture test kit (Model: AQ-2, Code 363303).

Determination of Growth performance and nutrient utilization

Growth parameters were calculated according to Panasea *et al.*, (2018): as shown below;

Mean body weight Gain: Weight gain was determined between the final weight and initial weight of experimental fish.

$$\text{Weight gain(g)} = \text{Final weight} - \text{Initial weight}$$

Specific Growth Rate:

It is the percentage rate of change in the logarithmic body weight and was computed.

$$\text{SGR\%} = \frac{\text{Log } W_2 - \text{Log } W_1}{T_2 - T_1} \times 100$$

Where; W2 = final weight of fish, W1 = initial weight of fish, T1 = begin of experiment (day) and T2= end of experiment (day).

Mean Percentage Weight Gain:

The percentage (%) weight gain was determined as follows;

$$\text{MPWG (\%)} = \frac{\text{Mean weight gain}}{\text{Mean initial weight}} \times 100$$

Feed Conversion Ratio:

This was calculated using the formula

$$\text{FCR} = \frac{\text{Feed fed}}{\text{Fish weight gain}}$$

Protein Efficiency Ratio:

It is calculated from the relationship between the increments in the weight of fish

(I.e. weight gain of fish) and protein consumed.

$$\text{PER (g)} = \frac{\text{Mean weight gain (g)}}{\text{Protein intake}}$$

Where Protein Intake:

$$\text{Where protein intake (g)} = \frac{\text{Protein (\%)} \text{ in feed} \times \text{Total Weight (g) diet consumed}}{100}$$

Mortality

$$\text{Mortality (\%)} = \frac{N_t - N_0}{N_0} \times 100$$

Where N_t and N₀ are the initial and final numbers of fish respectively

Carcass analysis of experimental fish

Five fingerlings were chosen at random for proximate analysis prior to the experiment. Two fish per tank (in triplicate) were slaughtered for proximate analysis after the 92-day trial according to AOAC (1990).

Determination of Physico-Chemical Parameters

The water pH, temperature, electrical conductivity and dissolved oxygen were monthly determined using LaMotte fresh water aquaculture test kit (Model: AQ-2, Code 363303).

All data collected were subjected to One way analysis of variance (ANOVA) to test for significant differences among treatments using IBM SPSS version 23, followed by Turkey's' Post-Hoc test which was used to separate significantly different means. The level of significance set for treatments was $P \leq 0.05$.

Data Analysis

Table 1 Ingredients/proximate composition of formulated diets (% Dry weight)

Ingredients	Control	T1	T2	T3	T4
Fish meal (75%)	35	35	35	35	35
Soybean meal (44%)	17	17	17	17	17
Yellow Maize	43	43	43	43	43
Cassava	2	2	2	2	2
Vitamin premix (a)	1.5	1.5	1.5	1.5	1.5
Mineral premix (b)	1.5	1.5	1.5	1.5	1.5
Total	100	100	100	100	100
Proximate composition of experimental diet					
Parameters					
Crude protein (%)	40.53	40.53	40.53	40.53	40.53
Crude fiber(g)	1.19	1.19	1.19	1.19	1.19
Oil	4.69	4.69	4.69	4.69	4.69
Ash (g)	8.04	8.04	8.04	8.04	8.04
Nitrogen free extract (%)	45.10	45.10	45.10	45.10	45.10

Vitamin Premix:

- Provided the following vitamins: Vitamin A 8,500,000.00IU; Vitamin D3 1,500,000.00 IU; Vitamin E 10,000.00IU; Vitamin K3 1500.00mg, Vitamin B1 1600.00mg; Vitamin B2 4000.00mg; Niacin 20,000.00mg; Pantothenic acid 5,000.00mg, Vitamin B6 1,500.00mg; Vitamin B12 10.00mg; Folic acid 500.00mg; BiotinH2 750.00mg; Choline Chloride 175,000.00mg; Cobalt 200.00mg; Copper 3,000.00mg; Iodine 1000.00mg; Iron 20,000.00mg; Manganese 40,000.00mg; Selenium 200.00mg; Zinc 30,000.00mg; Antioxidant 1,250.00mg
- Provided the following minerals (mg kg-1 diet): zinc (as ZnSO4·7H2O), 150; iron (as FeSO4·7H2O), 40; manganese (as MnSO4·H2O), 25; copper (as CuCl2), 3; iodine (as KI), 5; cobalt (as CoCl2·6H2O), 0.05; selenium (as Na2SeO3), 0.0

RESULTS

Within the probiotic treatment groups as presented in Table 2, growth performance and nutrients utilization increased with increase concentration of the probiotic administration. The highest final mean weight (121.3g), mean weight gain (113.5g) and percentage mean weight gain (1456.5%) were recorded in T4 (2.0ml/80L). Similarly, the best mean protein intake (640.9g), feed conversion ratio (0.92) and protein efficiency ratio (2.6), were recorded in T4.

Table 2 Influence of yeast based probiotic administration in culture water, on growth performance and nutrients utilization

Parameters	(T0) Control	T1	T2	T3	T4
IMW(g)	7.6±0.09 ^a	7.9±0.26 ^a	7.6±0.07 ^a	7.5±0.20 ^a	7.8±0.17 ^a
FMW(g)	90.5±2.62 ^c	100.0±1.42 ^b	103.8±0.47 ^b	115.5±2.54 ^a	121.3±1.62 ^a
MWG(g)	83.3±2.45 ^c	92.1±1.38 ^b	96.2±0.53 ^b	107.9±2.39 ^a	113.5±1.6 ^a
PMWG (%)	1102±45.5 ^d	1172±42.4 ^{cd}	1272.1±18.0 ^{bc}	1433.5±26.0 ^{ab}	1456.5±37.0 ^a
SGR (%/day)	1.17 ±0.01 ^b	1.20 ±0.01 ^b	2.19 ±0.01 ^a	1.29 ±0.01 ^a	1.30 ±0.01 ^b
MPI(g)	507.5±2.89 ^d	527.6 ±11.50 ^{cd}	585.4±5.78 ^{bc}	608.3±4.62 ^{bc}	640.9±11.55 ^a
FCR	1.63±0.02 ^a	1.52±0.04 ^{abc}	1.57±0.01 ^{ab}	1.46±0.00 ^c	1.34±0.01 ^c
PER	2.2±0.0 ^c	2.4±0.09 ^{bc}	2.3±0.02 ^d	2.5±0.01 ^{ab}	2.6±0.04 ^a
%SURV.	88.9±2.20 ^c	91.1±2.20 ^c	93.3±0.00 ^{ab}	95.5±2.23 ^{ab}	100±0.00 ^a

Values within each row not sharing a common superscript letter are significantly different. Data are means ± SEM.

Key: IMW: Initial Mean Weight **SGR:** Specific Growth Rate **FMW:** Final Mean Weight **MWG:** Mean Weight Gain **PMWG:** Percentage Mean Weight Gain **MPI:** Mean Protein Intake **PER:** Protein Efficiency Ratio **FCR:** Feed Conversion Ratio **%SUR.:** Percentage Survival

There was no significant difference ($P < 0.05$) in carcass composition (Table 3), among the probiotic treated groups and also, between probiotic treated groups and the control. However, the highest crude protein ($69.08 \pm 5.06g$) was recorded in T4.

Table 3 Influence of probiotic administration in culture water, on Carcass composition of *Clarias gariepinus* fingerlings

Parameters	Control	T1(0.5ml)	T2(1.0ml)	T3(1.5ml)	T4(2.0ml)
Moisture (%)	9.53±0.71 ^a	10.37±0.65 ^a	9.99±1.16 ^a	10.06±0.98 ^a	10.34±0.50 ^a
Dry weight (g)	31.54±1.27 ^a	26.98±0.49 ^b	25.32±1.91 ^{bc}	27.89±3.11 ^{ab}	29.46±0.66 ^{ab}
Crude protein (%)	62.48±1.53 ^a	62.18±4.12 ^a	62.61±1.56 ^a	64.90±2.10 ^a	69.08±5.06 ^a
Oil (%)	10.15±0.71 ^a	9.41±0.55 ^a	10.02±0.35 ^a	9.51±0.52 ^a	8.89±0.39 ^a
Ash (g)	14.84±0.64 ^a	15.84±0.63 ^a	14.89±0.20 ^a	15.82±0.51 ^a	15.26±1.07 ^a
Nitrogen free Extract (%)	9.80±0.38 ^a	9.10±0.52 ^a	9.20±1.06 ^a	8.87±0.87 ^{ab}	8.57±0.49 ^{ab}

Values within each row not sharing a common superscript letter are significantly different. Data are means ± SE of triplicate tanks.

Physico-chemical parameters

The mean values of water quality parameters (table 4) recorded for all the treatment groups and the control, during the research period were not significantly different ($P < 0.05$). Temperature range between $25.2 \pm 4.10 - 26.3 \pm 4.32$ °C; dissolved oxygen $6.55 \pm 0.93 - 6.68 \pm 0.76$ mg/L; pH $7.20 \pm 7.07 - 7.21 \pm 7.07$ and TDS $56.0 \pm 7.07 - 60.0 \pm 14.1$ mg/L.

Table 4. Mean values of physico-chemical parameters of water during the experimental period

Treatments	Temperature (°C)	pH	Dissolved Oxygen (mg/l)	TDS (mg/l)
T0	25.4 ± 3.96 ^a	7.23 ± 0.02 ^a	6.65 ± 0.79 ^a	60.0 ± 14.1 ^a
T1	26.2 ± 4.24 ^a	7.21 ± 0.02 ^a	6.68 ± 0.76 ^a	56.0 ± 7.07 ^a
T2	26.3 ± 4.32 ^a	7.20 ± 7.07 ^a	6.56 ± 0.79 ^a	60.0 ± 14.1 ^a
T3	25.2 ± 4.10 ^a	7.11 ± 7.07 ^a	6.60 ± 0.81 ^a	56.0 ± 7.07 ^a
T4	25.2 ± 4.25 ^a	7.22 ± 0.04	6.55 ± 0.93 ^a	56.0 ± 7.07 ^a

Values within each columns not sharing a common superscript letter are significantly different. Data are means ± SE of triplicate tanks.

DISCUSSION

Growth performance and nutrients utilization

Administration of single strain *Saccharomyces cerevisiae* probiotic in the culture water enhanced growth and nutrient utilization of *Clarias gariepinus* fingerlings with increase concentration in the present study. This agrees with EL-Dahhar *et al.* (2014), who reported a better growth, feed utilization, and survival rate of sea bream larvae administered liquid probiotics in the culture water, in comparison to the control. A

probiotic acts by reducing the feed conversion ratio, resulting in an increase in daily live weight gain, which is achieved through a natural physiological way and improvement of digestion by balancing the resident gut microflora as reported by Fuller, 1989; Enyidi and Onuoha. 2016. This may explain relatively lower fed conversion ratio recorded in the probiotic treated groups. Yeast probiotic has beneficial effects of promoting a healthy gastrointestinal tract environment by nourishing the enterocytes, improving ileal mucosal development and reinforcing mucosal barrier function through maintaining epithelial integrity which improve

growth and nutrient utilization (Aluwong *et al.*, 2013). Yeast acts as a source of enzymes, i.e. amylase, protease and lipase that improve food digestion and consequently food utilization, resulting in growth increased (Liu *et al.*, 2016). Yeast is also a very good source of vitamin B6 as reported by Mc Dowell (1989), which act as a stimulator of growth hormone (Hassan, 2007).

Carcass Composition

Concerning crude protein content, the result illustrated that all the treatments were not significant but exhibited higher values compared to the control group. Similar result was reported in *Clarias gariepinus* (El-feky *et al.*, 2017) and *Mystus cavasius* (Banu *et al.*, 2020). The high carcass protein observed could be due to good protein retention for growth and also because the energy available in the diets was adequate to spare the protein. Furthermore, the difference in values of carcass protein and lipid in the present study shows that, there were different levels of utilization which could be linked with the changes in their synthesis and deposition rate in the fish muscles as reported by Aluwong *et al.* (2013). It is also, very likely that *Saccharomyces cerevisiae* administration assisted in improving protein syntheses which also increased growth of fish in all the probiotic treatment groups in comparison to the control.

Physico-chemical parameters

The water quality parameters in which the fish were reared are ideal, and fall within acceptable range for the survival and growth of fish, particularly *Clarias gariepinus*. Sanai *et al.* (2015) reported a temperature range of 24.92 – 26.78 °C for warm water fish and dissolved oxygen range of 5.0 – 6.0 mg/L.

CONCLUSION

Administration of single strain *Saccharomyces cerevisiae* probiotic in the culture water significantly improved growth and nutrient utilization of *Clarias gariepinus* fingerlings than the control group without probiotic administration. Although not significant, there was increased in carcass crude protein in all probiotic treated groups in comparison to the control, although the increase was not significant ($P < 0.05$).

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