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# Evaluation of growth performance of Nile tilapia (*Oreochromis niloticus*, Linnaeus, 1752) with supplementary feeding of brewery waste in concrete ponds at Tehuledere district, Amhara Region, Ethiopia

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**Abstract**
This research was carried out to investigate the effect of brewery waste on the growth performance of Nile tilapia in concrete ponds. Fingerlings were stocked at a density of two fish per $m^2$. The treatment groups were fed at 5% of their body weight twice daily with locally available brewery waste for 180 days whilst the control group was fed only on natural food items. After the study period, the mean final length (15.66 ± 0.19) and mean final weight (80.86 ± 1.78) of treatment groups was significant when compared with a mean final length (12.78 ± 0.13) and mean final weight (42.00 ± 1.12) of control groups. The mean body weight gain in treatments (72.28 ± 1.74) was significantly higher than the control groups (33.35 ± 0.63). Specific growth rate of the Nile tilapia in treatment groups (1.25 ± 0.02) was better than the control groups (0.88 ± 0.01). Similarly, the daily growth rate was significant in treatments (0.4 ± 0.01) as compared with control groups (0.19 ± 0.01). Most of the water quality parameters were optimal in both treatment and control groups. In conclusion, the supplementation of brewery waste ascertained the faster growth in Nile tilapia.

**Keywords:** Brewery waste, Fingerlings, Growth performance, Lake Logo, Nile tilapia, Water quality parameters

## 1. Introduction

Aquaculture is the beneficial and sustainable use of water as a medium to farm organisms, such as fish, molluscs, crustaceans and aquatic plants, is often cited as one of the means of efficiently increasing food production in food-deficit countries [1]. A rise in aquaculture productivity increases food and nutrition security by making fish available and affordable for the growing African population [2]

Aquaculture in Ethiopia has not attained its full potential, despite the fact that the country's environmental and socio-economic conditions support its development [3]. The consumption and demand for fish as a cheap source of protein is on the increase in Ethiopia. Ministry of Agriculture [4] reported that the demand for fish in the country, especially in major cities has highly immensely. The reason for this is due to high population growth rates and demographic shifts towards urbanization.

Accordingly, fish production in most of the water bodies of Ethiopia is far below the estimated yield. The ever increasing population has resulted in a change in demand of fish which has led to the overexploitations of capture fishery of the country [5]. Thus, capture fishery should be supplemented by aquaculture.

Tilapia, which belongs to family Cichlidae, originated in Africa and later became cosmopolitan [6]. Tilapia farming is expanding world-wide in both developed and developing countries, because of its rapid growth rate, tolerant to a wide range of environmental conditions and ease culture technique [7]. Consequently, tilapia can be commercially farmed in ponds, cages, in tanks or raceways [8].

Tilapia is regarded as the second most cultured aquaculture species globally. This is because the species easily adapt to tropical and sub-tropical conditions of the world. They are fast-growing, able to survive in poor water conditions, eat a wide range of food types, and breed easily with no need for special hatchery technology.

They are low on the food chain, adaptable and herbivorous, feeding mainly on plankton, algae, aquatic macrophytes and other vegetable matter [8, 9]. Nile tilapia is considered as a standout amongst the most critical freshwater species for commercial aquaculture because of its qualities (high-quality proteins, omega-3 fatty acids and amino acids), quick development rate and resistance to diseases [10].

Furthermore, producers are also pleased with the fish because they thrive in a wide range of aquatic ecological conditions from purely freshwater to brackish or semi saline waters, ease culture technique and high market demand [11]. *O. niloticus* is capable of using a wide range of food materials from tiny plankton to aquatic macrophytes, other vegetable matter and grows well on artificial feeds [12, 13]. Keeping these in mind, an attempt has been made to evaluate growth performance of *O. niloticus* fed on brewer waste as feeding supplement.

## 2. Materials and Methods

### 2.1 Description of study area

The study was conducted in Hyke Stefano's Monastery which is found in Tehuledere Woreda (District) is situated in South Wollo, Amhara National Regional State, Ethiopia. This study site is located 430 km away from Addis Ababa on the main road to Mekele towards North. The hydrology of this Woreda included two lakes. They are Lake Logo and Lake Ardibbo. The entire Lake Logo is situated in Tehuledere Woreda. However, Lake Ardibbo located in both Tehuledere and Kalu Woredas.

The required fingerlings were procured from Lake Logo which is located between 110 3' N to 110 18' North latitude and 39 0 41' E to 390 68' East longitude with an average elevation of 1911 meter above sea level. The average depth of Lake Logo is 37 m with maximum depth of 81 m. Lake Logo is classified as a small highland lake with fresh water. The major cations and anions in the lake are magnesium and carbonate/ bicarbonate, respectively [14]. The physio- chemical parameters of this lake is suitable for aquatic organisms as well as domestic use [15].

### 2.2 Preparation of ponds and stocking

The study was conducted in Hyke Stefano's Monastery, which is found in Tehuledere Woreda. Here four (three experimental, one control) concrete square ponds of 5mx5m x1-1.5m were constructed. The study was conducted for 180 days from July to December, 2016. After conditioning, the ponds were filled with lake water to a level of 85cm and left for one week before stocking of the fingerlings. The experimental fish were captured from Lake Logo using monofilament gillnets in the shallower part of the lake. A total of 200 fingerlings of *O.niloticus* of similar size were captured. The total length (TL) of sample fish was measured to the nearest centimeter (cm) using a measuring board, while their body weight (BW) was determined to the nearest gram (g) using a Scaltel Digital Balance (model SF-400). 50 fishes were transferred to each experimental pond with density of two fish per $m^2$.

**Fig 1:** Fish harvesting from the ponds

The fingerlings of treatment group were fed by hand for 180 days with brewery waste (obtained from Kombolcha BGI brewery factory) at 5% of their body weight following the method of Nandlal and Pickering, (2004). First feeding was given to fingerlings between 9.00 to 10.00 AM and second feeding was given to fingerlings between 4.00 to 5.30 PM. The feed rate was adjusted every month on the bases of fish weight. The control groups were feed only on natural food items.

### 2.3 Length-weight relationships and Fulton's conditional factor

Length-weight relationship is a good indicator for the general "well-being" of the fish population in a given environmental conditions. This relationship is an important parameter to characterize the growth pattern and growth performance of fish in different culture systems [16, 17]. The relationship between TL and BW was calculated using Least Square Regression Analysis [18] as follows:

$BW = aTL^b$

Where *a* and *b* are the Y-intercept and the slope of the regression line, respectively. The *a* value which is the y-intercept of the log transformed line indicates the average condition factor of the fish, while the *b* value, which is the slope of the transformed line shows the growth pattern of the species in a given environment [19]. If the value of b is less than 3 (i.e., the fish grows faster in length than in weight) and greater than 3 (i.e., the fish grows faster in weight than in length), indicates allometric growth pattern of the fish, whereas b value is equal to 3 growth is isometric [20].

### 2.4 Data Analysis

Fish data were analyzed from collected samples started from the beginning of the activities and their growth performance were determined interms of initial stocking weight (g), final weight (g), initial length (cm), final length (cm), weight gain

(g), daily growth rate (%), Fulton condition factors (FCF) (g/cm) and survival rate (%).
To determine the growth performance of juvenile *O. niloticus*, all fishes were sampled every month in order to measure their body weight and body length to the nearest g and cm, respectively. Mortality from each aquarium was regularly recorded throughout the experiment.
Growth performances of fish final body weight (FBW), body weight gain (Wg), specific growth rate (SGR), and rate of survival were calculated as prescribed by [21]:
Weight Gain (WG) = final weight (g)- initial weight (g).
Average Daily weight gain (ADG) = weight gain (g)/ culture time (days)
Survival rate (%) = (Number of fish harvested/Number of fish stocked) x100
FCF = $100TW/TL^3$, where TW is total body weight in g, TL total length in cm
Specific Growth Rate (SGR) = 100[Ln final weight (g) - Ln initial weight (g)]/ Time (days).
Growth parameters of treatment and control groups were compared by independent samples t-test using (SPSS 21.) version software. $p \leq 0.05$ was considered to be statistically significant. Graphical presentations were done using Microsoft excel sheets 2007.

### 2.5 Determination of Physico-chemical water parameters
The pH values (pH scale) of the water were determined using a pH meter. Similarly, the turbidity of the water sample was assessed using a digital turbidity meter. Water temperature was measured using a mercury- in-glass thermometer calibrated in degree Celsius (°C).

## 3. Results and Discussion
### 3.1 Effects of brewery waste on growth performance of *O. niloticus*
Growth performance parameters for the Nile tilapia fingerlings after the feeding trial are presented in Table 1. The mean initial length of fingerlings in treatment and control group was 7.96 ± 0.18 and 8.35 ± 0.19, respectively. The mean initial weight of fingerlings in treatment and control group was 8.59 ± 0.18 and 8.65 ± 0.22, respectively. There was no significant difference in mean initial length and mean initial weight between treatment and control groups (Table 1). After 180 days of treatment period, mean final length of the fish in treatment and control group was 15.66 ± 0.19 and 12.78 ± 0.13, respectively. The mean final weight of the fish in treatment and control group was 80.86 ± 1.78 and 42.00 ± 1.12, respectively. The treatment group showed significant increased mean final length and mean final weight when compared with the control groups (Table 1). The mean body weight gain in treatment and control group was 72.28 ± 1.74 and 33.35 ± 0.63, respectively. Similar results were reported after supplementing poultry manure to Nile tilapia [11], pig manure and formulated diets [22], fish that were fed multi feed diets [23] and using maize flour and noug cake [24]. Such significant increase in length and weight is mainly due to the effect of nutrients in the supplementary feed that facilitate the growth of the fish [25, 26, 27]. While, lack of diet impaired the growth performance the fish found in the control environment [28, 29].
Specific growth rate of the Nile tilapia in treatment and control group was 1.25 ± 0.02 and 0.88 ± 0.01, respectively. The specific growth rate per day in treatment group was significant when compared with the control groups (Table 1). Similarly, 33% crude protein supplements to Nile tilapia showed 1.24%/day specific growth rate [30]. In the present study, the daily growth rate in treatment and control groups was 0.4 ± 0.01 and 0.19 ± 0.01, respectively. The daily growth rate in treatment group was significantly better than the control groups (Table 1). The Nile tilapia supplemented with brewery waste in addition to natural food increases the daily growth. On the other hand, survival rate in treatment and control groups was 88.16% and 86.55%, respectively [26]. In fact, the mean Fulton condition factor (K) in treatment and control was 2.08 ± 0.10 and 1.81 ± 0.15 (Table 1). This value of Fulton condition factor was higher than the range of 1.58 to 1.82 [31].

**Table 1:** Growth parameters of Nile tilapia

| Growth parameters | Treatment group | Control group |
|---|---|---|
| Mean initial length (cm) | 7.96 ± 0.18 ns | 8.35 ± 0.19 |
| Mean initial weight (g) | 8.59 ± 0.18 ns | 8.65 ± 0.22 |
| Mean final length (cm) | 15.66 ± 0.19* | 12.78 ± 0.13 |
| Mean final weight (g) | 80.86 ± 1.78* | 42.00 ± 1.12 |
| Mean body weight gain (g) | 72.28 ± 1.74* | 33.35 ± 0.63 |
| Daily growth rate (%) | 0.4 ± 0.01* | 0.19 ± 0.01 |
| Specific growth rate per day (%) | 1.25 ± 0.02* | 0.88 ± 0.01 |
| Survival rate (%) | 88.16 | 86.55 |
| Mean Fulton condition factor (K) | 2.08 ± 0.10 ns | 1.81 ± 0.15 |

Values are expressed as mean ± SEM;
* $p \leq 0.05$ Treatment group vs. Control group;
ns – Non significance;

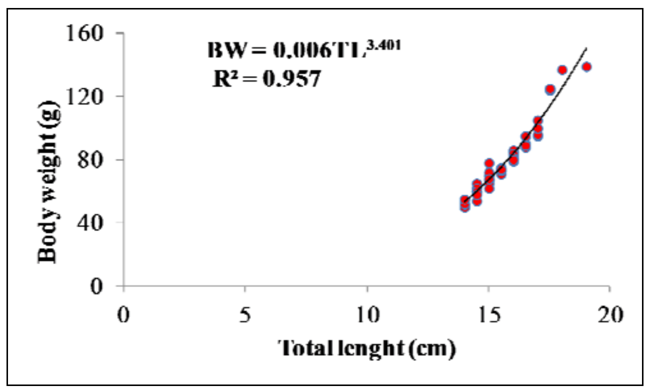


**Fig 2:** The relationship between total length and body weight of *O. niloticus* from the treatment groups

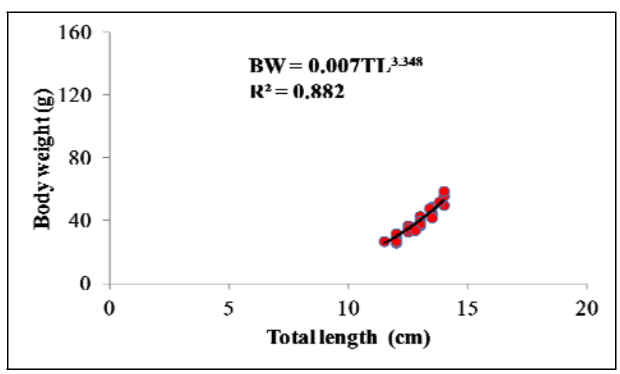


**Fig 3:** The relationship between total length and body weight of *O. niloticus* from the control group

The results of the present study showed that the corresponding growth pattern of Nile tilapia in treatment and control was 3.401 and 3.348, respectively. This signifies that the treatment with brewery waste and control showed allometric growth as the obtained value was greater than 3 i.e., the fish grows faster in weight than in length. In addition to this, the relationship between length and weight in treatment group was stronger ($R^2$ = 0.92) than the control group ($R^2$ = 0.88) (Figure. 2 and 3). In a report by [32] found that the species was attend the growth pattern ranged from 2.1 to 2.3 which is lower than the present results.

### 3.2 Water quality parameters measurement

Water quality is the first most important limiting factor in pond fish Production. Its quality directly affects feed efficiency, growth rates, the fish's health and survival. Fish do not like any kind of changes in their environment. Any changes add stress to the fish and the larger and faster the changes, the greater the stress. So the maintenance of all the factors becomes very essential for getting maximum yield in a fish pond [33]. The water quality parameters revealed the environmental conditions under which the fish were cultured during the study. The average values of water quality parameters monitored throughout the trial are summarized in (Table 2).

**Table 2:** Average water quality parameters in different seasons

| | **Physico-Chemical water quality Parameters** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Rainy Season (July-September)** | | | | **Dry Season (October-December)** | | |
| | **Temperature (°C)** | **Turbidity (NTU)** | **pH** | | **Temperature (°C)** | **Turbidity(NTU)** | **pH** |
| Treatment Groups | 23.96 | 8.57 | 7.57 | | 24 | 4.9 | 7.3 |
| Control Groups | 24.3 | 9.01 | 6.18 | | 24.5 | 3.62 | 7.70 |

As the fish are ectothermic, change in water temperature affects growth, metabolism, reproduction, feed consumption, physiology and survival of Nile tilapia. The average water temperature in treatment and control groups was optimal (Table 2). In fact, optimal temperature range for the growth and survival of Nile tilapia is from 20-35°C [34, 35]. As the pH of water is one of important water quality parameters in re-circulating aquaculture system [36] Nile tilapia can survive in a wide range of water pH and this fish can grow with the pH range of 6.5–9.0. In the present study, the value of pH in both dry and rainy seasons was suitable for the growth of tilapia species (Table 2).

In water bodies, water turbidity can result from planktonic organisms or from suspended clay particles and it affects light penetration, thereby limiting photosynthesis in the bottom layer [37]. High turbidity of water can decrease fish productivity, as it will reduce light penetration into the water and thus oxygen production by the water plants. Dissolved suspended solids will also clog filters and injure fish gills [38]. The value of the turbidity of the water from 5-30 NTU, characterizes as slightly turbid water, was reported to be suitable for the best development of *O. niloticus* [39]. The turbidity value of our findings is considered as ideal for the normal growth of *O. niloticus* (Table 2).

### 4. Conclusion

In conclusion, the results of this experiment showed that supplementation of brewery waste resulted in better growth performance Nile tilapia fingerlings grow in ponds as compared to the fishes which were not taking additional diets. It was revealed that test comparison of mean final body weight was significantly higher in the treatment groups than the control groups (at p≤0.05). All the water quality parameters were within the acceptable ranges as recommended for the growth of tilapia species.

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