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# Growth Response of Nile Tilapia (*Oreochromis niloticus*) Fries Fed on Silage-based Diets

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## ABSTRACT

Fish silage was prepared by minced fish body leftovers by adding formic acid and formulated with other plant sources. The silaging process was completed after 48 days and incorporated into the experimental diets. The growth trial was conducted to investigate the effect of silage incorporation in the diets of Nile tilapia (*Oreochromis niloticus L.*) fries. Three dried diets containing ($T_1$) 0, ($T_2$) 20, ($T_3$) 30 were prepared with 30% crude protein and the experiment was conducted in 12 glass aquaria with a stocking density of 30 fish/aquarium for 16 weeks. Results indicated that Non-significant differences in WG, FCR, and SGR of *O. niloticus* were observed between $T_2$ and $T_3$ diets. The least growth performance was recorded in $T_1$ and it was significantly different ($P < 0.05$) with $T_2$ and $T_3$. The fries fed on silage incorporation were the best survival rate (100%) but the fries that fed without silage had less survival rate (83.3%). This indicates fish silage was the best feed for *O. niloticus* growth and survival rate at an early stage. Under the present study condition, incorporation of fish silage at 20% inclusion in the diets of *O. niloticus* fries is better and further study is necessary for different inclusions.

**Keywords:** Silage; Growth performance; *O. niloticus*

## INTRODUCTION

Aquaculture is now the fastest-growing food-producing sub-sector in many countries and it is expected that this trend will continue despite numerous constraints, which may become more challenging in the future. In many developing countries, there is significant scope for enhancing contributions of aquaculture to food supplies and poverty alleviation [1]. However, according to FAO [1], aquaculture in the developing region is facing significant challenges and among those, meeting the growing demands for seed, feed, and fertilizers; in terms of quantities and quality have the highest priority. Challenges for the development of aquaculture in Ethiopia include not only a lack of knowledge and institutional support, but also a shortage of several production factors; among them, the lack of reasonably priced and locally available fish feed of sufficient nutritional quality.

Commercially produced compound feeds are readily available for aquaculture in developed countries. In most developing countries, formulated feeds for fish are scarce or entirely unavailable [2]. Although some developing countries are importing formulated fish feeds, these are usually too expensive for economically viable fish production. Since feed costs represent 40-50% of the total variable production costs [3], locally produced and reasonably priced feedstuffs of sufficient nutritional quality are a key element in the development of aquaculture in countries like Ethiopia [4]. As aquaculture production becomes more and more intensive, fish feeds will be a significant factor in increasing the productivity and profitability of the sector [5]. Because feed management determines the viability of aquaculture as it accounts for at least 40 - 60% of the cost of fish production [3,5].

Fishing operations yield includes considerable waste materials such as by-catch fish and filleting scrap. Unfortunately, the lack of processing facilities in many lesser-developed countries like Ethiopia often leads to the paradoxical situation of wastage occurring where the need for protein is greater. Although priority should be given to the direct use of fish for human consumption, there are often considerable quantities of fish wastes available for animal feeding. In Ethiopia, where supplies of fish waste may be small and irregular, it is uneconomical either to transport the waste to a fishmeal plant or to build a small local factory. Fish ensilaging may be a suitable alternative method of preserving fish waste in these circumstances. According to Backhoff [6], Acid preserved fish silage is a liquid product prepared by adding acid to fish or fish waste and liquefaction is caused by proteolytic enzymes, present

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naturally in the fish. The addition of acid stimulates enzymic proteolysis, which helps in dissolving bones and prevents bacterial and fungal spoilage [7]. Feeding trials have shown that fish silage can replace fishmeal in the diets of carp [8]. Therefore, this study aimed to evaluate the nutritive value and incorporate the waste as protein sources in the diet of O. *niloticus* fries.

## MATERIALS AND METHODS

### Experimental units

A total number of 360 fries of O. *niloticus* with an average initial weight of 0.4 g were used in this study. The fish were divided into 12 similar groups in glass aquaria (73 x 43 x 35 cm) containing an equal amount of water (100 litters) in each, representing three dietary treatments each in four replicates. Each aquarium was supplied a circulating water one liter/minute. Water temperature was controlled thermostatically by automatic heaters and was measured two times daily using multiline probe.

### Experimental fish

All fish were taken from the National Fishery and Aquatic Life Research Center (NFALRC) hatchery. All fish were kept for two weeks in a fiberglass tank before their distribution into the experimental aquaria for adaptation to the new environment. The fish were then randomly divided into equal groups in the experimental aquaria (30 fish/aquarium). The fish were kept one week in the aquaria before the beginning of the experiment.

### Experimental diets

Fish silage was prepared using discards of O. *niloticus* fish, which was collected from Lake Ziway, landing sites. The leftover was collected, washed, and minced into small size. Then it was immediately treated with a 1.5% formic acid and 1.5% sulfuric acid by weight of a homogenized fish mixture [9]. Then, it was closed and transported to NFALRC laboratories. The homogenized fish mixture was stored for 48 days by mixing thoroughly once a day. The chemical analysis of the produced fish silage after 48 days storage period was reported. Before the formulation of the experimental diets, fish silage was neutralized by adding 1.6% calcium hydroxide to raise the silage pH from 4.1 to 5.2. Fish silage was mixed with the other ingredients to formulate 3 diets containing, 0%, 20%, and 30% of fish silage Table 1.

### Experimental procedure

The experiment lasted for 12 weeks after the start [10]. During the experimental period, fish were fed the experimental diets at a rate of 10% of the live body weight daily and the feed was offered twice daily at 9.0 A.M. and 3.0 P.M. [11]. The fish groups were weighed monthly and the amount of the feed was adjusted according to the actual body weight changes. Water samples were taken from each aquarium to determine water quality parameters. One-third of water volume was changed weekly and the whole water volume was changed every month to clean the aquaria walls and remove the attached algae.

### Proximate analysis

Proximate analysis for silage and experimental diets were carried out for moisture, ash, protein, and fat according to the methods described by AOAC [12]. The ingredients of the experimental diets were ground in a hammer mill and mixed. Thereafter, water was added to the mixture and made dough [11]. The composition of the experimental diets tested and the proximate analysis is shown in Table 1.

### Growth and feed utilization parameters

Specific growth rates (SGR), feed conversion ratio (FCR) and survival rate were calculated using the following formulae [13] respectively.

$$SGR\,(\%\,day^{-1}) = \left(\frac{lnW_f - lnW_i}{dt}\right) \times 100$$

Where: $W_f$ and $W_i$ are the final and initial body weight of the fish, respectively; dt is the culturing period.

$$FCR = \frac{Fi(g)}{Wg(g)}$$

Where: Fi is the amount of feed intake (g) in a dry weight basis, $W_g$ is Weight gain in gram (g)

$$Survival\,rate\,(\%) = (\frac{NSF - NDF}{NSF}) \times 100$$

Where: NSF and NDF are the Number of stocked and dead fish during the study period, respectively and the fish weight gain was calculated by the difference between the final weight and the initial weight.

### Water quality parameters

Measurement of temperature was conducted daily, while other parameters were taken every week. Samples of water were taken from each aquarium for determination of water temperature using a water thermometer, water pH value using a digital pH meter, dissolved oxygen concentration using an oxygen meter. Analysis of ammonia was conducted in the laboratory following a procedure described in Abelneh Yimer et al. [11].

### Statistical analysis

The obtained numerical data were statistically analyzed using SPSS version 20 for one-way analysis of variance. When the F-test result was significant, the least significant difference was calculated according to Duncan multiple range test.

## RESULTS AND DISCUSSION

### Water quality parameters

The average values of water quality parameters such as; temperature dissolved oxygen (DO) mg/L, pH, conductivity, and ammonia during the whole experimental period are shown in Table 2. These parameters were within the acceptable levels required for normal growth and physiological activities of Nile tilapia [14,15]. According to Kassaye Balkew [16], for optimum fish yield, water temperature, dissolved oxygen, transparency, pH, and salinity must be kept at an optimal level compatible with fish species. Water temperature is the most crucial parameter for fish growth. If the water temperature below the critical level, fish could stop feeding and would even die. The metabolic activity and physiological functions of aquatic animals (e.g., feed utilization, feed conversion, and growth rates) can be affected by the water temperature [17-19].

Results in Table 3 showed that the initial weight of Nile tilapia at the start of the experiment was around 0.4 g for all groups indicating the homogeneity of fish distribution into the experimental groups at the start of the experiment. The effect of the experimental diets on fish growth and feed utilization after 16 weeks of experimental feeding are included in Table 3. The highest growth trend was obtained with $T_3$ followed by $T_2$, but no significant difference between $T_2$ and $T_3$. The lowest growth response was in $T_1$, which was no silage incorporation. The present study showed that fish silage possessed adequate nutritional value for Nile tilapia fry at lower inclusion levels, making possible addition levels of up to 20%, but needs more experiment in different inclusion levels.

Fish growth performance: the FCR value of $T_2$ diet is almost similar to $T_3$ diet indicating that the diet with 20% acid silage and 80% wheat bran, brewery waste, and soybean meal can be safely used while preparing aquafeeds for Nile tilapia fries. However, FCR was higher as compared to other studies [20,21] due to the fluctuation of water qualities during the study period (power problem). The proximate analysis indicated in Table 1 is different from other studies. Our study showed higher protein and ash content [21]. This difference in proximate analysis values can be justified as described by Vidotti et al. [22] and Santana-Delgado et al. [23]. These researchers stated that these deviations in values of proximate analysis are due to the chemical composition of the different raw materials and nutritional values of raw materials used for acid silage preparation. The species of the fish utilized, sex of the fish, its reproductive status, and even the cut at the time of processing affect the chemical composition of silages.

According to Soltan and Tharwat [10], in fry and fingerling, fish feed formulation the silage inclusion level for Nile tilapia is 25% and catfish 20% level is recommended. The inclusion level for Nile tilapia is a bit higher due to a higher requirement of IAA compared to African catfish. According to other studies, these results agree with the findings of Soltan & Tharwat, [10]. They prepared fish silage with no removal of the lipid/oil. However, the result disagree with Haider et al. [21], who prepared fish silage by removing the excessive lipids/add antioxidants (to decrease oxidation of lipids) and they get better growth performance. During silage preparation for fish feed, removal of oil by centrifuging/adding anti-oxidants is necessary. Remove the excessive fat layers appearing on the surface of the mixture and stirring twice a day [21] and become fishy. The amount and type of acid added to the silage, for example, diets containing high proportion formic acid fish silage reduced growth performance of the fish, due to acidity of the diet, and a high proportion of free amino acids in fish silage. It has been suggested that acidity reduces diet acceptance and affects protease activity in fish guts, while free amino acids may depress fish appetite. Fish silage of the correct acidity keeps at room temperature for at least two years without putrefaction [24]. Generally, the fish growth performance (MBW, WG, SGR, FCR) was the lowest compared to other studies [21], due to the effect of water temperature.

**Table 1:** Chemical composition and analyses of the ration.

| Ingredients (%) | Rations for *O. niloticus* (%) | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Fish Silage | 0 | 20 | 30 |
| Brewery waste | 30.8 | 30.55 | 26.59 |
| Wheat bran | 26.5 | 29.09 | 32.11 |
| Soybean | 42.7 | 20.36 | 11.3 |
| **Composition** | | | |
| Moisture | 2.2 | 2.49 | 2.63 |
| Crude protein | 30 | 30 | 30 |
| Ash | 1.1 | 2.24 | 2.79 |

T1= 0% of silage; T2= 20% of silage; T3= 30% of silage, *expressed in: g 100g-1 of dry matter

**Table 2:** Physico-chemical values (mean) of the experimental aquaria.

| Parameters | Treatment | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Temperature (°C) | 22.7 | 22.8 | 22.7 |
| PH | 8.1 | 8.1 | 8.1 |
| DO (mg\L) | 4.7 | 4.3 | 4.06 |
| Conductivity | 194.8 | 195.5 | 195.5 |
| Ammonia (mg\L) | 0.15 | 0.24 | 0.25 |

**Table 3**: Growth performance of *O.niloticus* fries fed on silage incorporation formulated feeds.

| Growth parameters | Experimental diet | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Initial weight (g) | $0.45^a$ | $0.44^a$ | $0.48^a$ |
| Final weight (g) | $1.79^a$ | $3.04^b$ | $3.51^b$ |
| Weight gain (g/fish) | $1.34^a$ | $2.6^b$ | $3.03^b$ |
| Average daily gain (g/fish/day) | 0.015 | 0.028 | 0.034 |
| Specific growth rate % | 1.35 | 1.89 | 1.95 |

The same letter in the same row indicates ($p > 0.05$), but different letter showed ($p < 0.05$), Values with the same superscript in each row are not significantly different.

## CONCLUSION AND RECOMMENDATIONS

The results of the present study revealed the possibility of using a 20% silage inclusion feed formulation for the growth performance and economic viability of *O. niloticus* fries culture. However, one must remove the lipid content during silage preparation. In Ethiopia, there are many fish leftovers in many fish landing sites. It is a very important resource for animal feeds, however. The majorities of the wastes are disposed of in the lakes and lead to many problems on the water bodies/environment. Therefore, further studies on the silage preparation methods need to be conducted to use as a feed ingredient for the development of fish feed.

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