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Research Article

# Assessment of the Effect of Duckweed (*Lemna minor*) on Monosex *Nile tilapia* (*Oreochromisniloticus*) Farming at Ambo, Ethiopia

**Alemayehu N. Emana[1*], Misganaw E. Dubie[2]**

*[1]Department of Biology, Ambo University, PO Box 19, Ambo, Ethiopia [2] Stand for the Vulnerable Organization (SVO), PO Box 1176, Addis Ababa, Ethiopia*

## ABSTRACT

The effectiveness of duckweed fed monosex O.niloticus farming was assessed for 120 days from July-November, 2017 based on 35 young fish stockedin geo-membrane lined ponds ofeach 3*3 m area and 1.5m depth. Five dry diets consisting of 0%, 25%, 50%, 75%, and 100% duckweed formulated at 30% crude protein were fed to young fish (25±10.6g-32±16.6g) in the form of pellets at 5% body weight twice a day each with two replications where the 0% (wheat bran and corn bran) served as control. Mortality was recorded on daily basis whileweight gain,pond water temperature, and pH were determined every fortnight. Nutritional values of the diets and carcass of fish grown on the dietswere assessed using standard laboratory procedures.Maximum percentage average growth and survivalwas demonstrated by fish grown on 50% duckweed supplemented feed followed by those fed on 25% duckweed. Growth performance and percentage survival of fish grown under different treatments as well as that between fish fed on control diet and the experimental diets were significantly different ($p<0.05$). Average crude protein and lipid contents of the fish grown on 25% duckweed are relatively higher as compared to those grown on the rest diets. Assessment of the crude protein of fish grown on various levels of duckweed supplemented feed indicated a weak positive correlation ($r2=0.011$). Thus, the results showed that a diet comprising up to 50% duckweed could be used as a complete replacement for traditional feed in the diet of O. niloticus.

**Key words:** Duckweed; Feed replacement; Growth performance; Nutritive value; Tilapia

## INTRODUCTION

Tilapia are known as "aquatic chicken" because of their fast growth, good quality flesh, disease resistance, adaptability to a wide range of environmental conditions, ability to grow and reproduce in captivity, and feed on low trophic levels. *Nile Tilapia (O niloticus)* is the second most farmed fish and a first choice for introduction around the world In Ethiopia, it occurs in most of the country's inland waters and accounts for about 60% of the total annual commercial fishery in the country.

Feed is the single largest expenditure in semi-intensive and intensive fish culture and feeding cost accounts about 30-70% of the total operational cost in a fish farm [1]. Thus, the replacement of fishmeal with locally available and cheaper plant feedstuffs is proved to be very essential for the future development of aquaculture sector [2]. A substantial amount of research is already under way, testing potential protein sources that can replace fishmeal in tilapia diets including cassava leaf meal, barley and alfalfa and soybeans [3]. One of the most commonly encountered difficulties when alternative protein sources are used is acceptability due to the palatability of diets fed to fish.

Recently duckweed has been accepted as protein rich (40-45% of the dry weight) feed for fish [4], and its protein has high concentrations of the essential amino acids, lysine and methionine. Compared with other plants, duckweed leaves contain lower fiber (5% in dry matter) and highly digestible [5]. It can also easily grow abundantly with minimum cost and can be made available as much cheaper feed than other alternative plant protein sources [6]. The plant may be fed to fish either in the form of fresh or dried powder as in combination of other feed components such as wheat bran, rice bran etc.

The potential for duckweed resides in its use as a sole fish feed or a component of fish diets where it can be used at the site of production for fish cultivation [7]. Reports from other countries indicate that using duckweed in *O niloticus* feeding as a source of protein and energy in place of fishmeal is quite prominent. Nevertheless, so far no research work has been carried out in Ethiopia on the biology and effect of duckweed on fish farming. Thus, this study was conducted to assess the effect of duckweed on

**Correspondence to:** Alemayehu N. Emana, Department of Biology, Ambo University, PO Box 19, Ambo, Ethiopia, E-mail: EmanaNA@gmail.com

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growth performance, survival and nutritive quality of O. niloticus.

## MATERIALS AND METHODS

### Description of the experiment site

The experimental site, Ambo town is located in west Showa zone, 115 km west of Addis Ababa, the capital of Ethiopia. The main rainy months in the area range between June and September peaking in July and August. The dry months range from October to May with some intermittent rain from February to April. The minimum and maximum air temperaturesin the area range between 10 and 29 0C with the hottest and coldest months extendingfrom March to Mayand October to December, respectively. Teff, maize, wheat, and barley are the major crops produced in the area contributing to the main economy of the region (Figure 1).

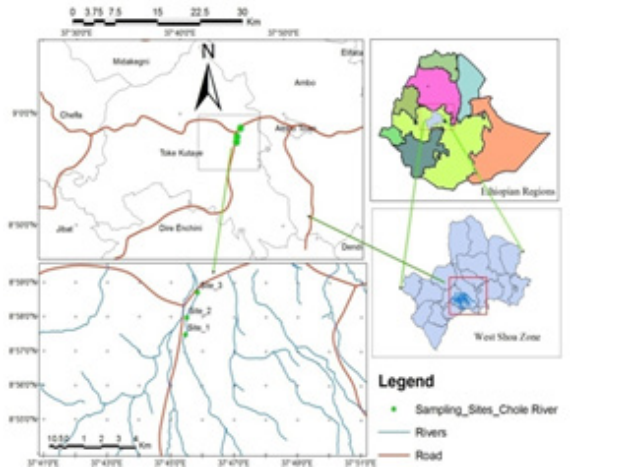


**Figure 1:** Map of the experimental area.

### Design of the Experiment

The experiment was conducted in Completely Randomized Design (CRD) using five treatments at 0%, 25%, 50%, 75%, and 100% levels of duckweed each having two replications in a series of ten rectangular geo-membrane lined ponds of similar area (9 m i.e 3m, 3m) and average depth of 1.5 m constructed at Ambo University main campus. Ponds were filled with water up to 1.25 m depth and fertilized with poultry waste and cow dung at the ratio 1:3 (1 kg/m), and urea and superphosphate were provided as an additional NPK supplement (1:4:1-100g/m) following [8]. The ponds were left for 10 days for development of natural food organisms. The water column was stirred every day for the proper mixing of water.

### Feed preparation

Control feed (diet prepared from locally available feed stuffs i. e wheat bran and corn bran) and experimental feed (25%, 50%, 75%, and 100% duckweed) with a protein content adjusted to 30% following Pearson Square method [9] were used to grow the fish. The feed stuffs were cleaned, dried, powdered, and the required proportions were weighed and made into dough by adding water. The dough was then steamed in the pressure cooker for 10 minutes and the cooked dough was made into pellets using pelletizer. Feed pellets were dried in an oven at 600 Degree C for 12 hours and stored in an airtight container until use.

### Stocking, feeding, and water quality monitoring

O. niloticus with average length from 10 ± 1.7cm to 13 ± 2.0cm werepurchased for the experiment from Ziway Fisheries and other living Aquatic Resources Research Center. Average initial length and weight of the fish were recorded and then fish were stocked in the control and experimental ponds at a rate of 35fish/pond. Fishwere fed with corn and wheat bran for a week during acclimatization period and feeding was discontinued one day before the experiment. Each time, 5% of the body weight of diet was given to fish every morning and evening using feeding trays for 120 days. Mortality was recorded on daily basis and pond water was renewed every three days. Pond water pH and temperature were measured with a portable digital pH meter and thermometer, respectively every fortnight.

### Growth performance and survival

Fish growth was determined by recording weight (g) of fish every two weeks using a sensitive balancefor which 2/3rd of the fishwas utilized. Diet performance was evaluated on experimental fish according to Olvera- Novoaet al. (1990):

Weight gain (%)= (Final body weight-Initital body weight )/(Initital body weight ) X100

Survival = (Final total fish number)/(Initial total fish number)×100

### Analysis of the nutritional values of feeds and tilapia

The proximate analyses of feeds (control and experimental) and carcass of fish cultured under different treatments were carried out using the procedure outlined by AOAC (2005) from which the following parameters were determined: moisture, crude protein, crude fat, crude ash, and crude fiber. The proximate compositions were analyzed in triplicates and reported as mean.

### Statistical analysis

Results on growth performance and survival of the fish were subjected to one way ANOVA to test if differences among different treatments were significant. T test was conducted to test the difference between control and experimental groups whereas regression analysis was conducted to test the effect of duckweed on the quality of fish carcass.

### Ethical consideration

We assert that the research is our original work and in compliance with internationally accepted practices, we have dually acknowledged and referred all materials used in this work. We understand that non-adherence to the principles of academic honesty and integrity, misrepresentation/fabrication/data/fact/source will constitute sufficient ground for disciplinary action and can also evoke action from the source which have not been properly cited or acknowledged.

## RESULTS AND DISCUSSION

No acceptability problem was encountered in the current study with any of the diets and the weight loss noted by fish grown on control feed at the beginning of the experiment is not clear from the available data. Relatively superior growth performance (132%) and percentage survival (93%) were determined in O *niloticus* grown on 50% duckweed supplemented feed (Table 1). Growth performance was depressed with further increase in the level of substitution and complete replacement of traditional feed with duckweed was found detrimental to fish production. This is supported by the work of

and [10] who reported that 100% inclusion of duckweed does not favor growth performance of *Nile Tilapia*.

The trend in growth performance demonstrated by the fish with respect to the diets fed was more or less consistent over the experimental period (Figure 1). Superior growth performance and survival demonstrated by the fish fed on 50% duckweed supplemented feed might be attributed to more balanced nutrition while total mortality of the fish fed on 100% duck weed could be because the plant may not meet all the nutritional requirements of the fish. The differences in growth performance and percentage survival of fish grown under different treatments as well as that between fish fed on control diet and the experimental diets were statistically significant ($p<0.05$).

Average fish pond water temperature recorded during the experimental period ranged from 210C to 220C while pH ranged from 5.2 to 6.1 (Table 1). Tilapia thrive in warm water of 25-30°C usually found in areas of low elevation in tropical areas. Hence, the relatively cooler pond water temperature and slightly acidic pH in the present study might have negatively affected the growth performance and survival rate of the fish. According to El-[11], water pH 7-8 is suitable for tilapia culture for optimum growth performance and survival rate.

Average crude protein and ash increased in fish diets with increasing level of duckweed in contrast to crude fat and moisture content (Table 1).The average crude protein determinedin 100% duckweedis high (33.28%)though this is less as compared to the previous reports (40-45% of the dry weight) by [12,13]. This might be attributed to the lower level of nutrients in the water used for growing the plant though not determined in this study. The nutrients in the water upon which the duckweed is grown critically affect its nutritional value [14].

**Table 1:** Physicochemical parameters determined at the sampling sites.

| Parameter | S1 | S2 | S3 |
|---|---|---|---|
| pH | 8.52±0.38 (8.15-8.91) | 8.3±0.19 (8.12-8.5) | 8.62±0.2 (8.39-8.77) |
| EC (µS/cm) | 496±160 (319-630) | 565±194 (355-736) | 609±169 (449-785) |
| DO (mg/l) | 7.18±0.91 (6.27-8.09) | 4.29±1.85 (4.21-6.18) | 7.17±1.38 (5.6-8.19) |
| DO (%) | 108±26.7 (88.9-138.2) | 63.5±27.4 (40.9-94) | 112±27.3 (85.5-140) |
| H2O Temp | 22±6.73 (14.5-27.5) | 23±4.58 (18-27) | 24.6±2.71 (22-27.4) |
| Air Temp | 23.3±6.43 (16-28) | 23.8±4.37 (19-27.5) | 25.3±2.41 (23-27.8) |
| TP (mg/l) | 0.28±0.09 (0.2-0.37) | 6.09±0.09 (6-6.18) | 0.28±0.15 (0.16-0.45) |
| NH4+N | 0.014±0.006 (0.01-0.02) | 0.016±0.012 (0.009-0.03) | 0.091±0.067 (0.013-0.135) |
| NO3-N | 0.324±0.04 (0.291-0.37) | 0.941±0.076 (0.86-1.012) | 2.02±0.141 (1.86-2.125) |

Average crude protein and fat contents of the fish grown on 25% duckweed exceeded that offish grown on the rest diets. The level of crude fat determined in fish carcass slightly declined with increasing level of duckweed fed. There is no clear correlation between the proximate compositions of fish carcass and the respective diets fed Crude protein of the fish carcass determined is ($r2=0.011$). weakly positively correlated with that in the diets fed to the fish

## CONCLUSION AND RECOMMENDATIONS

The results of this study revealed that replacement of 50% fish meal with duckweed in the diet of O. niloticus promotes better growth. Thus, 50% duckweed supplemented feed may be used in tilapia culture and the potential contribution of duckweed to the advancement of sustainable aquaculture looks enormous as it is locally available and cheaper. The experiment should be repeated at lower elevations in warm water and the effectiveness of fresh duckweed fed tilapia culture should also be tested.

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