

## Evaluation of formulated feed of plant and animal origin on the growth performance of *Oreochromis niloticus* in ponds, Ethiopia

Mohammed Oumer, Haymanot Mulugeta, Getnet Temesgen

Bahir Dar Fisheries and other Aquatic Life Research Center, Ethiopia

### Abstract

The present study was conducted to evaluate the effect of supplementary feeding with only plant material origin (Noug cake, Brewery waste & wheat bran) and mixture of plant and animal origin (Fish meal, Brewery waste & wheat bran) with similar protein content of two formulated feeds on the growth of *Oreochromis niloticus* in concrete ponds.

The feeding trial was conducted in six concrete ponds of about 50 m<sup>2</sup> each. The control and experimental groups were run in duplicate with stocking density of 2 fish/m<sup>2</sup>. The treatment groups were fed at 5% of their body weight with the respective test feeds and the control group was left without any supplementary feed. The results of the experiment showed that fish given supplemental diets grew much faster (ANOVA,  $P < 0.05$ ) than the control group. Although no significant growth differences were observed between the test feeds (ANOVA,  $p = 0.42$ ), fish raised in mixture of plant and animal origin (0.35 g/day) showed better growth rate than plant origin. Differences in growth rates between the control and test feeds as well as among the test feeds can be attributed to both direct and indirect effects of supplementary feeds given to the fish. Direct intake of feeds by the fish provides more nutrients resulting in better growth and production. Therefore, all supplementary feeds have an impact on the growth of *O. niloticus* in ponds.

**Keywords:** Growth, *Oreochromis niloticus*, Pond experiment, Supplementary feeds

### 1. Introduction

Over the last decade, spectacular growth has taken place in aquaculture. Most production in developing countries is realized from pond-based or open-water extensive, improved extensive and semi-intensive practices using polyculture farming technologies.

It is obviously agreed that global aquaculture production will continue to increase, and much of the increased production in developing countries of Asia and Africa is likely to be achieved through the expansion of semi-intensive, small-scale pond aquaculture. Nutrition and feeding will play an essential role in the sustained development of this aquaculture. Therefore, it is imperative that fertilizers and feed resources continue to be produced and refined. Sustained development of aquaculture, however, must take into account and ensure that the needs of competing users are met, and that environmental integrity is protected. Therefore, sustainable aquaculture management should address allocation of inputs based on local circumstances, and balance maximizing profitability with social and environmental costs (Hasan, M.R. 2001) [1].

Improvement of feed and nutrition in aquaculture may give us the opportunity to further improve the nutritional quality and benefits of the fish consumed. Nutritional value, colour and appearance, smell and taste, texture and storing capacity may all be affected by the quality of nutrition and feed provided during culture.

Feed Technology is one of the least development sectors of aquaculture particularly in developing countries. Selection of feed ingredients for use as a fish feed will play a major role in matching its ultimate nutritional in addition to economic success. Fish feed generally constitutes 60–70% of the operational cost in aquaculture system. The need to minimize

feed cost through the use of newer and cheaper sources of feed ingredients, has already been considered. Several feed ingredients have been investigated in an attempt to find substitutes for fish meal in the diets of tilapia, including animal proteins and plant proteins sources. These feeds are cheaper than fish meal and enjoy high availability in certain regions of the world. The use of these ingredients in farmed tilapia diets have led to reduced feed efficiency and growth. Also, the competing demand for these fish feed stuff has made feed production expensive (Ahmed E., *et al.*, 2015) [2].

Feed ingredients of plant origin such as corn, soybean, cotton seed and wheat, and such by-products oil cake, bran, etc are locally available. Even though, bone and meat meal are locally available their supply are limited and variable. Since fish are processed mostly in an artisanal way, there is no reliable source of fish meal available (Arjo R *et al.*, 2012) [4].

Growth, health and reproduction of fish and other aquatic animals are primarily dependent upon an adequate supply of nutrient, both in terms of quantity and quality, irrespective of the culture system in which they are grown. Supply of inputs (feeds, fertilizers etc.) has to be ensured so that the nutrients and energy requirements of the species under cultivation are met and the production goals of the system are achieved (Hasan, M.R. 2001) [1].

Tilapia ingests a wide variety of natural food organisms, including plankton, some aquatic macrophytes, planktonic and benthic aquatic invertebrates, and larval fish, detritus, and decomposing organic matter. With heavy supplemental feeding, natural food organisms typically account for 30 to 50 percent of tilapia growth. In supplementally fed channel catfish only 5 to 10 percent of growth can be traced to ingestion of natural food organisms (Hepher, B. 1990) [12].

Tilapias are often considered filter feeders because they can

efficiently harvest plankton from the water. However, tilapia does not physically filter the water through gill rakers as efficiently as true filter feeders such as gizzard shad and silver carp. The gills of tilapia secrete a mucous that traps plankton. The plankton-rich mucous, or bolus, is then swallowed. Digestion and assimilation of plant material occurs along the length of the intestine usually at least six times the total length of the fish (Sargent, J. 1992) [21].

In general, tilapia digest animal protein in feeds with an efficiency similar to that of channel catfish, but are more efficient in the digestion of plant protein, especially more fibrous materials. Tilapia requires the same ten essential amino acids as other warm water fish. Protein requirements for maximum growth are a function of protein quality and fish size and have been reported as high as 50 percent of the diet for small fingerlings (Thomas P *et al.*, 1999) [22].

Investigations on the development of alternative low-cost feeds suitable for small-scale farmers have become a priority in many developing countries, including sub-Saharan Africa. Agro-industrial byproducts are known to be important sources of carbohydrate, lipids and protein for somatic growth of fish in semi-intensive cultures (Liti *et al.*, 2005; 2006; Ashagrie Gibtan *et al.*, 2008) [17, 18, 6].

Aquaculture development in Ethiopia has been among the less attended sector of the economy for a longer time, with limited budget and manpower allocated to it. It needs to be recognized as an alternative means of achieving food security and poverty reduction in the rural area, and is now considered an integral part of rural and agricultural development policies and strategies (Asfaw, 2011) [5].

Even though few farmers are starting an aquaculture farm, feeding their fish is not still practiced. Therefore, it is necessary to look for appropriate candidates which are least cost among the locally available food sources for the better fish production. This study was therefore, conducted to evaluate the effect of supplementary feeding of only plant material origin (Noug cake, Brewery waste & wheat bran) and mixture of plant and animal origin (Fish meal, Brewery waste & wheat bran), on the growth performance of *O. niloticus* in concrete experimental ponds.

## 2. Objectives

- To evaluate the growth performance of Nile tilapia among locally available feeds
- To identify the best fish feed combination among locally available feeds.
- To examine the effect of feeds on water quality

## 3. Materials and Methods

The pond experiment was conducted at Bahir Dar Fisheries and other Aquatic Life Research Centre (BFALRC), which is located 1.5 km from town to center and situated at 1800 m above.

A total of 6 concrete ponds each with an area of 50 m<sup>2</sup> were used to carry out the experiment. The experiment was conducted for a period of six months between May and November 2015. It was conducted on a randomized design with duplicates per treatment. All ponds were then filled to an average depth of 0.8 m from Lake Tana and about one-third of the pond water was changed monthly.

Before the stocking of the ponds with the experimental fingerlings, all ponds were left for two weeks to allow the

natural growth of algae. *Oreochromis niloticus* fingerlings stocked for the experiment were collected from the Bahir Dar Fisheries and other Aquatic Life Research Centre.

The collected fingerlings were then acclimatized in ponds for about two weeks before the start of the feeding experiment. The feeding trial consisted of two treatment groups, fed with only plant material origin (Noug cake, Brewery waste & wheat bran) and mixture of plant and animal origin (Fish meal, Brewery waste & wheat bran).

The control group was deprived of any feed supplementation. Fish having similar sizes (7- 8 cm TL) were selected and stocked randomly into ponds. A total of 100 fish (2 fish/m<sup>2</sup>) were stocked in each pond. Total length (TL) and total weight (TW) of fish were measured from each pond every month throughout the study period. Fish were fed with supplementary diets at 5% of their total body weight. The daily ration was given twice a day, in the morning (10:00 am) and in the afternoon (3:00 pm).

The daily ration was calculated and adjusted regularly according to the weight gain of the fish every month. About 50% of the stocked fish and water quality data were sampled monthly to monitor the growth of fish to the nearest 0.1 cm in total length and 0.1 g total weight. Mortality of fish was monitored and recorded continuously throughout the experiment. At the end of the experiment, the volume of the water was reduced and all fish were harvested using beach seine.

Growth performances of fish were determined in terms of final individual weight (g). Rates of survival (%), Relative growth rates (RGR) and Fulton's condition factor (FCF) were computed in the experiment. Growth parameters were calculated following standard equations given below (Adebayo *et al.*, 2004) [1].

- Relative growth rate (RGR) (Busacker *et al.*, 1990) [8]:

$$RGR = [(W_2 - W_1) / (W_1 \times T)] \times 100 (\% / \text{day})$$

Where:

W<sub>1</sub>: Initial weight at the start of the studied period (g).

W<sub>2</sub>: Final weight at the end of the studied period (g).

T: Time of the studied

- DGR (g/day) = Final weight (g) – Initial weight (g)/culture period
- Weight gain (g) = Final weight (g) – Initial weight (g)
- Survival rate (%) = (Number of fish harvested/Number of fish stocked) x100
- FCF = TW/TL<sup>3</sup>\*100, where TW is total body weight in g, TL total length in cm

Nutrient content of supplementary feeds was chemically determined following the Association of Official Analytical Chemists methods (AOAC, 1990) [3]. Moisture content was estimated by heating samples in an oven at 100°C for 24 hours, and weight loss of samples was computed and expressed in percentage. Total organic matter (TOM) was determined by igniting a known weight of sample at 550°C for 6 hours in a furnace. Loss in weight between the initial and final weight was taken as TOM. Crude protein was estimated based on the nitrogen value multiplied by a factor of 6.25 (Gnaiger and Bitterlich, 1984) [10]. Lipid was determined gravimetrically using chloroform-methanol solvent (Barnes and Black, 1973) [7]. Total carbohydrate was estimated calorimetrically using standard technique (AOAC, 1990) [3].

A one-way ANOVA was used to test the effect of supplementary feeds on the growth performance of experimental fish. Differences were considered significant at  $p < 0.05$ . All data were analyzed using the SPSS software program of statistical analysis (Mead *et al.*, 1993) <sup>[19]</sup>.

**4. Results**

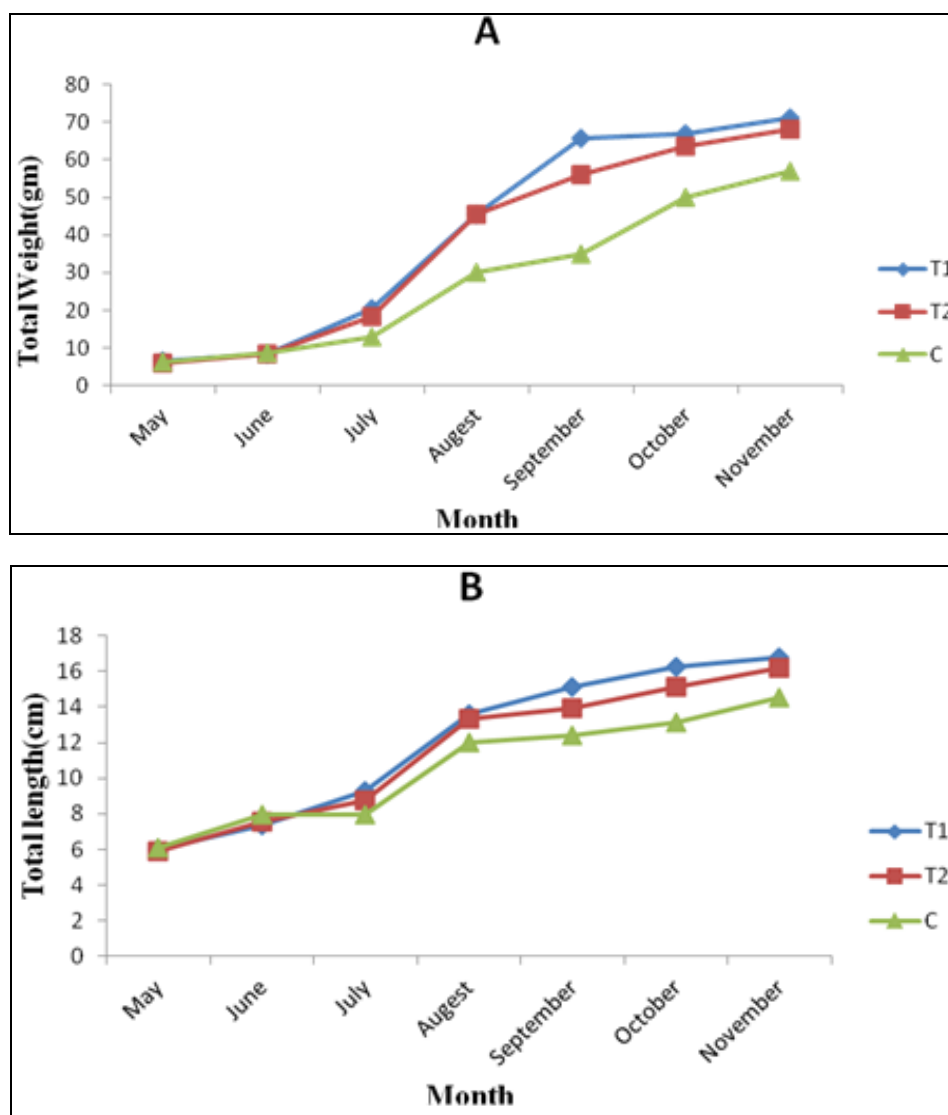
Among the growth parameters of *Oreochromis niloticus* final weight, weight gain, final length, daily growth and Relative growth rate showed significance difference (ANOVA,  $P < 0.05$ ) between treatments presented in Table 1. Generally, among the dietary supplements, fish fed with mixture of plant and animal origin (Fish meal, Brewery waste & wheat bran) had the highest mean weight followed by only plant material origin (Noug cake, Brewery waste & wheat bran). However, the control group showed the lowest mean weight compared with the treatment groups.

**Table 1:** Growth parameters of *O. niloticus* including  $\pm$  Standard Error (SE) Parameter Mean ( $\pm$  SE)

Parameters	T1	T2	Control	P-Value
Initial weight (g)	8.2 $\pm$ 0.57	8.25 $\pm$ 0.34	8.5 $\pm$ 0.39	$P > 0.05$
Final weight (g)	71 $\pm$ 1.41	68.23 $\pm$ 2.12	57 $\pm$ 4.24	$P < 0.05$
Initial length (cm)	7.4 $\pm$ 0.14	7.5 $\pm$ 0.01	7.93 $\pm$ 0.17	$P < 0.05$
Final length (cm)	16.7 $\pm$ 0.35	16.1 $\pm$ 0.08	14.5 $\pm$ 0.71	$P < 0.05$
Weight gain (g)	62.8 $\pm$ 1.98	59.98 $\pm$ 2.12	48.48 $\pm$ 4.63	$P < 0.05$
Daily growth rate (g/day)	0.35 $\pm$ 0.01	0.33 $\pm$ 0.14	0.27 $\pm$ 0.02	$P < 0.05$
Relative growth rate (RGR)	4.27 $\pm$ 0.43	4.03 $\pm$ 0.02	3.17 $\pm$ 0.44	$P < 0.05$
Survival rate (%)	93.5 $\pm$ 0.71	93.5 $\pm$ 0.71	92	$P > 0.05$

T1- fish meal, wheat bran & brewery waste T2- noun cake, wheat bran & brewery waste

Growth trends of *Oreochromis niloticus* supplied with different supplemental diets are shown in Fig.1. The rate of growth of fish appears faster between July and September.



**Fig 1:** Growth in (a) total weight and (b) total length of *O. niloticus* fed with different agro-industrial feeds in ponds. (C - Control, T1- Treatment1 & T2- Treatment2)

Feed formulation of the two group were based on 30%CP. The levels of major chemical nutrients found in the supplemental diets composition are shown in Table 2. FM (57.4%), NC

(31.2%) and BW (27%) contained more protein compared with WB (13.7%).

**Table 2:** Nutrient composition (% dry weight) of supplementary feeds.

Nutrient content% DM	FM	NC	BW	WB
Crude protein	57.4	31.2	27	13.7
Total lipid	1.8	6.7	2.7	3.6
Organic matter	33.6	90	94.8	92.2
Ash	5.2	10.2	3.2	7.8
Dissolved matter	92	91	90.5	89.2

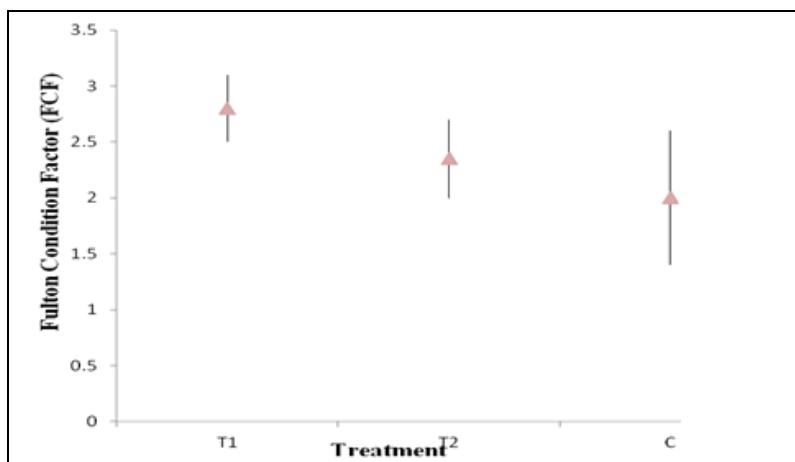
FM-fish meal, NC- noug cake, WB- wheat bran, BW- brewery waste

During the experiment, among the physical water quality parameter total dissolved solid showed significance difference ( $p < 0.05$ ) between treatments, excluding total dissolved solid the other physical parameters showed no significance difference ( $p > 0.05$ ) between treatments (Table 3).

**Table 3:** Water quality parameters recorded during the period of study including  $\pm$  Standard error (SE) parameter mean ( $\pm$  SE)

Parameter	Treatments			P-Value
	T1	T2	C	
T <sup>0</sup>	24.38 $\pm$ 2.20	23.88 $\pm$ 2.36	23.50 $\pm$ 2.33	$p > 0.05$
Cond	128.62 $\pm$ 24.52	126.37 $\pm$ 15.34	126.88 $\pm$ 25.44	$p > 0.05$
Sp.con	128 $\pm$ 25.07	127.37 $\pm$ 18.94	125.87 $\pm$ 26.53	$p > 0.05$
TDS	0.08 $\pm$ 0.01	0.08 $\pm$ 0.01	0.18 $\pm$ 0.29	$P < 0.05$
Sal	0.06 $\pm$ .010	0.06 $\pm$ .006	0.06 $\pm$ .011	$p > 0.05$
DO	5.38 $\pm$ 1.061	5.75 $\pm$ 1.035	5.88 $\pm$ 1.126	$p > 0.05$
PH	7.25 $\pm$ 1.165	7.38 $\pm$ 1.188	7.12 $\pm$ 1.36	$p > 0.05$

The Fulton's condition factor of the fish in the treatment and control groups showed variations as shown in Fig. 2. Fish given supplementary diets were found to be in better condition than the control which agrees with the superior growth rate of the treatment groups.



**Fig 2:** Fulton's condition factor (FCF  $\pm$  s.d.) of *O. niloticus* fed with different agro-industrial byproducts. C - Control, T1-(brewery waste, wheat bran, Fish meal) and T2 – (brewery waste, wheat bran, noug cake)

**5. Discussion**

Feeding of plant and animal origin (Fish meal, Brewery waste & wheat bran) and only plant material origin (Noug cake, Brewery waste & wheat bran) to *Oreochromis niloticus* fingerlings showed notable variations on the growth performance of fish between the test groups and the control. Results were also reported on single which are not formulated supplementation feeds experiment on brewery waste, noug cake and wheat bran to *Oreochromis niloticus* fingerlings

showed remarkable variations on the growth performance of fish (Zenebe Tadesse *et al.*, 2012) [24]. Fish supplied with supplementary feed grew significantly better than the control group (ANOVA,  $P < 0.05$ ). Among the experimental groups, fish fed mixture of plant and animal origin grew better than fish fed with only plant material origin. However, the difference in fish length and fish weight between the treatment group was not significant (ANOVA,  $p = 0.17$  &  $p = 0.42$ ; Table 4).

**Table 4:** One-way ANOVA results on the variations in total weight and total length of fishes fed with different supplemental diets.

Parameters	df	F critical value	Tabulated F value	P-value
1) Variation in fish total weight (TW)				
a) All groups (Controls; T1;T2)	2	9.552	16.235	$P < 0.05$
b) Between treatments (T1;T2)	1	18.513	1.031	.42
2) Variations in fish total length (TL)				
a) All groups (Controls; T1;T2)	2	9.552	18.877	$P < 0.05$
b) Between treatments (T1;T2)	1	18.513	4.617	.17

The considerable variations in the results recorded for optimum dietary protein requirements for maximum growth might be due to the variations in fish size and age, stocking density, protein quality, hygiene and environmental conditions or other unknown factors which mask the standardization of the parameters (Ahmad *et al.*, 2004).

A study by De Silva and Radampola (1990) [9] on tilapia (*Oreochromis niloticus*) showed that the optimal protein level required for the growth of both males and females was 30%. According to this experiment *Oreochromis niloticus* can achieve the optimum growth and feed utilization at moderate dietary protein level of 27% CP (Mohsen Abdel-Tawwab, 1990) [20].

This indicates that the amount of protein level in this study appear to be sufficient enough for optimal growth of the fish. The growth rate of fish varied between months in all groups. Fish showed relatively better growth rate between July and September. On the other hand relatively better growth rate was observed between March and June (Zenebe Tadesse *et al.*, 2012) [24]. The difference for growth rate of fish might be because of the climatic change during the study period.

Fish kept in the control group showed lower growth rate indicating that the natural diet is insufficient to support high fish growth. Comparably poor growth of the control fish has been reported in a similar experiment conducted earlier by Kebede Alemu (2003) [16]. Variation in growth performance and feed utilization efficiency were caused due to differences in the quality of supplemental diets in terms of nutrient composition (Kassaye *et al.*, 2014) [14].

Among the growth performance parameter of *Oreochromis niloticus* final weight, weight gain, final length, daily growth and relative growth rate showed variation between treatments. This result showed on similar experiment fish fed with brewery waste (BW) and noug cake (NC) had the highest mean weight followed by wheat bran (WB). However, the control group showed the lowest mean weight compared with the treatment groups (Zenebe Tadesse *et al.*, 2012) [24]. In contrary experiments showed there were no significant differences in SGR, weight gain, apparent consumption or survival among dietary treatments (John M, *et al.*, 2007) [13].

The mortality of fish was found no significant difference ( $p < 0.05$ ) between treatments. In pond and in tank experiments, survival rate did not show any significant differences, and values were higher in both culture systems, ranging from 89.4% to 93.3% in tanks and from 85.0% to 90.0% in ponds. Similar result showed in pond and in tank experiments, survival rate did not show any significant differences (Y. Abou *et al.* 2013) [23].

## 6. Conclusion

It is concluded that supplementation of agro industrial byproducts such as brewery waste, noug cake and wheat bran resulted in better growth performance of in ponds. Mixing of fish meal, brewery waste and wheat bran with 30%CP resulted in better growth performance of *O. niloticus*. Even though mixed sex and social behavior of the fish have impacts on the growth performance *O. niloticus*. More detailed studies should be conducted to investigate these aspects under different agro-ecologies, feed combination, and tilapia strain and pond management in the future.

## 7. Acknowledgement

I would like to express my appreciation to all staffs for their support during monthly fish sampling and data collection especially for Gebeyehu Fantahun. I would also indebted to Sebeta Fisheries and Other Aquatic Life Research Centre for assistant to provide fund and other facilities for the research.

## 8. References

1. Adebayo OT, Fagbenro OA, Jegede T. Evaluation of *Cassia fistula* meal as a replacement of soyabean meal in practical diets of *Oreochromis niloticus* fingerlings. Aquacult. Nutr. 2004; 9:99-104.
2. Ahmed E Ali, Mohamed I Mekhamar, Ali G Gadel-Rab, Alaa GM Osman. Evaluation of Growth Performance of

- Nile Tilapia *Oreochromis niloticus* Fed *Piophil* *casei* Maggot Meal (Magmeal) Diets, Department of Zoology, Faculty of Science, Al-Azhar University, Assiut, EAJLSE, 2015; 3(6-1):24-29.
3. AOAC (Association of Official Analytical Chemists). Official Methods of Analysis. 15th ed. AOAC, Arlington, V.A. USA. 1990.
4. Arjo R, Arie P, Eshete D, Andries K, Willem V, Eugene R *et al.* Business opportunities for aquaculture in Ethiopia. 2012.
5. Asfaw A. Effect of feed quality on growth performance and water quality in cage culture system for production of Nile tilapia [*Oreochromis niloticus*, (LINNAEUS, 1758)] in lake hora-arsedi, ethiopia, school of graduate studies, Addis Ababa university. 2011.
6. Ashagrie Gibtan, Abebe Getahun, Seyoum Mengistou. Effects of stocking density on the growth performances and yield of Nile Tilapia (*Oreochromis niloticus* L. 1758) in a cage culture system in Lake Kuriftu, Ethiopia. Aquac. Res. 2008; 39:1450-1460.
7. Barnes H, Black J. Estimation of lipids in marine animals and tissues: Detailed investigation of the phosphovanilline method for "total" lipids. J Exp Mar Biol Ecol. 1973; 12:103-118.
8. Busacker GP, Adelman IR, Goolish EM. Fish growth. In C.B. shereck and P. Moyle editors. Methods for fish Biology. American Fisheries Society, Maryland. 1990, 363-387.
9. De Silva SS, Radampola K. Effect of dietary protein level on the reproductive performance of *Oreochromis niloticus*. In: The Second Asian Fisheries Forum, (Hirano and Hanyu, I., Eds.). AFS, Manila, Philippines. 1990, 559-563
10. Gnaiger E, Bitterlich G. Proximate biochemical composition and caloric content calculated from elemental CHN analysis: A stoichiometric concept. Oecologia 1984; 62:289-298.
11. Hasan MR. Nutrition and feeding for sustainable aquaculture development in the third millennium, Department of Aquaculture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh. 2001.
12. Hephher B. Nutrition of pond fishes, Cambridge, Cambridge University Press, 1990, 388.
13. John M, Gonzales Jr, Alison H Hutson, Megan E Rosinski y, V Wu, Paul B Brown *et al.* Evaluation of Fish Meal-Free Diets for First Feeding Nile Tilapia, *Oreochromis niloticus*, JAA, 2007; 19(3).
14. Kassaye Balkew Workagegn, Elias Dadebo Ababboa, Girma Tilahun Yimer, Tigist Ashagre Amare. Growth Performance of the Nile Tilapia (*Oreochromis niloticus* L.) Fed Different Types of Diets Formulated from Varieties of Feed Ingredients, Department of Biology, College of Natural and Computational Sciences, Hawassa University. 2014; 5:3.
15. Kaushik SJ. Applied nutrition for sustainable aquaculture development. In Book of Synopses, p. 155-158. NACA/FAO International Conference on Aquaculture in the Third Millennium, 20-25 February 2000, Bangkok. 2000.
16. Kebede Alemu. The growth performance of *Oreochromis niloticus* L. reared in fresh water ponds loaded with

- varying levels of poultry manure. SINET: Ethiop. J Sci. 2003; 26:17-21.
17. Liti D, Cherop L, Mungitti J, Chorn L. Growth and economic performance of Nile tilapia (*Oreochromis niloticus*) fed on two formulated diets and two locally available feeds in fertilized ponds. Aquac. Res. 2005; 36:746-752.
  18. Liti DM, Mugo RM, Munguti JM, Waidbacher H. Growth and economic performance of Nile tilapia (*Oreochromis niloticus* L.) fed on three brans (maize, wheat and rice) in fertilized ponds. Aquacult. Nutr. 2006; 12:239-245.
  19. Mead R, Curnow RN, Hasted AM. Statistical Methods in Agriculture and Experimental Biology. 2nd ed. Chapman & Hall, London, UK, 1993, 415.
  20. Mohsen Abdel-Tawwab. Comparative growth performance and feed utilization of four local strains of Nile tilapia (*Oreochromis niloticus* L.) collected from different locations in Egypt, Fish Ecology Department, Central Laboratory for Aquaculture Research, Abbassa, Abo-Hammad, Sharqia, Egypt. 1990.
  21. Sargent J. New developments in the omega-3 story from man to fish and heart to brain. Aquacult. News, 1992; 14:4-5.
  22. Thomas Popma, Michael Masser. Tilapia Life History and Biology, Southern Regional Aquaculture Center SRAC, Publication No. 283 Auburn University and Texas A&M University. 1999.
  23. Youssouf Abou, Martin P Aina, Emile D Fiogbé, Jean-Claude Micha. Growth and fatty acid composition of Nile tilapia (*Oreochromis niloticus* L.) fed *Azolla*-diets, in tanks and in earthen ponds: A comparative study, 2013; 5(1):77-83.
  24. Zenebe Tadesse<sup>1</sup>, Abeba Wolde Gebriel, Mulugeta Jovani, Fekadu Tefera, Fasil Degefu. Effect of supplementary feeding of agro-industrial byproducts on the growth performance of Nile tilapia (*Oreochromis niloticus* L.) in concrete ponds, Ethiop. j biol sci. 2012; 11(1):29-41.