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Replacing Soya Bean Meal with Fish Offal Meal and Poultry Litter in the Diets of Nile Tilapia (*Oreochromis niloticus*) Reared in Pond Culture on their Growth Performance and Carcass Composition

Sebsibe Amesa[1], Tegene Negesse[2]* and Yosef Teklegiorgis[2]

[1]*Agricultural Technical and Vocational Educational Training College, Ethiopia*

[2]*School of Animal and Range Sciences, Ethiopia*

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***Corresponding author:** Tegene Negesse, School of Animal and Range Sciences, College of Agriculture, Hawassa University, P. O. Box, 05, Hawassa, Ethiopia, Email: tegenengss38@gmail.com

Abstract

The objective of this study was to evaluate the effect of substituting soya bean meal (SBM) with fish offal meal (FOM) and poultry litter (PL) in the diets of Tilapia (*Oreochromis niloticus*) on their growth and profitability. A feeding trial was conducted for 84 days with four diets run in duplicates in eight concrete ponds of about 25m^2 areas with a stocking density of 2fish/m^2. Fifty (50) fingerlings per pond (7.28+0.19gm, 7.56+0.26cm long) were randomly assigned to each of the four diets. The basal diet was formulated out of bone and meat meal (40-46%), noug seed cake (5-9%), wheat flour (20%) and maize flour (11-16%). Diets were: T1=15% soya bean meal +85% basal diet, T2=10% soya bean meal +5% wheat bran+85% basal diet, T3=15% poultry litters +85% basal diet, T4=15% fish offal meal +85% basal diet. Fishes were fed 5% of their body weight twice a day (10:00 Am and 4:00 Pm). At the end of the experimental period, flesh/filet was taken from five fishes per replicate to evaluate its composition. There were no significant differences (P≤0.05) in body weight gain, body length, feed intake, feed conversion ratio, protein efficiency ratio and carcass composition among groups although fish fed T3 and T4 showed slightly higher growth performance than those fed on T1. In addition to the direct intake of nutrients; the addition of PL and FOM might have increased the growth of organic nutrients which are natural and good quality food for the fish resulting in better growth. The numerically lower growth performance observed on fishes fed T1 might be due to trypsin-inhibitor present in SBM. Dietary replacement of SBM with PL and FOM in fish diet produced similar effect on growth performance, health and profitability of Nile Tilapia. Further study on digestibility of poultry litter and fish offal meal in fish diet is suggested.

Keywords: *Oreochromis niloticus*; Poultry litter; Fish offal meal; Carcass composition; Growth performance

Introduction

Aquaculture is the fastest growing food-production sector in the world and is viewed as a viable solution to alleviate global nutritional deficiencies and poverty. Given the declining status of wild fish stocks, aquaculture may one day surpass capture fisheries in terms of food-fish production. In addition to the economic contributions, aquaculture has the potential for mitigating environmental impacts, because it does not emit greenhouse gases in to the atmosphere and that makes fish species desirable for production [1-3]. Tilapia fish species are among the most important warm water fishes used for aquaculture production in the tropics and sub-tropics [4].

Over 20 species of Tilapia are known to be used in aquaculture either at subsistence or commercial scale worldwide. Nile Tilapia, *Oreochromis niloticus*, is one of the most cultured fish accounting for over 60% of the total tilapia finfish production in the world due to its suitability for semi-intensive and intensive culture system and its ability to utilize a variety of feed originating from plants, animals or mixed feeds [5-6]. In addition its reproduction, growth and tolerance to salinities up to 19 parts per thousand [7] makes it a desirable candidate for aquaculture.

To increase the productivity of Nile Tilapia in aquaculture requires the use of complete diets since the natural feed is not able to meet the requirements of fish when raised in tanks and pond, where nutrient deficiencies or unbalanced diets can lead to productivity losses and consequently lower economic profit. In intensive fish farming, the feeding factor can reach up to 70% of the total production cost, a fact that has stimulated studies on finding alternative foods that meet the nutritional requirements of animals, without, altering the quality of diets [8].

Diets in cultured *O. niloticus* are mostly based on conventional feedstuffs such as soybean meal, fish oils and fishmeal but these ingredients are expensive for the poor fish farmer, because of greater competition between fish and other livestock as well as human beings during times of food shortages [9]. Consequently attention should be focused on wise use of resources available on farm such as agro-industrial byproducts which is a more feasible mechanism for the farmer to increase the productivity of the pond at minimal cost than conventional feeds [10].

The by-product from poultry industry tend to have high concentration of nitrogen (N), phosphorus (P) and potassium (K), cheap and easily available compared with other sources of organic animal proteins. The production of tilapia in ponds using poultry litters as fertilizers and as supplementary feed allows production of low-cost fish [9].

According to Oparaku [11] fertilizing the pond with raw poultry litters will enhance the production of natural food organisms such as microbes, phytoplankters and zooplankters which would serve as food for the fingerlings. These natural foods contain excess of protein, which is limiting and costly nutrient in supplementary feeding.

A notable feed ingredient with high nutrient content that deserves attention as livestock protein source available in the rift valley of Ethiopia is fish offal meal. Fish offal meal is cheaper, locally available and provides an important protein and oil source for most fish and animal culture. Its unique amino acid profile, high digestibility and oil content have led to its use in most Nile Tilapia fish diets and reduce competition for food with humans and solve the problem of waste disposal [12,13].

Substitution of commercial soya bean meal and fish meal, with economically feasible agro-industrial by-products is being widely explored in aquaculture and on-farm formulation of these feed using locally available material could reduce the costs of fish farming, increase profits and growth performance of fish.

However, information on feeding of fish offal meal, wheat bran and poultry litter for fish is not present in the study area. Therefore in this study growth performance, meat composition and profitability of of *O. niloticus* was evaluated when soya bean meal in the diet was totally replaced with fish offal meal and poultry litter and partially replaced with wheat bran.

Materials and Methods

Description of the study area

This experiment was conducted at Alage Agricultural Technical and Vocational Education and Training College. The college is located 217km south of Addis Ababa and 32km west of Bulbula. It is situated at 7 ° 65' N latitude and 38° 56' E longitudes and at an altitude of 1600 meters above sea level. The mean annual rainfall is 800 mm, the annual mean minimum and maximum temperatures are 11°C and 29 °C, respectively.

Experimental ponds and fish management

Fish rearing was done in eight rectangular concrete ponds, each having an area of 25m^2 with 1.4m depth. Water supply to these ponds was obtained from reserve water via the main canals of the Jido River. Before the water entered into the experimental ponds, it was sieved to avoid entrance of wastes, frogs and pests. The ponds had common water supply and drainage through fuel pump.

Before the start of the actual experiment, ponds were dried and disinfected by adding limestone (15 kg/ha) to prevent the growth of pests and frogs that may affect the actual experiment. Liquid lime was applied by spraying homogeneously on the floor of the experimental ponds. All ponds were filled to an average depth of 1m and about one-third of the water was changed every two weeks. Un-sexed Nile Tilapia (*Oreochromis niloticus*) fingerlings were collected from Zeway Fishery Resource and Research Center and transported early morning using air-conditioned transport car. Then fishes were acclimatized to the ponds for 14 days before actual experimental data collection began. During the adaptation period, the fish were fed the basal diet and death of fishes was recorded daily.

Water temperature and pH were measured every 7 days, two times a day at 10:00 AM and 4:00 PM using thermometer and pH meter (Crimson instruments, S.A., Riera Principal, 34.36, Spain), respectively. The water turbidity was measured every month by using a 25cm wide black and white Secchi disc [6].

Collection and preparations of experimental feeds: Soybean meal, wheat flour, maize flour, nouge seed cake and wheat bran were purchased from Zeway local market and bone and meat meal from Addis Ababa abattoir center (*Kera*). Soybean was roasted for 5 minutes till the beans were brown to deactivate the trypsin inhibitor [14].

Six months old poultry litter was collected from the layer house of poultry farm of the Alage ATVET College. It contained sawdust that was used as a bedding material, dropping from birds, small feathers and broken eggs and leftover feeds. It was ground and sieved through 2mm to remove coarse materials.

Fish offal (gut, head, skin, scale, eggs, gills, and gonads of catfish and tilapia) was bought from the fishermen of Zeway; collected in clean plastic sheets to protect from contaminations; and transported to the Alage ATVET College. The wet weight was recorded for each sample each day and average dry matter was determined. The content was chopped using knife to reduce the particles size to facilitate cooking and grinding of the offal and then boiled at 100 °C for 20 minutes [12]. After removing the water and oil from the surfaces, the residue was sun dried for seven days with a minimum turning of three times a day to facilitate drying. Then it was ground mechanically using pestles and mortar, sieved through 2mm and put in clean sacks and stored in a cool, clean and dry place [15].

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Experimental diets: Proportion of feed ingredients used in this study is presented in Table 1. The experimental diets were prepared by fine grinding of the feed ingredients. Thereafter all ingredients included in each experimental diet were thoroughly mixed to produce a crumble and then sun dried and stored in safe area.

Table 1: Proportions of feed ingredients used to formulate treatment diets (% offered).

	Treatments			
Ingredients (%)	T-1	T-2	T-3	T-4
bone and meat meal	43	45	46	40
wheat flour	20	20	20	20
maize flour	13	11	14	16
Noug seed cake	9	9	5	9
soya bean meal	15	10	0	0
Wheat bran	0	5	0	0
poultry litters	0	0	15	0
fish offal meal	0	0	0	15
Total	100	100	100	100

Experimental design, stocking and treatment

A completely randomized design (CRD) with four treatments was used to conduct the feeding experiment. Four hundred *O. niloticus* fingerlings (7.28+0.19gm and 7.56+0.26cm long) were collected. Thereafter, fishes having similar body weight and length were randomly stocked into four groups at the rate of 2fishes/m2. The experimental groups were in duplicate. After 14 days of adaptation, fishes were offered the test diets at 5% of their body weight and fed two times a day (10:00 Am and 4:00 Pm) for 84 days through hand casting of the crumbled feed. The offer was measured daily and it was adjusted every 14 days according to the weight gain of the fish after taking body weight measurements [6].

Data collection

Every 14 days 50% of the experimental fish per pond were randomly taken and put in plastic water containers filled with water to a depth of 0.5m and body weight measured using sensitive balance (0.1gm sensitivity) and the length using a measuring board with 0.1cm sensitivity. At the end of the experiment, the volume of the pond water was reduced and all fish were harvested using beach seine net and group weight and individual final body length measured.

Total length was expressed as the distance from the tip of the snout to the end of the fine. Fish mortality was also registered throughout the trial period.

According to the data collected on change of body length and mortality, body weight gain (BWG, %) and feed intake (g); the feed conversion ratio, protein conversion ratio survival rate and Fulton condition factors were calculated [14,16].

Total weight gain (g/fish) (TWG): was calculated by subtracting initial from final body weight; average daily gain by dividing TWG by experimental period (days). Feed conversion ratio (FCR) is feed offered (g) per g of live weight gain. Protein efficiency ratio (PER) is live weight gain (g)/protein intake (g); Where protein intake per fish is the total feed offered multiplied by the % of crude protein in feed [17]. Survival rate (SR), SR= (NSF -NDF)/ NSF×100; where =NSF-Number of stocked fish and NDF=number of dead fish. Fulton condition Factor FCF = $(TW/TL^3)*100$, where TW is total body weight in g, TL total body length in cm.

Partial budget analysis

The partial budget analysis was conducted [18] to determine the profitability of agro-industrial by-product feeding for fingerlings. The partial budget analysis involves calculation of variable cost and benefits. Price of feeds was assessed three times from the local markets at Zeway, Bulbulla and Addis Ababa before purchasing experimental feeds. The selling price of experimental fishes at the beginning and end of the trial was estimated. The difference between selling prices in each treatment before and after the experiment was considered as total return (TR). The net income (NI) was calculated by subtracting total variable cost (TVC) from TR. The change in net income (ΔNI) was calculated as the difference between the change in total return (ΔTR) and the change in total variable cost (ΔTVC).The marginal rate of return (MRR) measures the increase in net income (ΔNI) associated with each additional unit of expenditure (ΔTVC) and was calculated as MRR = $\Delta NI / \Delta TVC$.

Chemical analysis of feeds and carcass

The proximate composition of diets and ingredients was analyzed in the laboratory of the Ethiopian Health and Nutrition Research Institute (EHNRI) at Addis Ababa, Ethiopia and of the fish carcass was analyzed in Animal nutrition laboratory of College of Agriculture at Hawassa University. At the end of the experiment, five fish per replicate were taken randomly and fillet was prepared to determined composition. Proximate composition of feeds and fillet were determined according to standard methods [19]. Dry matter was determined after drying the sample in an oven at (Binder model, USA) 100 °C for 24 hrs, protein (N×6.25) by using the USA manufactured Automated Gerhardt (Kjeldatherm) for digestion and Automated Kjeldhal for distillation the Kjeldhal method after acid digestion, ether extract by hexane extraction in a Soxhlet system (ANKOM XT10 fat extractor, USA), ash was determined by incineration of ingredients in a muffle furnace (Nabertherm 30-3000 °C, Germany) at 550 °C for 3 hrs. The fiber components of ingredients were also determined (ANKOM 220 fiber analyzer, USA) [20].

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Statically analysis and model used

One-way analysis of variance (ANOVA) was done using SPSS version 20 (IBM SPSS V 20, AIX, HP-UX, Lin UX, Solaris, Windows, IOS) and means were separated using the General Linear Model (GLM) and student's Tukey test at significance level of 5%.The Model used for data analysis was: Yij=μ+Ti +eij where Yij =the observed value (response parameters), μ = population mean, Ti =the effect of diet on ith treatment (i=1, 2, 3, 4) and eij = the standard error(residue).

Results and Discussion

The chemical composition of treatment feeds

The result of chemical analysis of feed ingredients used in formulation of the ration is shown in Table 2. Four experimental diets were formulated to contain about 34% crude protein, less than 5% crude fiber with variable ME content.

Table 2: The Chemical composition of the ingredients used in the experimental diets.

Ingredient	DM (%)	CP (%DM)	EE (%DM)	CF(%DM)	Ash(%DM)	ME(kcal/kg)
Noug seed cake	92.02	29.92	10.81	18.78	10.53	3393
Fish offal meal	93.61	48.6	30.46	0.24	17.64	4182
Soybean meal	92.62	33.1	17.67	4.61	3.29	4010
Poultry litters	91.46	30.27	4.39	15.29	15.09	2892
Wheat flour	90.39	11.57	3.05	1.89	1.51	3263
Maize Flour	89.43	7.82	5.33	1.84	1.02	3361
Bone and Meat meal	94.17	52.25	18.77	1.7	21.21	3492
Wheat bran	89.71	15.31	5.34	12.49	4.57	3247
T1	92.37	33.5	13	3.74	11	3465
T2	92.32	33.5	12.65	4.1	11.46	3379
T3	92.24	33.5	11.19	4.66	12.99	2732
T4	92.38	34	14.51	3.1	12.54	2552

Growth performance

Table 3: Growth performance, nutrient efficiency and survival rate of O. niloticus fed with treatment diets.

	Treatments					
Parameters	T-1	T-2	T-3	T-4	SEM	SL
Initial weight(g/fish)	7.2	7.6	7.6	6.8	0.39	NS
Final body weight(g/fish)	39.4	36.4	46.2	41.5	1.28	NS
Initial body length(cm/fish)	7.2	7.6	7.6	7.3	0.52	NS
Final body length(cm/fish)	13.8	12.1	14.7	12.6	1	NS
Body weight gain(g/fish/14d)	6.5	7.4	7.7	7.2	0.73	Ns
Daily body weight gain(g/fish)	0.38	0.34	0.46	0.41	0.01	NS
Body length gain(cm/fish/14d)	1.3	0.8	1.3	1.2	0.15	NS
Feed intake (g/fish/14d)	16.1	16.8	19.3	17.9	1.83	NS
Feed conversion ratio	2.5	2.3	2.5	2.6	0.13	NS
Protein efficiency ratio	4.4	3.8	5.6	5	0.49	NS
Survival rate (%)	100	100	100	100		

Growth performance (body weight and length) of the fishes fed the treatment diets is presented in Table 3. The growth of fish fed on the various diets tended to differ, although not significantly ($p>0.05$).Growth and production in fish culture are dependent on the daily feed consumption, qualities of feed and feeding frequency [21]. According to Emmanuel et al. [17] variability in the composition of agro-industrial by-products and diets were formulated to influence the growth of *O. niloticus.* The ability of *O. niloticus* to utilize various diets could be attributed to wide range of preference for foods. *O. niloticus* readily adapts to eating a wide variety of feeds because they have very long intestines necessary to digest feeds.

In this study, differences in growth performances expressed in terms of body weight gain (MWG) and body length gain of *O. niloticus* when substitution of soya bean meal with fish offal meal (FOM), poultry litters (PL) and wheat bran (WB) was not statistically significant ($P<0.05$) among treatment groups, this may perhaps be due preference of fishes to FOM, PL and WB. This argument agrees with the idea that poultry litters have high amount of NPK nutrients which improves its palatability and digestibility [17]. The PL is directly fed by the fish and indirectly promotes the growth of blue-green algae and diatom which are rich in protein and natural feeds of the fish. David & Kriengkrai [22] reported similar ideas where fishes raised in PL may act mainly indirectly or directly to support fish production and according to Hernandez et al. [23] PLs are consistent in quality and digestibility and more suitable for the diet of fish, due to its

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palatability, high protein, total digestible dry matter, digestible protein, ash and energy contents. As reported by Al-Asgah & Ali [24] the incorporation of PLs in fish diet up to 20% did not show any toxic effect and it has been suggested that feeding poultry litters can have the potential to replace any *O. niloticus* diets.

On the other hand as reported by Soltan et al. [25] the fish offal meal represented a good protein source due to its high content of the essential amino acids which can replace the conventional diets of *O. niloticus* The soybean protein was inferior to fish meal in terms of amino acids and protein availability due to the presence of relatively higher amounts of anti-nutritional factors in soya bean and protein is found in soybean meal as phytic acid. This form of protein is poorly utilized by fish because phytase is not present in fish and has been responsible for lowering the digestibility of protein to Nile Tilapia, *O. niloticus*. Soya bean meal is deficient in essential amino acids, especially methionine and contains protease inhibitors [26].

The optimum body growth performance of Nile Tilapia (O. niloticus) not only depends on the supplemented diet but also on natural production of organo-trophic algae which are nutritionally better than the blue-greens and the temperature, water turbidity and pH of the water, as well as the feed, formulated [6,27-29].

Feed conversion ratio (FCR) and protein efficiency ratio (PER)

Nutrient efficiencies of the fishes fed the treatment diets are presented in Table 3. Feed conversion ratio (FCR: feed per unit of body weight gain) is also an important indicator of the quality of fish diets, a lower FCR indicate better utilization of the fish feed [30].

The FCR of fishes fed diet T1, T2, T3 and T4 were not significantly different from each other which may imply that the experimental diets had comparative nutritional value to control diet. Siddiqui et al. [31] reported FCR values of 1.7-2.3 for tilapia that were fed a diet containing 34% protein for 98 days in outdoor concrete tanks. Stickney & McGeachin [32] fed a 32% protein diet to tilapia for 84 days in aquaria and obtained FCR values of 1.9-2.8. Victor et al. [33] reported FCR values of 1.67-1.79. The FCR in the present study are also higher compared to earlier reports (2.30) by Emmanuel et al. [17] and with those from Siddiqui et al. [31] and Victor et al. [33], but lower than those (2.2-5.9, 4.84-5.92) of Kassaye et al. [14] and Stickney & McGeachin [32], respectively. According to Kassaye et al. the variation in FCR may be due to lower content of protein used for body building and higher fiber content and anti-nutritional factors that limit availability of nutrients, which imply higher feed conversion ratio of fish fed. Ways to reduce those factors in the diets using different techniques to increase their potential for fingerling feeding must be devised.

Mary et al. [34] reported that high fiber and ash in the diet reduced the digestibility of other ingredients and thus lower palatability, fish growth and feed conversion efficiency.

As shown in Table 3, feed intake of the experimental fishes fed the different diets was not significantly different (p>0.05), but fish fed T3 and T4 consumed slightly higher than the rest of the groups indicating that poultry litter and fish offal meal were more palatable and digestible. Earlier Asrat et al. [12] reported no significant differences in feed intake of a monogastric animal, poultry, as protein from tilapia by-product meal substituted soybean meal protein.

In the present study, all feed offered was assumed to have been consumed by the fish. This is in line with the study of Gulderen & Murat [35]. The amount of consumed feed was calculated by feed offered. Many factors can affect the feed consumption in fish such as amount of feed, feeding frequency, size of fish, water temperature, growth, diet formulation and feed quality. Feeding frequency and amount of feed are basic principles in fish rearing and should be performed regularly. Excessive feeding causes accumulation of uneaten feed in culture media which may dissociate and affects water quality negatively. Feed losses and poor water quality decrease the feed efficiency and growth of the fish.

The results of this study revealed that protein efficiency ratio (PER) was not significantly different among treatment diets although T3 and T4 were slightly better than the other treatments.

The PER obtained in the present study is in disagreement with previous reports (1.42-1.56; 1.28-1.91) when fishes were fed for 10 weeks in glass aquarium [14,32], respectively). These differences may be due to the difference in ability of fish to utilize the protein in the experimental diets and the differences in capacity of diets to promote growth of algae and diatom.

Water quality of experimental ponds

The pH, temperature and turbidity of the experimental ponds used for the feeding trial were almost similar (Table 4).

Table 4: The pH, temperature and turbidity of the experimental ponds used for the feeding trial with *O. niloticus*.

	Treatment			
Parameters	T-1	T-2	T-3	T-4
pH value	6.77	6.87	7.93	6.78
Temperature (°C)	20.4-24.1	20.4-24.1	20.4-24.1	20.4-24.1
Sechi-depth (cm)	26.75	27.42	26.13	27.75

T-1= basal diet +15% SBM, T-2= basal diet+10% SBM +5% WB, T-3= basal diet +15% PL, T-4= basal diet +15 % FOM (Basal diet=bone and meat meal, nouge seed cake, wheat flour and maize flour), SBM: Soya Bean Meal; WB: Wheat Bran; PL: Poultry Litters; FOM: Fish Offal Meal

Management of the water quality parameters is essential in pond culture systems because environmental factors affect the fish body condition, growth performance and yield [36].

In the present study mortality was not observed by the inclusion FOM, PL and WB throughout the experimental period which disagrees with the findings of Ponce & Gernat [37], and

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Maigualema & Gernat [38] who have observed 1.74 to 2.43% and 5.35% mortality respectively when soybean meal was replaced with tilapia by-product meal. In the work of Asrat et al. [12] no impact was observed on health of chickens when fed fishmeal containing diets.

During experimental period, most water parameters in ponds were in suitable ranges for fish growth. Although there was little fluctuation in water temperature from morning to afternoon, the ranges of these values were still suitable for the growth of tilapia [21].

Water transparency in this study was between 25cm to 30cm which is optimum for fish production [39]. According to Bhatnagar & Pooja [40] turbidity ranging between 30 and 80cm is good for fish health; between 15 and 40 cm is good for intensive culture system and less than 12 cm causes stress. The pH of natural waters is greatly influenced by the concentration of carbon dioxide which is an acidic gas. In this study, the pH value was in line with earlier recommendations [40,41] whereby the pH value between 7.0 and 8.5 is optimum, ideal for biological productivity and conducive to fish life. Fishes can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0 and death is common at pH value of less than 4.0 or greater than 11.

Fulton condition factors

The Fish in all treatment groups were not significantly different (P≤0.05) for Fulton condition factors measured every 14 days (Figure 1). The result of this study revealed that Fulton's condition factors (FCF) of the fish fed all the experimental diets were not significantly different (P>0.05). This implies that the substitution of soya bean meal by fish offal meal, poultry litter and wheat bran in the fish diet could not affect the condition factor of the fish.

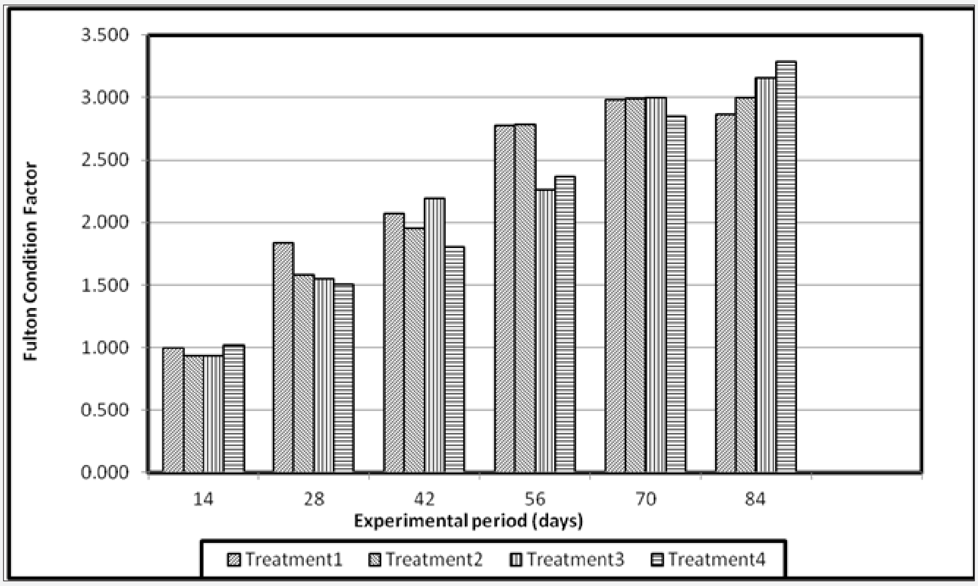

Figure 1: Mean Fulton Condition Factors (FCF) of O. niloticus over the experimental period (days) under different treatment diets

The condition factor shows the degree of well-being of the fish in their habitat and is expressed by coefficient of condition also known as length - weight factor. This factor is a measure of various ecological and biological factors such as degree of fitness, gonad development and the suitability of the environment with regard to the feeding condition [36]. Works from Emmanuel et al. [17] also relates condition factor with variations observed in average final weight (AFW), MWG, PER and FCR observed between treatment diets.

FCF values (2.89-3.02) reported by Al-Asgah & Ali [24] are close to, but those values (2.14-2.38 vs 1.6-2.0) reported by Kassye et al. [42] and Zenebe et al. [12], respectively, are much lower than the FCF found at the end of this growth trial. The FCF in the present study indicates that conditions were favorable for the growth of which implies that the management of the pond was appropriate for the experimental fishes. In the work of Khallaf et al. [43] it was indicated that when condition factor value is higher it means that the fish has attained a better condition. The condition factor of fish can be affected by stress, sex, season, availability of feeds, and other water quality parameters.

Carcass composition of experimental fish

As shown in Table 5, the results of ANOVA declared that differences in carcass composition of *O. niloticus* fed on diets when soybean meal was substituted with fish offal meal and poultry litter were not significantly different (P>0.05). The high numeric value for moisture content was shown from T3, for crude protein from T4, for ether extract from T2 and for crude fiber from T3. The chemical composition (%DM) of carcass of is presented in Table 5. From the present study crude protein *O. niloticus* (CP %) content of the fish flesh is higher than earlier reports (53.59-58.14% and 30.1-39.6%) by Samy et al. [44] and

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Mary et al. [34], respectively. However, they are only slightly higher than the values (62.6-69.9% CP) reported by Ahou et al. [45]. Ether extract and ash contents were higher than earlier reports (5.8-8.1, 3.6-4.0% EE; and 1.49-3.26, 1.31-1.41% ash) by Mary et al. [34] and Mary et al. [30], respectively. This indicates that diets were well balanced and they were also able to fertilize the living environment of the fish as manifested by the growth of blue-green algae.

Table 5: Carcass Composition of *O. niloticus* fed with treatment diets (%DM basis).

	Treatment					
Parameters	T-1	T-2	T-3	T-4	SEM	SL
Dry matter (%)	20	16.7	15.76	18.75	0.45	Ns
Crude protein (%DM)	71.37	69.46	70.33	73.31	0.28	Ns
Ether extract (%DM)	12.29	13.12	12.33	12.55	0.75	Ns
Ash (%DM)	10.48	12.16	12.12	12.12	0.56	Ns

Values are expressed as mean± SEM. Mean values in the same row having no superscript letters are indicated not significantly different (P>0.05). T-1= basal diet +15% SBM, T-2= basal diet+10% SBM +5% WB, T-3= basal diet +15% PL, T-4= basal diet +15 % FOM (Basal diet=bone and meat meal, nouge seed cake, wheat flour and maize flour), SBM: Soya Bean Meal; WB: Wheat Bran; PL: Poultry Litters; FOM: Fish Offal Meal; SL: Significance Level, NS: Not Significant

This is in line with Oliver [28] who reported that the type of feed significantly affected the lipid and amino acids profile but not the overall proximate composition for the other constituents of flesh. Like in study fish flesh quality is similarly affected by feed type, level of dietary intake and fish growth [44]. Feed composition has a major influence on the proximate composition of the whole body as well as the fillet of fish [44]; in particular, whole body lipids, as well as the lipid content in the edible fillet, are directly related to dietary fat content, while the fatty acid composition of the fish flesh is also strongly influenced by the dietary fatty acid profile. An increase in feeding rate and fish size resulted in enhanced deposition of fat and decreased water content in fish body. The protein content, however, remains more or less stable.

Partial Budget analysis

As indicated in Table 6 the partial budget analysis indicates positive net returns for all treatment diets, however the highest profit (NI) was obtained from T3 followed by T4 which is a reflection of high fish yield from these groups.

Although net returns were higher for T3 and T4, which might be due to the zero cost of poultry litters and lower cost of fish offal meal and net return in T1 is lower because of higher cost of soybean while compared to fish offal meal and poultry litter with lower variable cost which led to higher return and MRR. This is in agreement with other studies which indicated that by-product based diets were cost-effective in the production of in pond culture [34]. Dietary replacement of soybean with poultry litter and fish offal meal in fish diet produced similar effect on growth performance, health and profitability of Nile Tilapia which implies that soybean can be fully replaced with these farm byproducts. The limitation of this study is that digestibility of poultry litter and fish offal meal in fish diet was not measured.

Table 6: Partial budget analysis of substituting soybean meal with fish offal meal, poultry litter and wheat bran in the diet of *O. niloticus.*

	Treatments			
Parameters	T-1	T-2	T-3	T-4
Purchasing prices (25ETB/100 fish)	21.45	22.8	22.8	20.25
Selling Prices (30 ETB/ Kg)	118.26	109.11	138.39	124.5
Income return /100fish	96.81	86.32	115.59	104.25
Feed costs	71.09	63.24	64.63	74.91
Other costs	10	10	10	10
Prices of fish offal meal(5ETB/Kg)	-	-	-	0.53
Prices of poultry litters(ETB/kg)	-	-	0	-
Total variable cost (ETB/100 fish)	81.09	73.24	74.63	85.44
Net income (ETB/100 fish)	15.72	13.08	40.96	18.81
ΔTVC	-	-7.85	-6.46	4.35
ΔNI	-	-2.64	25.24	3.09
MRR =ΔNI /ΔTVC	-	0. 34	-3.91	0.71

T-1= basal diet +15% SBM, T-2= basal diet+10% SBM +5% WB, T-3= basal diet +15% PL, T-4= basal diet +15 % FOM (Basal diet=bone and meat meal, nouge seed cake, wheat flour and maize flour), SBM: Soya Bean Meal; WB: Wheat Bran; PL: Poultry Litters; FOM: Fish Offal Meal; ΔTVC: Change in Total Variable Cost; ΔNR: Change in Net Income MRR: Marginal Rate of Return; ETB: Ethiopian Birr; price was estimated by weight of the fish,1$=23 ETB

Conclusion

This experiment was conducted to evaluate growth performance, Impact on meat composition and profitability of *O. niloticus* when soya bean meal in the diet was replaced with fish offal meal, poultry litters and partially replaced with of wheat bran.

No significant differences were observed in the growth performance, feed intake, feed conversion ratio, protein efficiency ratio, condition factors and carcass composition of *O. niloticus* by substituting of soya bean meal with fish offal meal, poultry litter and wheat bran in its diet.

This is because fish offal meal has high amount of protein which may possibly contain essential amino acids and poultry litters may support algal development and indirectly promote fish production. On the other hand, anti-nutritional factors found in soya bean and soybean protein such as phytic acid and trypsin inhibitors might have hindered fish growth. Further study on digestibility and palatability of fish offal meal, poultry litter and wheat bran in fishes is recommended.

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