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# Effect of fasting and inclusion plant protein on growth and feed efficiency of hybrid red tilapia (*Oreochromis mossambicus* × *Oreochromis niloticus*) fry

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**Abstract**
An experiment was conducted on hybrid red tilapia fry (*Oreochromis mossambicus* × *Oreochromis niloticus*) under laboratory condition; it consisted of three treatments, the first treatment (T0) the fish did not feed or the feeding prevention with reliance on live food in reared pond. The second (T1) and the third treatments (T2) were conducted to evaluate the effect of total replacement of fish meal protein with soybean meal protein on growth performance and feed efficiency. The T1 was contain (25.3 % crude protein compose as: 1/3 animal protein source (Fish meal) and 2/3 plant protein source). However, in the T2 fry was fed on diet with 25.1% crud protein after totally replacement fish meal with plant protein source (Soybean meal). This experimental was triplicated and done in nine cement pond ($1m^3$). Fish fry with mean initial weight of (0.083±0.31g) were stocked at 25 fry/ pond, and fed to apparent situation in twice daily. The experimental duration was 60 days. The results reveled that, in spite of the feeding prevention in T0 fish can fed on natural phytoplankton in water of Qaroun lake and this can contribute 35% of the growth rate of hybrid red tilapia fry compared with fish fed on fish meal diet (T1). Also, the statistical analysis showed that there were significant differences ($p<0.05$) between T1 and T2 in specific growth rate (SGR) and survival rate, whereas the diet (T1), which contained 1/3 animal protein was better than the diet (T2), which substitute fish meal with soybean meal as a plant protein source. It can be confirmed that the hybrid red tilapia fry can used as a new tolerance species for the environmental changes condition in Qaroun Lake. The results also revealed that the supplementary diet in rearing red tilapia was essential to enhance its growth and feed efficiency.

**Keywords:** Hybrid red tilapia, animal protein, plant protein, growth performance, phytoplankton

## Introduction

Tilapia is an important freshwater fish species in aquaculture sector. They are characteristics by fast growth, adaptability to rearing on wide range of environmental conditions, disease resistance, and high flesh quality, ability to grow and reproduce in high stoking and fed on low trophic levels area (El-Sayed, 2006) [14]. Tilapia are feeding on a wide variety of dietary sources, including phytoplankton, periphyton, zooplanktons, larval fish, and detritus or it can be fed on all sources of nutrients on water bodies (Tesfahun and Temesgen, 2018) [40]. Consideration of water shortage and scarcity of fresh water in Egypt so it must be search for a new aquaculture species, which can be tolerance for high salinity, high nutrition value with a good price, such as Red hybrid tilapia. Moreover, Egypt includes many of marine lakes as well as Red and Mediterranean Sea. Red tilapia fish consider highly adaptable to seawater and showed better growth performance at water salinities more than 30 ppt. (Al-Moudi, 1987) [4]. Because of red tilapia are hybrid resulted from *O. mossambicus* male with *O. nilotics* female, therefore it showing faster-growing rates as *O. niloticus*, *O. aureus* or their hybrids.

On the other hand, nither nor the nutrition represents over 50% of operating costs but also protein itself represents about 50% of feed cost in intensive culture (El-Sayed, 2004) [13]. Therefore, replacement of fishmeal with alternative, sustainable and less expensive protein sources would be beneficial in reducing feed costs. For the mentioned reasons, soybean meal (SBM) is the main vegetable source of protein ingredients in commercial aquaculture feeds. Soybean products will play an even more important role in providing high quality protein for tilapia and other fish species. Moreover, it's containing a balanced amino acid compared with other plant protein sources (Nguyen, 2008) [27].

The new environmental changes in Qaroun lake make its reasonable to search for rearing a new tolerance fish species, so the present study aimed to evaluate the effect of Qaroun water changes in growth of red hybrid tilapia fry without feeding as well as determine the effect of the total replacement of fish meal by soya bean meal as the main source of plant protein in fry diet.

## Materials and Methods

The present study was conducted in Shakshouk Fish Research Station, Fayoum Governorate, National Institute of Oceanography and Fisheries (NIOF), Egypt. Hybrid red Tilapia (*Oreochromis mossambicus* × *Oreochromis niloticus*) fry were obtained after broodstock hatching in the station. The experimental done through June –July 2016 and lasting 60 days after start.

### The experiment design and distribution of fish in ponds

The experimental was conducted to investigate the effect of fasting (Prevention) of artificial feed and depended on the natural food in reared water ponds (T0). Three treatments were conducted to evaluate the effect of total replacement of fish meal with soybean meal in the fry diet of hybrid red tilapia as follows: the first without artificial feeding (T0) and the second treatment the fry were fed on a diet (25.3% CP) which, formulated to contain 1/3 of its protein from fish meal (T1), while the third treatment (T2) the fry fed on the diet contained (25.1% CP) with a total replacement of fish meal by soybean meal as presented in (Table, 1). This trial was conducted in nine square concrete ponds with a total water volume of 1m³. Each dietary treatment was carried out in triplicates. Fish were stocked at density of 25 fry in each pond with mean initial body weight (0.083±0.31g). Fish was hand fed to apparent satiation at (11:00 and 17:00 h) in twice daily and the water exchange rate was 35% of water volume every two days.

### Fish diet preparation

Two diets (T1 and T2) were prepared and mixed by hand. The diets formulated to be almost containing 25.3 and 25.1% crude protein (Table, 1). The diet T1 contained 1⁄3 of their protein animal protein (Fish meal), where diet T2 was used plant protein (Soybean meal) and were tested without supplemented amino acids according to Nguyen and Davis (2009) [28] and Wu *et al.* (2004) [47]. They observed that, supplementation of encapsulated methionine into diets without fish meal didn't improve growth rate, survival, and feed conversion ratio in fish. As well as, Viola *et al.* (1994a, b) [43] they found that, the addition of Lysin to soy bean meal (SBM-based diets) fed to tilapia hybrids was ineffective at 25 and 30% dietary protein.

**Table 1:** Ingredients and a proximate chemical analysis of the experimental diet

| Ingredients | Diet A (g/100 g) | Diet B (g/100 g) |
|---|---|---|
| Fish meal (72%CP) | 11.7 | - |
| Soybean meal (44% CP) | 26.3 | 45.5 |
| Yollow corn | 54 | 46.5 |
| Linseed oil | 3 | 3 |
| Starch | 2 | 2 |
| Vit. & Min. & Avimix [1] | 2 | 2 |
| Mono phosphate calcium | 1 | 1 |
| Total | 100 | 100 |
| ***chemical analysis % on Dry matter basis*** | | |
| Dry matter (DM) | 90.80 | 90.50 |
| Crude protein (CP) | 25.30 | 25.10 |
| Ether extract (EE) | 6.30 | 5.50 |
| Crude fiber (CF) | 3.00 | 5.00 |
| Ash | 4.10 | 3.40 |
| Nitrogen free extract (NFE) | 61.30 | 61.00 |
| Gross energy (GE, KJ/g)[2] | 19.57 | 19.69 |
| Digestible energy (DE, KJ/g)[3] | 16.84 | 16.45 |
| P/E ratio (mg CPKJ$^{-1}$ DE) | 15.02 | 15.25 |

Notice: - Chemical analysis was determined according to (A.O.A.C, 2006) and NFE was calculated by difference
1-Specification per 3kg of vitamin and mineral Avimix used in experimental diets, (Agri-vet for manufacturing vitamins and feed additives. Avimix for broilers).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Vitamin A | 12000.00 IU | Vitamin B² | 5000 mg | Nicotinic acid | 30.000 mg | Copper | 10.000 mg |
| Vitamin D³ | 2000.000 IU | Vitamin B6 | 1500 mg | Folic acid | 1000 mg | Iodine | 1000 mg |
| Vitamin E | 10.000 mg | Vitamin B12 | 10 mg | Manganese | 60.000 mg | Selenium | 100 mg |
| Vitamin K | 2000 mg | Biotin | 50 mg | Zinc | 50.000 mg | Cobalt | 100 mg |
| Vitamin B¹ | 1000 mg | Pantothenic acid | 10.00 mg | Iron | 30.000 mg | Carrier $CaCO_3$ | Add to3 Kg |

2-Calculated according to NRC (2011) [29].
3- Cited by Piedecausa *et al.* (2007)

### Rearing water system

The water was forced by two pumps from the source of water (Qaroun lake) to the sandy filter unit, which connected with two large tanks measure (10000 liter each tank) and then the water was release to experimental units.

### Aeration system

The system consisted of two blowers to force the air through PVC tubes, which connected with plastic pipes and this pipes transport the air to each experimental unit, the air diffusers was used to distribute of air in all pond area.

**Water measurements in experimental ponds**

Temperature, pH and salinity were measured and recorded daily by centigrade thermometer, Orion digital pH meter model 201, Refract meter (VITAL Sine SR-6, China). While, dissolved oxygen was measured every week by oxygen meter (Cole Parmer model, 5946).

**Growth performance indices**

The growth and feed efficiency parameters were calculated according the following equations:

Condition factor (K) =W/L$^3$×100.Where:W =fish weight (g) L=fish length (cm), Total Gain(TG, g) = final weight ($W_2$) – initial weight ($W_1$), Average Daily Gain (ADG, g/day) = average weight gain, g / experimental period, day, Relative Growth Rate (RGR, %) = [($W_2$ - $W_1$) / $W_1$] × 100, Specific Growth Rate (SGR, % /day) = [(ln $W_2$-ln $W_1$)/t] × 100 whereas ln: is the natural log. and t: is the time in days, Survival rate (SR%) = (Number of fish at end/ Number of fish at start) × 100 Feed Intake (FI, g/fish)= feed intake during the trial period/ the final number of fish for this trial, Protein Intake (PI g/fish) = feed protein during the reared period/ fish, Energy Intake (EI, KJ/ fish = feed energy / fish energy after the trial end, Feed Conversion Ratio (FCR) = feed intake, g / weight gain, g., Feed Conversion Efficiency (FCE, %) = (weight gain, g./ feed intake, g) × 100, Protein Efficiency Ratio (PER)= Weight gain, g/ Protein intake, g. Energy Efficiency Ratio (EER) = Weight gain, g/ Energy intake, KJ,

Cost Index (CI) = feed cost consumed/fish produced (g), Profit Index (PI**,** Egyptian pound) = value of fish crop/cost of feed consumed and the economic conversion ratio = feed cost × FCR.

**Chemical analysis**

The conversional chemical analysis of diet and whole body fish samples were carried out as described by (AOAC, 2006) [5] and Gross energy (GE) was estimated by using these factors 23.62, 39.54 and 17.56 Kilo Joule (KJ)/g for CP, EE and carbohydrates respectively (NRC, 2011) [29].

**Statistical analysis**

The data were analyzed by one-way analysis of variance (ANOVA) and significant differences were determined by Duncan Multiple range test at significant level 0.05. Data were analyzed using stat graphic package software (SPSS, 2007) [34] SPSS Inc. Released 2007. SPSS for Windows, Version 16.0.

**Results and Discussion**

**Water quality**

Water quality parameters are shown in Table (2). The averages of water temperature, water pH, water salinity, dissolved oxygen (DO) were in the optimal range of hybrid red tilapia fry as reported by (El-Sayed, 2006 and Mjoun *et al.*, 2010) [14, 24].

**Table 2:** Mean (±SE) of water quality parameters.

| | |
|---|---|
| Temperature (ºC)$^1$ | 22.77±0.49 |
| Temperature (ºC)$^2$ | 23.06±0.53 |
| pH | 8.73±0.03 |
| Salinity ‰ | 29.62±0.20 |
| DO mg/L | 7.26±0.07 |

Temperature degree before water change operation
Temperature degree after water change operation

**Growth performance parameters**

As shown in Table 3,the effect of prevention of feed (fasting) and dependent only to natural food from the lake (T0). However, the experimental diets were used in (T1) and (T2) by using fish meal in (T1) and total replacement of fish meal with soybean meal in (T2). In the first treatment (T0), the fish didn't feed on artificial diets and it depended on natural food in the water ponds. So this treatment did not statistical compare with the other treatments (T1&T2) due to the different feeding system between the (T0) and fish fed on artificial diets including (T1&T2).

**Table 3:** Growth performance parameters

| Items | Treatments | | | Sig. | SED* |
|---|---|---|---|---|---|
| | T0 | T1 | T2 | | |
| | Without feeding | Diet A | Diet B | | |
| Initial weight ($w_1$), g | 0.11 | 0.038 | 0.100 | - | - |
| Final length ($L_2$), cm | 2.52 | 2.90$^a$ | 2.88$^a$ | 0.88 | 0.15 |
| Tail length, cm | 0.85 | 0.87$^a$ | 0.85$^a$ | 0.86 | 0.13 |
| Body height, cm | 0.85 | 0.82$^a$ | 0.81$^a$ | 0.91 | 0.08 |
| Condition factor (g/cm$^3$) | 1.90 | 2.07$^a$ | 2.20$^a$ | 0.72 | 0.30 |
| Final weight ($W_2$), g | 0.30 | 0.58$^a$ | 0.53$^a$ | 0.81 | 0.18 |
| Total weight gain (TG), g | 0.19 | 0.54$^a$ | 0.43$^a$ | 0.81 | 0.18 |
| Average daily gain (ADG), g/day | 0.0032 | 0.009$^a$ | 0.007$^a$ | 0.61 | 0.0031 |
| Relative growth rate (RGR),% | 172.727 | 1421.052$^a$ | 430.0$^b$ | 0.059 | 430.98 |
| Specific growth rate (SGR/day, %) | 1.67 | 4.54$^a$ | 2.78$^b$ | 0.061 | 0.55 |
| Survival rate (SR,%) | 24 | 89$^a$ | 60$^b$ | 0.001 | 1.00 |
| Survival rate (SR, %) | 24 | 89$^a$ | 60$^b$ | 0.001 | 1.00 |

(a, b,) Average in the same row having different superscripts significantly different at (P≤0.05).
*, SED is the standard error of difference

From the same table, it can be found that, weight gain of fish (T0) was 0.19 g, which less than (T2&T3). While WG of fish fed T1 and T2 were 0.54 and 0.43, respectively. This decrease reached in (T0) as 35.18% in comparison with T1, if we consider that WG of T1 represent 100% as shown in (Fig. 1). This result agreed with the previous results reported by Abdel-Aziz (2013) [1] on red tilapia juvenile for detect the effect of fasting and the dependence only on the contents of Qaroun lake water from natural food. He reported that, Qaroun lake water contributed in fish growing 25.7% in comparison with the highest treatment in WG. Qaroun water lake is rich in phytoplankton and considered eutrophicated water as reported by Abdel-Aziz (2016) [2] who analyzed water Qaroun Lake of phytoplankton and its contents were presented in (Table, 4).

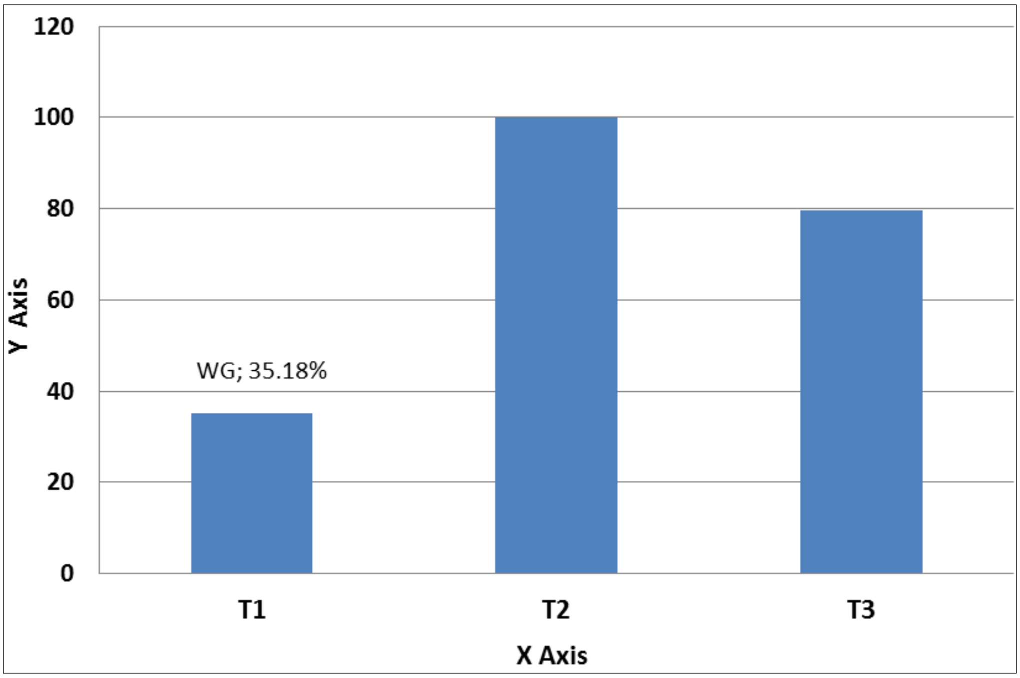


**Fig 1:** The growth of T0, if it could be considered WG of T1=100%

**Table 4:** Total phytoplankton density (No. × $10^4$ cell/l) of Lake Qaroun water according to Abdel-Aziz (2016) [2]

| List of Species | NO | List of Species | NO |
|---|---|---|---|
| Bacillariophyceae | | Cyanophyceae | |
| Amphora ovalis (Ehr.) | 5 | Chroococcus cohaerens (Breb.) Nag. | 5 |
| Coscinodiscus lineatus (Naegeli) Collins. | 5 | Eucapsis minuta (F.E.Fritsch) | 5 |
| Campylodiscus latus Her. | 5 | Lyngbya limnetica Lemmer. | 5 |
| Cymbella gastroides Grun. | 5 | Merismopedia punctata (Meyen) | 5 |
| Cyclotella glomerata (Grun) | 10 | Gomphospharium lacustris var. compacta (Lemmer.) | 5 |
| Cyclotella meneghiniana (Kutzing) | 75 | Lyngbya limnetica Lemmer. | 5 |
| Cyclotella operculata | 5 | Subtotal | 30 |
| Fragilaria construens ver.venete (Ehr.)Grun | 5 | List of Species | NO |
| Grammatophora angulosa (W. Smith) | 5 | Chlorophyceae | |
| Melosira granulata (Her.) Ralfs | 5 | Cosmarium sp. (Brebisson) Ralfs. | 10 |
| Navicula creptocephla (Gregory) | 5 | Cardiomonas Carca | 5 |
| Navicula dicephala (Gregory) | 5 | Crucigenia tetrapedia (Kirchner) West & West | 5 |
| Nitzschia acicularis W. Smith | 5 | Scenedesmus ecornis (Ehrenberg) Chodat. | 5 |
| Nitizschia palea (Chodat) | 5 | Scenedesmus dimorphus (turpin) kutz. | 5 |
| Syndra ulna (Nitzsch) Her. | 20 | Tetraedron minimum (Braun) | 5 |
| Subtotal | 165 | Subtotal | 35 |
| List of Species | NO | List of Species | NO |
| Dinophyceae | | Chrysophyceae | |
| Peridinium pusillum Stein. | 5 | Dinobryon borgei | 5 |
| Prorocentrum micans (Woloszynska) | 50 | Mallomonas sp. (Perty) | 5 |
| Prorocentrum scutellum (Woloszynska) | 125 | Mallomonas acaroides (Perty) | 5 |
| Prorocentrum minimum (Woloszynska) | 640 | Subtotal | 15 |
| Subtotal | 820 | | |

Phytoplankton were classified as microalgae and include species from the following divisions: *Cyanobacteria* (blue-green algae), *Chlorophyta* (Greenalgae), *Prochlorophyta, Euglenophyta*, *Pyrrhophyta* (Dinoflagellates), *Cryptophyta* (Cryptomonads), *Chrysophyta* and *Bacillariophyta* (includes diatoms). (Sandifer *et al.,* 1980 and Dawes, 1998) [32, 12]

As it's known that the natural food is the best and the preferable of fish fry. It is natural, healthy and money saving. Natural food plays an important role in successful spawns. Also, Planktonic algae are the primary producers of aquatic ecosystems and form the base of aquatic food webs that supports the zooplankton and fish. Micro algae are a natural component of the diet in many fish fry, it directly consumed or fed on other prey species such as rotifers (Graham *et al.,* 2009, Henry, 2012 and Rahman, 2015) [19, 21, 31].

Phytoplankton have attract ability as a feed for the fish. It is acceptable, palatable and consumes low biological oxygen also it reduced any chance of microbial degradation. Plankton regulates transparency and dissolved oxygen hence regulating sun's ray penetration and temperature and decreased accumulation of $CO_2$, $NH_3$ $NO_2$, $H_2S$ (Naipagropediaraichur, 2012) [26].

The plankton contains different ranges of protein, lipid and carbohydrate, which detected as 12.0-35.0% protein, 7.2-23.0% lipid and 4.6-23.0% carbohydrate on dry weight basis. Microalgae could be considered rich source of highly unsaturated fatty acids (HUFA) and ascorbic acid (0.11-1.62% dry weight). Microalgae have high contents of essential amino acids and improve the poly- unsaturated fatty acid of live prey. Moreover, phytoplankton affecting to increasing dissolved oxygen and decrease toxic gases like ammonia, nitrite, hydrogen sulfide, methane, carbon dioxide in water ponds. Phytoplankton provides many essential biomolecules such as, sterols, fatty acids (FAs), and amino acids (AAs) to consumers, which cannot synthesize them adequately (Brown *et al.*, 1997 and Naipagropediaraichur, 2012) [9, 26].

The survival rate in fish of T0 was 24%, this percent was conflicted with Abdel-Aziz (2013) [1], who recorded that, the fasting or prevention of feed didn't effect on survival rate of red tilapia juvenile (24.7g) after 90 days rearing period. Hence, decreases of survival rate for fish of T0 may be due to insufficient quantity of phytoplankton in rearing ponds or didn't fit with fry density in each pond. Moreover, fry of hybrid red tilapia more tolerate to the feeding prevention in comparison with fingerlings or juvenile.

No significant differences were detected between T1 and T2 in $W_2$, $L_2$, WG, CF and ADG. However, T2 was higher in RGR (1421.051 %), SGR (4.54 %/day) and SR (89%) than T3, which had RGR (430%), SGR (2.78%/day) and SR (60%). These results ascertained and cleared an importance of animal protein source in red tilapia diet. As it is know the fish meal (FM) is the good source of fish protein in diet, it is high protein content and balanced essential amino acid, moreover it is excellent source of fatty acids, energy, minerals vitamins and high digestibility and low levels of anti-nutritional factors as reported by (Tacon, 1993 and Zhou *et al.*, 2004) [36, 50]. In addition to, fish meal increases of aperitif and the diet palatability, hence there are increasing in feed intake. Tilapia fish consider omnivorous fish and it prefer the diets which contain animal protein source, whereas fish meal requirement for omnivorous is about 30 to 40% and for carnivorous it is more than 40 % (Hardy, 2010) [20]. On the contrary, Plant ingredients have anti-nutrition factors, are deficient in certain Essential Amino acids (EAA), have less nutrient digestibility, have lesser nutrient bio-availability, and less palatability due to high levels of non-soluble carbohydrates such as fiber and starch (Daniel, 2018) [10].

The animal protein in the diet decrease the mortality rate compared with the diet free of animal protein. The total replacement of fish meal by soy protein resulted in the lower dietary protein concentrations, as well as inadequate amounts of certain essential amino acids as reported by (Gatlin *et al.*, 2007) [16]. Furthermore, Storebakken *et al.* (1998) [35] stated that, soybean meal typically does not have enough methionine to meet the nutritional requirements of rainbow trout. Also, the major deficiency in soybean meal (SBM) compared with FM in content EAA, particularly a low methionine level (Nguyen and Davis, 2009) [28].

Many studies advised that, dietary lysine and methionine supplementation are necessary for the replacement of fish meal by plant protein sources (Murai *et al.*, 1982 and Takagi *et al.*, 2001) [25, 37]. In the same trend, Santiago and Lovell (1988) [33] cleared Total Saturated Amino Acids (TSAA) requirement of tilapia and revaled that, TSAA requirement in semi purified diet of Nile tilapia, *Oreochromis niloticus*, fry is 0.9% of the diet (0.75% methionine and 0.15% cystine) or 3.22% of dietary protein and also Kasper *et al.* (2000) [23] reported that the requirement of TSAA was only 0.5% of the diet or 1.56% of dietary protein for the same species. Likewise, Yamamoto *et al.* (1998) [48] found that plant ingredients contained low level of taurine, thus dietary taurine supplementation may be required for plant-based diets to improve growth performance and feed conversion ratio for juvenile rainbow trout *Oncorhynchus mykiss* and juvenile red sea bream (Gaylord *et al.*, 2006 and Takagi *et al.*, 2011) [17, 38]. Supplementations of taurine to low fish meal diet not only improved growth performance but also prevented green liver syndrome in red sea bream (Takagi *et al*., 2006) [39].

The percent of dietary protein play an important role in the success of replacement operation, then, decreasing of dietary protein negatively affected on fish growth and this effect increases with replacement of animal protein with plant protein as obtained with T2 diet. This finding agrees with the previous results of Davis and Stickney (1978) [11]. They reported that the utilization of SBM as primary protein source in diets containing 15% protein reduced growth of blue tilapia, while SBM could totally replace FM if protein level was 36% because the EAA profile at this protein level was above the requirement.

Generally, in the present study, the diet (T1) which contained 1/3 animal protein (FM) had the best RGR, SGR and SR compared with the diet (T2) which did not contain animal protein. These result was completely in agreement with Abdel-Aziz (2013) [1] who reported that, 1/3 animal protein of red hybrid tilapia diet had the positive effect on growth performance of fry, fingerlings and juveniles. In the same trend, other researchers reported that, at 24% protein diet, SBM could replace up to 67% FM (Nguyen and Davis, 2009) [3]. This result also was in agreement with Abdelghany (2003) [1] who reported that soybean flour (SBF) has good potential, as a substitute protein source, for up to 75% of herring fishmeal (HFM) in red tilapia diets with no significant ($P > 0.05$) effects. Over and above, Wu *et al.* (2004) [47] found that growth of hybrid tilapia (*O. niloticus* × *O. aureus*) offered diets devoid of FM was significantly lower ($P< 0.05$) than those fed diets containing FM because of poor palatability. In addition to Attalla and Mikhail (2008) [7] reported that, tilapia Fry fed 100% soybean produced the lowest growth performance (SGR% 1.81) and the highest FCR%. Also they mentioned that their results are in agreement with Hung (2004) [22].

Atack *et al.*, (1979) [6] cleared that, the reduced growth performance might be attributed to a dietary imbalance as defined by a deficiency of one or more limiting amino acids in the plant protein and the presence of various anti-nutrients in soybean. However, Furuya *et al.* (2004) [15] found that fishmeal could be totally replaced with plant protein sources without any adverse effect on the growth of tilapia. Viola *et al.* (1988) [42] found that no effect of FM replacement by SBM on hybrid tilapia growth if 3% dicalcium phosphate was supplemented to the diet. They also observed that supplementation of encapsulated methionine into non-FM diets did not improve growth.

**Feed efficiency parameters**

Feed efficiency parameters were taken of both (T1&T2) treatments as presented in table (5). There were significant differences between T1 and T2 in FI, PI, EI and FR. Whereas, T2 was the highest values for these parameters. However, no differences were shown between T1 and T2 in FCR, FCE, PER and EER.

**Table 5:** feed efficiency para

| Parameters | Treatments | | Sig. | SED* |
|---|---|---|---|---|
| | T1 | T2 | | |
| | Diet (A) | Diet(B) | | |
| Feed intake (FI, g) | 4.50[b] | 5.50[a] | 0.047 | 0.223 |
| Protein intake (PI, g) | 1.13[b] | 1.38[a] | 0.046 | 0.054 |
| Energy intake (EI, KJ/fish) | 88.07[b] | 108.29[a] | 0.044 | 0.083 |
| Feed conversion ratio (FCR) | 8.33[a] | 12.79[b] | 0.342 | 3.44 |
| Feed conversion efficiency (FCE) | 12.0[a] | 7.82[b] | 0.360 | 3.57 |
| Protein efficiency ratio (PER) | 0.47[a] | 0.30[a] | 0.365 | 0.141 |
| Energy efficiency ratio (EER) | 0.006[a] | 0.004[a] | 0.367 | 0.002 |

(a, b) Average in the same row having different superscripts significantly different at ($P \leq 0.05$).*, SED is the standard error of difference

As shown in the present results from FCR, FCE, PER and EER didn't significantly differ between theT1 and T2, however these parameters were better with T1 than T2 not only for the above parameters but also in FI, PI and EI, whereas the T1 was lower in feed intake than T2. Hence, it can be confirmed that animal protein plays a vital role for improving feed efficiency of hybrid red tilapia fry diet. Soybean meal (SBM) is the best plant protein source in terms of protein content and EAA profile. However, it is potentially limiting in sulfur-containing amino acids (methionine and cystine) and contains some anti-nutrient substances such as trypsin inhibitor hemagglutinin, and antivita- mins (Tacon, 1993) [36]. SBM was lower in essential amino acids (EAA), mainly methionine, lysine and threonine compared with FM (NRC, 2011) [29]. Methionine is sulphur containing amino acid and plays an important role in metabolism process. The addition of methionine to plant protein, which contains low amounts of EAA, is a proper diet for fish feeding (Wang and Shao, 2007) [45]. Furthermore, the negative effect on feed utilization was probably an effect of the viscosity caused by the non-starch polysaccharides in soybean products. There is a significant interaction between methionine and choline to tilapia **(**Kasper *et al.*, 2000) [23]. In table 5 it's cleared that T2 had the highest FI and these result was cope with Gomes and Kaushik (1992) [18]. They previously reported that the voluntary feed intake of tilapia fed 100% vegetable protein was higher than the other treatments.

Various authors referred to the less apparent digestibility coefficient in plant protein (Gatlin *et al.*, 2007) [16], intestinal damage (Yu *et al.*, 2015) [49], deficiency of one or more EAAs (Bautista-Teruel *et al.*, 2003) [8], less palatability (Torstensen *et al.*, 2008) [41] and presence of anti-nutrition factors (ANFs) (Welker *et al.*, 2016) [46].

**The economic evaluation**

The economic evaluation was showed in table (6) and it's appeared that, the diet T1 was higher in price than diet T2, however, the diet T1 was better incident cost and profit index than T2 diet, because the T1 diet include Fish meal. Moreover, fish meal improved SGR and decreased of mortality rate, hence increased fish production. Thus, it can be concluded that, the T1 diet was more economic than T2 diet.

**Table 6:** the economic evaluation

| Items | Treatments | |
|---|---|---|
| | Diet (A) | Diet (B) |
| Price of feed gram | 0.815 piaster | 0.655 piaster |
| Fish produced, g | 12.015 | 6.450 |
| Incident cost (IC) | 0.305 | 0.558 |
| Profit index (PI) | 8.200 | 4.480 |
| The economic conversion ratio (ECR) | 7.359 | 8.704 |

Notice: price of fish gram equal 2.5 piaster and piaster equal 0.01 Egyptian pound

**This evaluation aimed only to clear and not applied**

From this study, it can be supported that, animal protein in hybrid red tilapia fry diet improved SGR and survival rate as shown by statistical analysis. However, the statistical analysis didn't show any significant difference between T1 and T2 in WG, ADG, and FCR. So, one third animal protein in fry red tilapia diet consider the minimum saved ratio can be substituted by plant protein in terms of growth performance and feed efficiency. Moreover, the total replacement of fishmeal with plant protein resulted insignificant differences between T1 and T2 in some parameters as mentioned above, where animal protein diet was the best in all parameters and this reflected on the economic evaluation. Additionally, it can be predicted that, outdoor rearing, EAA supplementation in plant protein diet may be improve the growth performance and survival rate as well as in diet contain one third animal protein Viola *et al*. (1988) [42]. They studied the limiting factors in SBM for tilapia hybrids (*O. niloticus* x *O. aureus*) reared within outdoor ponds and noticed that fish fed a SBM based diet supplemented with lysine, methionine, lipid and di-calcium phosphate (DCP) had the same performance as fish fed FM based diet (at 100% substitution level) without negative effects on fish growth.

**Conclusion**

The present study cleared that, phytoplankton in water Qaroun lake contribute about 35% from the growth rate of hybrid red tilapia fry and the rest of value can be covered with the artificial feed as recoded in each T0 and T1 when the fry reared in (cement pond $1m^3$). Also, the fasting negatively affected on fry survival rate as illustrated with (T0). Moreover, the study suggested that, 1/3 animal protein in diet 25% crude protein (T1) positively more effect in SGR and survival rate than the diet which free of animal protein. In addition to 1/3 animal protein considers the minimum of replacement animal protein by plant protein in diet of 25% crude protein without EAA supplementation, which under laboratory conditions. Moreover, this study confirmed the potential of hybrid red tilapia as a new species can rear under the current changes in the environmental condition and to developing fish production of Qaroun Lake.

**References**

1. Abdel-Aziz MFA. Effect of some environmental conditions and protein quality on reproductive and productive performance of red hybrid tilapia (*Oreochromis* sp.). M.sc. thesis, Fac. Agri. Fayoum Univ. Egypt, 2013.

2. Abdel-Aziz MFA. Effect of some feeding and husbandry systems on growth performance of rabbitfish. Ph.D. Thesis, Fac. Agri. Fayoum Univ. Egypt, 2016.
3. Abdelghany AE. Replacement of Herring Fish Meal by Soybean Flour in Practical Diets for Red Tilapia, (*Oreochromis niloticus* × *O. mossambicus*), Grown in Concrete Tanks. J. Appl. Aquacul. 2003; 14:69-87.
4. Al-Amoudi MM. Acclimation of commercially cultured *Oreochromis* species to sea water - an experimental study. Aquacultu. 1987; 333-342.
5. AOAC. Official Methods of Analysis of AOAC International, 18th ed. Rev.1. AOAC International. (Gaithersburg, MD, USA.), 2006.
6. Atack TH, Jauncey K, Matty AJ. The evaluation of some single-cell protein in the diet of rainbow trout. II. The determination of the protein utilization, biological values and true digestibility. In: Finfish nutrition and fish feed technology (ed. by J.E. Halver & K. Tiews). Heenemann, Berlin. 1979; 261-273.
7. Attalla RF, Mikhail Samia K. Effect of replacement of fish meal protein with boiled full fat soybean seeds and dried algae on growth performance, nutrient utilization and some blood parameters of Nile tilapia (*Oreochromis niloticus*). Egypt. J. Aquat. Biol. & Fish. 2008; 12:41-61.
8. Bautista-Teruel MN, Fermin AC, Koshio SS. Diet development and evaluation for juvenile abalone, *Haliotis asinina*: animal and plant protein sources. Aquacul. 2003; 219:645-653.
9. Brown MR, Jeffrey SW, Volkman JK, Dunstan GA. Nutritional properties of microalgae for mariculture. Aquacul. 1997; 151:315-331.
10. Daniel N. A review on replacing fish meal in aqua feeds using plant protein sources. Int. J. Fisheries & Aquat. Studies. 2018; 6:164-179.
11. Davis AT, Stickney RR. Growth responses of Tilapia aurea to dietary protein quality and quantity. Trans. Amer. Fisheries Soc. 1978; 107:479-483.
12. Dawes CJ. Marine Botany. 2nd edition. John Wiley and Sons Inc., New York, NY, 1998.
13. El-Sayed AFM. Feed color affects growth feed utilization of Nile tilapia. Glob. Aquacul. Adv. 2004; 7(2):76.
14. El-Sayed AFM. Tilapia culture. CAB Interna- tional, Wallingford, UK, 2006.
15. Furuya WM, Pezzato LE, Barros MM. Use of ideal protein concept for precise formulation of amino acid levels in fish-meal-free diets for juvenile Nile tilapia (*Oreochromis niloticus* L.). Aquacul. Res. 2004; 35:1110-1116.
16. Gatlin DM, Barrows FT, Brown P, Dabrowski K, Gaylord TG, Hardy RW. Expanding the utilization of sustainable plant products in aquafeeds: A review. Aquacul. Res. 2007; 38:551-579.
17. Gaylord TG, AM Teague, Barrows FT. Taurine supplementation of all-plant protein diets for rainbow trout (*Oncorhynchus mykiss*). J. World Aquacul. Soc. 2006; 37:509-517.
18. Gomes E, Kaushik SJ. Effect of the replacement of dietary inorganic zinc by zinc/methionine on vegetable and animal protein utilization by rainbow trout. In: Fish Nutrition in Practice (eds S.J. Kaushik and P. Luquet), Biarritz, France, 1991, 897-902. INRA editions, Les Colloques, 1992.
19. Graham LE, Graham JM, Wilcox LW. Algae. 2nd edition. San Francisco: Pearson Education, 2009.
20. Hardy RW. Utilization of plant proteins in fish diets: effects of global demand and supplies of fishmeal. Aquacul. Res. 2010; 41:770-776.
21. Henry EC. The use of algae in fish feeds as alternatives to fishmeal. Int. Aquafeed. 2012; 10-13.
22. Hung LT. Evaluation of soybean meal as supplementary for red tilapia (*O. niloticus* × *O. mossambicus*). J. Appl. Aquacul. 2004; 16:147-156.
23. Kasper CS, MR White, Brown PB. Choline is required by tilapia when methionine is not in excess. J. Nutr. 2000; 238:238–242.
24. Mjoun K, Rosentrater KK, Brown ML. Tilapia Environment biology and nutritional requirements South Dakota cooperative extension service. 2010; 1-7.
25. Murai T, Ogata H, Nose T. Methionine coated with various materials supplemented to soybean meal diet for fingerling carp (*Cyprinus carpio*) and channel catfish (*Ictalurus punctatus*). Nippon Suisan Gakkaishi. 1982; 48: 85-88.
26. Naipagropediaraichur. Important of plankton in fish culture pond.http:// agropedia.iitk.ac.in/ content/ importance-plankton-fish-culture-pond, 2012.
27. Nguyen TN. The utilization of soybean products in tilapia feed. A review 8th Int. Sym. tilapia in aquacult. 2008; 53-65.
28. Nguyen TN, Davis DA. Evaluation of alternative protein sources to replace fish meal in practical diets for juvenile tilapia (*Oreochromis* spp). J. World Aquacul. Soc. 2009; 40:113-121.
29. National Research Council, NRC. Nutrient Requirements of fish and shrimp. National academy press, Washington, D.C., USA, 2011.
30. Piedecausa MA, Mazon MJ, Garcia-Garcia B, Hernandez MD. Effects of total replacement of fish oil by vegetable oil in the diets of sharpsnout sea bream (*Diplodus pintazzo*). Aquacul. 2007; 263:211–219.
31. Rahman MM. Effects of co–cultured common carp on nutrients and food web dynamics in rohu aquaculture ponds. Aquacul. Enviro. Interactions. 2015; 6:223–232.
32. Sandifer PA, Miglarese JV, Calder DR, Manzi JJ, Barclay LA. Ecological characterization of thesea island coastal region of South Carolina and Georgia. III: Biological features of the characterization area. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, DC. FWS/OBS-79/42, 1980.
33. Santiago CB, Lovell RT. Amino acid requirements for growth of Nile tilapia. J. Nutr. 1988; 118:1540-1546.
34. SPSS. Statistical package for social science (for Windows). Release 16 Copyright ©, SPSS Inc., Chicago, USA, 2007.
35. Storebakken T, Shearer K, Roem AJ, Availability of protein, phosphorous and other elements in fish meal, soy protein concentrate and phytase-treated soy protein-concentrate-based diets to Atlantic salmon (*Salmo salar*). Aquacul. 1998; 161: 365–379.
36. Tacon AGJ. Feed ingredients for warm water fish: Fish meal and other processed feedstuffs. FAO Fisheries Circular No. 856. FAO, Rome, Italy, 1993.
37. Takagi S, Shimeno S, Hosokawa H, Ukawa M. Effect of lysine and methionine supplementation to a soy protein concentrate diet for red sea bream Pagrus major. Fish. Sci. 2001; 67:1088-1096.
38. Takagi S, Murata H, Goto T, Hatate H, Endo M, Miyatake H, Yamashita H, Ukawa M. Role of taurine

deficiency in inducing green liver symptom and effect of dietary taurine supplementation in improving growth in juvenile red sea bream Pagrus major fed non-fishmeal diets based on soy protein concentrate. Fish. Sci. 2011; 77:235-244.

39. Takagi S, Murata H, Goto T, Ichiki T, Endo M, Hatate H. Efficacy of taurine supplementation for preventing green liver syndrome and improving growth performance in yearling red sea bream Pagrus major fed low-fishmeal diet. Fish. Sci. 2006; 72:1191-1199.
40. Tesfahun A, Temesgen M. Food and feeding habits of Nile tilapia *Oreochromis niloticus* (L.) in Ethiopian water bodies: A review. Int. J. Fisheries and Aquat. Studies. 2018; 6:43-47.
41. Torstensen BE, Espe M, Sanden M, Stubhaug I, Waagbø RH. Novel production of Atlantic salmon (*Salmo salar*) protein based on combined replacement of fish meal and fish oil with plant meal and vegetable oil blends. Aquacultu. 2008; 285(1):193-200**.**
42. Viola S, Arieli Y, Zohar G. Animal-protein- free feeds for hybrid tilapia (*Oreochromis niloticus* × *O. aureus*) in intensive culture. Aquacul. 1988; 75:115–125.
43. Viola S, Angeoni H, Lahav E. Present limits of protein sparing by amino acid supplementation of practical carp and tilapia feeds. Isr. J. Aquacul.-Bamidgeh. 1994; 46: 203-211.
44. Viola S, Angeoni H, Gur N, Lahav E. Growth performance, protein and energy balances of hybrid tilapia fed two levels of lysine at three levels of protein. Isr. J. Aquacul.-Bamidgeh, 1994; 46:212-22.
45. Wang L, Shao Q. The Effect on the growth of fish. Water fisheries, Reservoir Fisheries. 2007; 1:108-110.
46. Welker T, Barrows F, Overturf K, Gaylord G, Sealey W. Optimizing zinc supplementation levels of rainbow trout (*Oncorhynchus mykiss*) fed practical type fishmeal-and plant-based diets. Aquacultu. nutr. 2016; 22:91-108.
47. Wu GS, Chung YM, Lin WY, Chen SY, Huang CH. Effect of substituting de-hulled or fermented soybean meal for fish meal in diets on growth of hybrid tilapia (*Oreochromis niloticus x Oreochromis aureus*). J. Fisheries Soc., Taiwan. 2004; 30:291-297.
48. Yamamoto T, Akimoto A, Kishi S, Unuma T, Akiyama T. Apparent and true availabilities of amino acids from several protein sources for finger- ling rainbow trout, common carp and red sea bream. Fish. Sci. 1998; 64: 448-458.
49. Yu HB, Gao QF, Dong SL, Wen B. Changes in fatty acid profiles of sea cucumber *Apostichopus japonicus* (Selenka) induced by terrestrial plants in diets. Aquacul. 2015; 442:119-124.
50. Zhou QC, Tan BP, Mai KS, Liu YJ. Apparent digestibility of selected feed ingredients for juvenile cobia *Rachycentron canadum*. Aquacul. 2004; 241:441-451.