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The Effects of Dietary of Soybean Lecithin on the Growth Performance Feed Conversion and Body Composition of Tilapia (*Oreochromis niloticus* L.) Fry

[1]Hasan H. Atar, [1]Süleyman Bekcan and [2]Murtaza Ölmez
[1]Department of Fisheries and Aquaculture, Faculty of Agriculture,
Ankara University, 06110 Diskapi, Ankara, Turkey
[2]Faculty of Egirdir Fisheries, Süleyman Demirel University, 32500 Egirdir, Isparta, Turkey

Abstract: Tilapias are one of the most important domesticated fish today. Production widely distributed around the world. Lecithin also known as Phosphatidyicholine (PC), is a special type of lipid (a phospholipid) found naturally in the body. Research has shown that crustaceans and fish cannot adequately synthesise the phospholipids they require for maximum performance. Therefore, phospholipids must be added to their diet. Therefore, the experiment was designed to evaluate the effects of soybean lecithin on the growth and performance of feed conversion in Tilapia fry. The experimental period was planned as a 3 months period. Twenty one aquariums (7 groups-3 replicates) were used and 25 fish were stocked at the rate of 200 fish m^{-3} in each aquarium, by a completely randomized design. The effects of supplementary feeding of the tilapia (*Oreochromis niloticus*) fry with feeds enriched with soybean lecithin were evaluated by adding soybean lecithin to the basal diet at the rate of 1-5%. The fish were fed for 90 days to check the growth, protein efficiency ratio, feed conversion ratio, body composition and survival ratio. At the end of experiment, the best live weight increase was found to be 3% protein efficiency ratio and the feed conversion ratio was found to be 1.90 and 1.75, respectively in the 2% lecithin-treated group, supplementing soybean lecithin at the rate of 4 and 5%, which enhanced the fat content of treated fish ($p<0.05$).

Key words: Tilapia, growth performance, *O. niloticus*, lecithin, phosphatidylcholine, phospholipid

INTRODUCTION

Aquaculture products need macronutrients like proteins, fats, carbohydrates and micronutrients like vitamins and trace elements as in other animal species. Implementation of the results of previous research to the economically important fish species and crustaceans has resulted in improved breeding (NRC, 1981). Recently, it has been determined that phospholipids are important nutrient in aquaculture (Kanazawa *et al*., 1979; Conklin *et al*., 1980; Hilton *et al*., 1984; Kean *et al*., 1985; Harada, 1987; Hung *et al*., 1987; Hung and Lutes, 1988; Hung, 1989; Briggs *et al*., 1988; Meyers, 1990; Poston, 1990a, b, 1991; Koven *et al*., 1993; Veronica *et al*., 1993).

Phospholipids exist in all plant, animal and microorganisms. The most important of them is lecithin, with a molecular structure composed of a single glycerol molecule to which it is esterified with two molecules of aliphatic fatty acids and one molecule of phosphoric acid, with choline esterified to the phosphate Poston (1991). Previously, Harada (1987), Hung *et al*. (1987) and Ketola *et al*. (1989) have emphasized that lecithin needs to be added in feeds of cultured fish to improve digestion and absorption of fat.

Lecithin from various sources has commonly been used for dietary supplementation of phospholipids for fish, which show improved growth and lipid mobilization in response to dietary lecithin (Ketola, 1976; Hung and Lutes, 1988; Hung, 1989; Poston, 1991). However, studies concerning the influences of dietary phospholipid have not been conducted with the tilapia by using practical diets.

The objective of this study was to determine the effects on weight gain, feed conversion, protein efficiency, survival rate and body composition of supplying soybean lecithin to the practical diet of tilapia (*O. niloticus* L.) fry.

MATERIALS AND METHODS

The experiment was carried out at the Fisheries and Aquaculture Department of the Ankara University, Turkey. The experimental duration was 6 months. The nutrition experiments were conducted in 21 glass aquariums (80×45×30 cm) using 525 tilapia (*Oreochromis niloticus*) fry obtained from the hatchery brood stock (of the Aquaculture and Fisheries Department). In the experiment, fatless soybean lecithin (Sigma Aldrich

Corresponding Author: Hasan H. Atar, Department of Fisheries and Aquaculture, Faculty of Agriculture, Ankara University, 06110 Diskapi, Ankara, Turkey

Chemical Co. Ltd. St. Lo. Mo) with 40% phosphatidylcholine was used. A basal diet (T_{C1}) given to a control group consisted of granulated feed containing 30% crude protein and 2900 kcal kg^{-1} digestible energy, a nutrition requirenment specified by NRC (1981) (Table 1 and 2). In place of vegetable oil that is one of the components of the feed, soybean lecithin in proportions of 1-5% was solubilized in 400 mL of a chloroform-methanol solution (3:1 v v^{-1}), which was then added to the feed by spraying (T_{L1}-T_{L5}) before peletting. Pellet feed was granulated and used for the treatment groups. In addition to these diets, a second control group diet (T_{C2}) containing chloroform-methanol solution in the same proportion was added to experimental diets (400 mL) for determination of the effects of the chloroform-methanol used in solving lecithin added to basal diet.

In the experiment, a digital balance with 0.01 tolerance for weighing live weight, a thermostated heater for adjusting the heat of water, air stone in ventilation of the water, a filter in aquarium for rough filtration, an Eheim filter for balancing the chemical contents of water, a thermometer, pH-meter, oxygen-meter for measuring water temperature, pH and oxygen values, Kjeldahl-soxaleth equipment for analysing nutrient composition of fish and test diets and deep freeze for conservation of diets and fishes were used.

The experimental period was planned as a 3 months period. In the feeding experiment, 21 aquariums (7 groups -3 replicates) were used and 25 fish were stocked at the rate of 200 fish m^{-3} (Viola *et al*., 1988; Tung and Shiau, 1991) in each aquarium according to a completely randomized design. Because groups consisted of fry born on same date, initial live weights and total mean length were equal.

Tilapia fry were fed with one of three diets: Basal diet (T_{C1}) containing 30% crude protein -2900 kcal kg^{-1} digestible energy; a control diet (T_{C2}) to which a vehicle of 400 mL chloroform-methanol solution was added to the basal diet and a test diet (T_{L1}-T_{L5}) to which soybean lecithin in the chloroform-methanol vehicle was added to the control diets at the rates of 1-5%. The mean live weight of fry was assessed every 14 days for 3 months as a measure of growth and the data are showin in Table 3.

The effects on growth, Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Survival Rate (SR) and nutrient matter content of feeding tilapia fry with various diets were studied: a basal diet of 30% crude protein -2900 kcal kg^{-1} digestible energy; a control diet composed of 400 mL chloroform-methanol solution added to the basal diet and a test diet composed of soybean lecithin added to the control diet formulation in the rates of 1-5%. Fish were fed *ad libitum*.

Table 1: The composition of the basal diet

Ingredients	(%)
Fish meal	24.51
Cotton seed meal	5.00
Maize	4.62
Soybean meal	18.00
Bran	34.68
Vegetable oil	5.00
Vitamin premix[a]	1.00
Mineral premix[b]	1.00
Di-calcium phosphate[c]	3.70
Salt (NaCl)	1.00
Methionine	0.45
Lysin	1.04

[a]Rovimix 107 (Vit. A: 4000000 IU kg^{-1}, Vit. D3: 600000 mg kg^{-1}, Vit. E: 40000 mg kg^{-1}, Vit. K3: 2400 mg kg^{-1}, Vit. B1: 4000 mg kg^{-1}, Vit. B2: 6000 mg kg^{-1}, Niacin: 40000 mg kg^{-1}, Cal-D-Pantothenate: 10000 mg kg^{-1}, Vit. B6: 4000 mg kg^{-1}, Vit. B12: 10 mg kg^{-1}, Folic acid: 1600 mg kg^{-1}, D-Biotin: 100 mg kg^{-1}, Vit. C: 40000 mg kg^{-1}, Inositol: 60000 mg kg^{-1}). [b]Remineral B (Manganez: 90000 mg kg^{-1}, Iron: 65000 mg kg^{-1}, Zinc: 80000 mg kg^{-1}, Copper: 12500 mg kg^{-1}, Cobalt: 400 mg kg^{-1}, Iodine: 1800 mg kg^{-1}, Selenium: 150 mg kg^{-1}). [c]Di-calcium phosphate (18% P, 22% Ca)

Table 2: Nutrient composition of the basal diet (Control)

Nutrient composition	(%)
Dry matter	90.24
Moisture	9.76
Crude protein	30.00
Crude fat	9.02
Crude fiber	6.00
Crude ash	13.02
N-free extract[a]	32.20
Digestible energy (Kcal kg^{-1})[b]	2900.00

[a]Calculated by (Dry matter-crude protein-crude fat-crude fiber-crude ash), [b]Calculated according to the average nutrient content of diet

The live weight of individual fish was measured every 14 days. Oxygen and pH were measured on first and last days of every 14 days during the experiment. The analysis of nutrient matter of the test diets was performed according to Cunniff (1995). The water temperature was fixed at 26±2°C an optimum temperature for tilapia fry; by use of thermostatic heaters by careful controlling temperature variations. The mean dissolved oxygen of aquarium water was 6.60±0.05 mg L^{-1} and pH was 6.75±0.1 during the experiment. Feed and metabolism residuals accumulated on the floors of all 14 aquaria were siphoned out and cleaned every morning before feeding. Siphoned water was replaced with the same temperature water. In addition, experimental aquaria were all emptied out and cleaned after measurement period of 14 days.

During the research, growth in terms of live weight was evaluated by computing the absolute growth with respect to the measurement period (El Sayed, 1990; De Silva *et al*., 1991). The Feed Conversion Ratio (FCR) was computed by proportionating the total feed given during the experiment to total live weight gained. The Protein Efficiency Ratio (PER) was calculated by dividing the live weight gained during the experimental period by the crude protein taken with feed (El Sayed, 1990). The survival ratio was calculated by dividing the count of live

Table 3: Live weight averages and weight gain of the tilapia fry fed with diets containing soybean lecithin at different rates (g)

	Control groups		Treatment groups				
Periods	T_{C1}	T_{C2}	T_{L1} 1% = 0.4 PC	T_{L2} 2% = 0.8 PC	T_{L3} 3% = 1.2 PC	T_{L4} 4% = 1.6 PC	T_{L5} 5% = 2.0 PC
N (3×25)	75	75	75	75	75	75	75
Initial	0.06±0.002	0.06±0.002	0.06±0.002	0.06±0.002	0.06±0.002	0.06±0.002	0.06±0.002
15	0.38 ± 0.02^{a}	0.38 ± 0.01^{a}	0.37 ± 0.01^{a}	0.42 ± 0.01^{a}	0.44 ± 0.01^{a}	0.38 ± 0.12^{a}	0.40 ± 0.13^{a}
30	1.08 ± 0.05^{a}	0.97 ± 0.04^{a}	1.16 ± 0.05^{a}	1.15 ± 0.04^{a}	1.25 ± 0.04^{a}	0.93 ± 0.02^{a}	1.14 ± 0.04^{a}
45	1.46 ± 0.06^{a}	1.24 ± 0.05^{a}	1.71 ± 0.07^{a}	1.81 ± 0.07^{a}	1.88 ± 0.06^{a}	1.34 ± 0.05^{a}	1.74 ± 0.07^{a}
60	2.22 ± 0.10^{a}	1.74 ± 0.08^{a}	2.25 ± 0.11^{a}	2.81 ± 0.13^{a}	2.58 ± 0.10^{a}	1.96 ± 0.10^{a}	2.74 ± 0.13^{a}
75	2.85 ± 0.14^{b}	2.97 ± 0.09^{b}	3.06 ± 0.18^{ab}	3.88 ± 0.21^{a}	3.95 ± 0.17^{a}	2.93 ± 0.17^{b}	4.15 ± 0.23^{a}
90	3.38 ± 0.19^{c}	3.48 ± 0.24^{c}	4.89 ± 0.33^{ab}	5.51 ± 0.31^{a}	5.62 ± 0.25^{a}	4.09 ± 0.27^{bc}	5.36 ± 0.30^{a}
Weight gain (g)	3.32	3.42	4.83	5.45	5.56	4.03	5.30
Differences from T_{C1} (%)	-	+3.01	+45.48	+64.16	+67.47	+21.39	+59.64
Differences from T_{C2} (%)	+3.01	-	+41.22	+59.36	+62.57	+17.84	+54.97

[a-c]Various letters show the importance of variation among group averages ($p<0.05$)

fish remaining in aquarium at the end of the experiment to the initial count of live fish at the start of the experiment. Evaluation of the data was compared by Analysis of Variance (ANOVA) with posthoc mean comparison by Duncan Multiple Range Test ($p<0.05$) using pocket programs for MINITAB for WINDOWS 10.5 and MSTAT-C.

RESULTS

Growth performance: The best growth performance in these diet groups starting from mean initial live weights of 0.06±0.002 g was in the T_{L3} group with mean live weight of 5.62±0.25 g at the end of the experiment. This group was fed with 3% soybean lecithin added to the basal feed. The other groups with successively lower mean live weights (growth) were fed with 2, 5, 1 and 4% soybean lecithin added to the basal diet and the mean weight values were 5.51 (±0.31), 5.36 (± 0.30), 4.89 (± 0.33) and 4.09 (±0.27) g, respectively. Mean live weights of the control group (T_{C2}), consisting of 400 mL chloroform-methanol mixture added to the basal diet was 3.48±0.24 g. Those fry fed only the basal diet had a mean weight of 3.38 (±0.19) g. ANOVA with Duncan test mean comparison showed no significant differences ($p>0.05$) between mean values of the groups until the 60th day. On the 75th day, the control group (T_{C1}) had grown to a mean 2.85 (±0.14) g; this mean growth was similar and statistically insignificant ($p>0.05$) from the live weight averages of the control group (T_{C2}), which was the group in which a 400 mL chloroform-methanol mixture had been added to the basal diet and also similar to the averages of the 1 and 4% soybean lecithin-containing groups (T_{L1}, T_{L4}). The T_{C1} weight was; however, different from the other soybean lecithin-containing groups (T_{L2}, T_{L3}, T_{L5}). There were no statistically significant differences between the live weight averages of the 2-5% soybean lecithin (T_{C1}) groups ($p>0.05$). At the end of the experiment the greatest growth, from largest to smallest, were the 3, 2, 5 and 1% soybean lecithin-containing groups, but their mean weights gains were not significantly different. The 4% soybean lecithin (T_{L4}) group, showed the least growth and control groups (T_{C1}, T_{C2}) did not possess weight averages significantly different from one another, but as group showed different weight averages from the other treatment groups.

Protein efficiency and feed conversion ratio: The protein efficiency and feed conversion ratios of the tilapia fry fed with basal diet (T_{C1}) containing 30% crude protein -2900 kcal kg^{-1} digestible energy, control diets (T_{C2}) with the added 400 mL chloroform-methanol solution to the basal diet and the test diets (T_{L1}-T_{L5}) with the added soybean lecithin to the control diets at the rates of 1, 2, 3, 4 and 5% for 3-months growth were given in Table 4. When protein efficiency ratios are considered, the highest value (1.90±0.02) was obtained from the group fed with feed containing 2% soybean lecithin (T_{L2}). The ratio of this group was followed from high to low ratios by the groups fed with the diets containing 1, 5, 3 and 4% soybean lecithin, the respective rates being 1.87±0.01, 1.74±0.03, 1.73±0.02 and 1.54±0.05.

The protein efficiency ratio of the control group (T_{C2}), the basal diet supplemented with the 400 mL chloroform-methanol mixture, was 1.41±0.07 and that of control group (T_{C1}) fed with just the basal diet was 1.35±0.05.

For the group fed with feed supplemented with 2% soybean lecithin, there was no statistically significant difference ($p>0.05$) in its the protein efficiency ratio, according to the variance analysis and Duncan test results, from the efficiency ratios of the groups fed with diet supplemented with 1, 5, or 3% soybean lecithin. However, it was different from the group fed with feed supplemented with 4% soybean lecithin and also from the control groups ($p<0.05$). The protein efficiency ratios of the control groups (T_{C1}, T_{C2}) were not statistically significantly different ($p>0.05$). There were differences ($p<0.05$) among other groups except for the group fed with feed supplemented with 4% soybean lecithin.

Table 4: Protein efficiency ratio and feed conversion ratio of the tilapia fry fed with diets containing soybean lecithin at different rates (g)

	Control groups		Treatment groups				
Groups	T_{C1}	T_{C2}	T_{L1}	T_{L2}	T_{L3}	T_{L4}	T_{L5}
PER	1.35±0.02[c]	1.41±0.06[c]	1.87±0.01[a]	1.90±0.04[a]	1.73±0.02[ab]	1.54±0.05[bc]	1.74±0.03[ab]
Differences from T_{C1} (%)	-	+ 4.44	+ 31.85	+ 40.74	+ 28.15	+ 14.07	+ 28.88
Differences from T_{C2} (%)	- 4.44	-	+ 26.24	+ 34.75	+ 22.70	+ 9.22	+ 23.40
FCR	2.46±0.03[c]	2,36±0.01[c]	1.78±0.01[a]	1.75±0.04[a]	1.92±0.03[ab]	2.16±0.05[bc]	1.91±0.02[ab]
Differences from T_{C1} (%)	-	-4.06	-27.64	-28.86	-21.95	-12.20	-22.36
Differences from T_{C2} (%)	+4.06	-	-24.58	-25.85	-18.64	-8.47	-19.07

[a-c]Various letters show the importance of variation among group averages ($p<0.05$)

Table 5: Body composition of the tilapia fry fed with diets containing soybean lecithin at different rates (%)

	Control groups		Treatment groups				
Nutrient composition	T_{C1}	T_{C2}	T_{L1}	T_{L2}	T_{L3}	T_{L4}	T_{L5}
Moisture	74.37±0.06[a]	75.43±0.05[a]	76.56±0.04[a]	76.27±0.07[a]	76.22±0.04[a]	75.47±0.12[a]	75.54±0.05[a]
Dry matter	25.63±0.06[a]	24.57±0.05[a]	23.44±0.04[a]	23.73±0.07[a]	23.78±0.04[a]	24.53±0.12[a]	24.46±0.05[a]
Crude protein	18.87±0.04[a]	18.65±0.14[a]	17.06±0.05[a]	17.83±0.07[a]	18.26±0.03[a]	18.77±0.08[a]	17.69±0.07[a]
Crude fat	0.66±0.04[b]	0.68±0.03[b]	0.49±0.01[c]	0.68±0.02[b]	0.65±0.04[b]	0.86±0.01[a]	0.93±0.03[a]
Crude ash	1.33±0.10[a]	1.00±0.04[b]	1.12±0.08[ab]	0.93±0.06[b]	1.11±0.03[ab]	1.00±0.02[b]	1.28±0.07[a]

[a-b]Various letters show the importance of variation among group averages ($p<0.05$). The Phosphatidylinositol (PI) in lecithin is also a good source of myoinositol, which is required in most aquaculture species as a co-factor in the production of certain enzymes (cholinesterase and transaminase). Myoinositol also boosts such basic body functions as gut emptying and fin integrity. A known chemo-attractant, lecithin can also reduce or eliminate the need for fishmeal and fish oil as a source of dietary fats and as an attractant in feed formulations

When the feed conversion ratios were examined, the best rate was 1.75±0.04 from the group fed with feed supplemented with 2% soybean lecithin (T_{L2}). Successively lower values were from the groups fed with diets containing 1, 5, 3 and 4% soybean lecithin. Feed containing 400 mL chloroform-methanol mixture (T_{C2}) and followed by the basal diet (T_{C1}). The respective values of the ratios were 1.78±0.01, 1.91±0.01, 1.92±0.03, 2.16±0.05, 2.36±0.04 and 2.47±0.03, respectively.

Comparing feed conversion ratios using variance analysis and Duncan test results, statistically similar results were obtained for protein efficiency ratio. Thus, the ratio of the group fed with diet supplemented 2% soybean lecithin was not significantly different ($p>0.05$) from the values for the ratios of the groups fed with diets supplemented with 1, 5 and 3% soybean lecithin, but the values in these groups did significantly differ from the group fed with feed containing 4% soybean lecithin and also from the control groups ($p<0.05$). The control groups (T_{C1}, T_{C2}) showing the lowest values for the feed conversion ratio were not significantly different ($p>0.05$) from each other, although they did have values for the ratios that were different ($p<0.05$) from the other groups except for the group fed with feed containing 4% soybean lecithin.

Body composition: The average nutrient material contents of the tilapia fry fed with the basal diet (T_{C1}) containing 30% crude protein -2900 kcal kg^{-1} digestible energy, the control diets (T_{C2}) with 400 mL chloroform-methanol solution added to the basal diet and the test diet (T_{L1}-T_{L5}) with soybean lecithin added to the control diets at the rates of 1-5% during a 3-months growth period are given in Table 5. The variance analysis and Duncan test results show no significant differences ($p>0.05$) in dry matter, moisture and crude protein values.

With respect to the crude fat, groups fed with feed containing 4 and 5% soybean lecithin have crude fat values which were not significantly different from one another ($p>0.05$). Although, they differed from the other groups ($p<0.05$), groups fed with feed containing 2 and 3% soybean lecithin and control groups were not significantly different from each other ($p>0.05$), although they showed different behaviour from the group fed with feed containing 1% soybean lecithin ($p<0.05$).

From the crude ash content analysis, the crude ash content values of the groups fed with feed containing 1, 3 and 5% soybean lecithin and that of first control group (T_{C1}) were not different statistically from each other ($p>0.05$), although they differed from the crude ash content values of the groups fed with feed containing 1 and 3% soybean lecithin, which were not significantly different from the group fed with feed containing 4% soybean lecithin nor different from the second control group (T_{C2}).

The group fed with feed having the least crude ash content and containing 2% soybean lecithin was not significantly different from the group fed with feed containing 4% soybean lecithin nor from the second control group (T_{C2}).

Survival ratio: Throughout the experiment, no death of fry was recorded in either control or experimental groups. Therefore, survival ratio was 100% for all groups.

DISCUSSION

A number of studies during last 20 years have reported the effects of adding lecithin to the diets of fishes and crustaceans. Although many researchers agree on the necessity of lecithin supplements to the diet; some maintain that supplements are not essential because the nutrient is synthesized by aquaculture products (Kean *et al*., 1985; Hung *et al*., 1987; Hung and Lutes, 1988).

In this study of feeding of tilapia fry, no significant differences were found on the effects of different lecithin supplements rates until the 60th day of the experiment. Thereafter, it was observed that weight differences in groups fed with feed containing 2, 3 and 5% lecithin by the 75th day. On the 90th day, the order of high to low weights was found, respectively in groups fed with feed supplmented with 3, 2, 5 and 1% lecithin with weights being 50-60% more than the weights of the control groups. Kanazawa *et al*. (1979) reported that soybean lecithin addition to the feed rations of larva and the young of kuruma prawn (*Penaeus japonicus*), ayu (*Plecoglossus altivelis*), red sea bream (*Chrysophrys major*), shark (*Oblegnathus fasciatus*), chinese prawn (*Penaeus chinensis*) and freshwater prawn (*Macrobrachium rosenbergii*) caused increased growth and survival rates, based on their evaluation of the feed. Conklin *et al*. (1980) and D'Abramo *et al*. (1981) have concluded that lecithin addition is necessary for lobster (*Homarus americanus*), which basically should be fed as semi-pure rations containing casein. Pascual (1986) for jumbo tiger prawn (*Penaeus monodon*), Hilton *et al*. (1984) and Briggs *et al*. (1988) for freshwater prawn (*Macrobrachium rosenbergii*) have found the same. These reported values agree with our findings for tilapia.

Kean *et al*. (1985) have stated that lecithin addition to the rations of sea lobster (*Homarus americanus*) has no significant effect on growth and that protein support given in the form of casein suffices. Positive effects of lecithin-supplemented feed for yellow tail fish (*Seriola quinqueradiata*) are reported by Harada (1987). The rate of body fat and the hepatosomatic index increased with the addition of 8% lecithin to pure experimental rations for white sturgeon (*Acipenser transmontanus*). The weight increase was less and other benefits reduced when young white sturgeons were fed with 8% lecithin-supplemented rations rather than feed containing 0.8% choline. Lecithin has been reported as unnecessary by NRC (1981), as reported that aquaculture products have the ability to synthesize lecithin according to Hung and Lutes (1988). Poston (1990a, b, 1991) has reported that addition of 4 and 8% soybean lecithin to feed rations of Atlantic salmon (*Salmo salar*) resulted in their activation of swimming near the surface, but that there was no effect on growth. However it has also been reported that the survival ratio of fry and the accumulation of body fat are increased. The addition of 4% soybean lecithin to the rations of 0.12 g rainbow salmon trout (*Oncorhynchus mykiss*) plays an important role in their increased growth and survival rates, improving feed evaluation, facilitating digestion and arranging energy metabolism. As reported both by Hung *et al*. (1987) for white sturgeon and by Poston (1990b) for Atlantic salmon, the appearance of a fatty condition was observed with increased lecithin in the feed as was observed have been seen also for the tilapia. Koven *et al*. (1993) have reported that in the larval period of gilt-head bream (*Sparus aurata*), their undeveloped digestive system results in a failure to absorb lecithin-like triglycerides and fat and thus the larva have a limited capacity for phospholipid synthesis necessary for the construction of lipoproteins and cell components. Therefore they indicate, in support of results of this study that lecithin is more effective in larval growing period of tilapia. Veronica *et al*. (1993) have also concluded that the addition of 3% soybean lecithin with the n-3 series unsaturated fat acids to the feed rations of female kuruma prawn (*Penaeus japonicus*) have a significant effect on increase in live weight, especially on gonad growth.

In studies conducted with purified basal diets that make use of choline chloride supplementation as the choline source, Vieira *et al*. (2001) have reported that supplementation with 375 mg kg^{-1} of choline to the basal diet met the nutritional requirements of Nile tilapia (*Oreochromis niloticus*) fingerlings (5.09±0.14 g). In their discussion Shiau and Lo (2000) found that the optimal dietary choline requirement for growth was about 1,000 mg kg^{-1} for juvenile hybrid tilapia (*Oreochromis niloticus* x *O. aureus)*. Although the phosphatidylcholine of soybean lechitin ratios obtained from this research and produced for practical diets was higher than the value stated by Vieira *et al*. (2001). The results of this study were in agreement with Shiau and Lo (2000).

The results showed live weight gain of 59.36 or 64.16% compared to control groups (T). Similarly, comparison of utilization values of 25.85 and 28.86% was done, it showed a feed balance against economic point of view for a 3 months feeding periods of tilapia fry.

CONCLUSION

Supplementing tilapia fish ration with 4 and 5% soybean lecithin significantly improve feed conversion and increase in fish weight.

REFERENCES

Briggs, M.R.P., K. Jauncey and J.H. Brown, 1988. The cholesterol and lecithin requirements of juvenile prawn (*Macrobrachium rosenbergii*) fed semi-purified diets. Aquaculture, 70: 121-129. DOI: 10.1016/0044-8486(88)90012-9.

Conklin, D.E., L.R. D'Abramo, C.E. Bordner and N.A. Baum, 1980. A successful purified diet for the culture of juvenile lobsters: The effect of lecithin. Aquaculture, 21: 243-249. DOI: 10.1016/0044-8486(80)90134-9.

Cunniff, P., 1995. Official Methods of Analysis of AOAC International. 16th Edn. Volume I-II. AOAC International Suite 400 2200 Wilson Boulevard Arlington, Virginia 2201-3301, USA. ISBN-13: 978-0935584547.

D'Abramo, L.R., C.E. Bordner, D.E. Conklin and N.A. Baum, 1981. Essentiality of dietary phosphatidylcholine for the survival of juvenile lobsters. J. Nutr., 111: 425-431. http://jn.nutrition.org/cgi/content/abstract/111/3/425.

De Silva, S.S., R.M. Gunasekera and K.F. Shim, 1991. Interaction of varying dietary protein and lipid levels in young red tilapia: Evidence of protein sparing. Aquaculture, 95: 305-318. DOI: 10.1016/0044-8486(91)90096-P.

El Sayed, A.M., 1990. Long-term evaluation of cotton seed meal as a protein source for Nile tilapia, *Oreochromis niloticus* (Linn). Aquaculture, 84: 315-320. DOI: 10.1016/0044-8486(90)90096-6.

Harada, K., 1987. Relationships between structure and feeding attraction activity of certain l-amino acids and lecithin in aquatic animals. Nippon Suisan Gakkaishi, 53: 2243-2247. http://www.journalarchive.jst.go.jp/english/jnlabstract_en.php?cdjournal=suisan1932&cdvol=53&noissue=12&startpage=2243.

Hilton, J.W., K.E. Harrison and S.J. Slinger, 1984. A semi-purified test diet for *Macrobrachium rosenbergii* and the lack of need for supplemental lecithin. Aquaculture, 37: 209-215. DOI: 10.1016/0044-8486(84)90153-4.

Hung, S.S.O., B.J. Moore, C.E. Bordner and F.S. Conte, 1987. Growth of juvenile white sturgeon (*Acipenser transmontanus*) fed different purified diets. J. Nutr., 117: 328-334. http://jn.nutrition.org/cgi/content/abstract/117/2/328.

Hung, S. and P. Lutes, 1988. A preliminary study on the non-essentiality of lecithin for hatchery-produced juvenile white sturgeon (*Acipencer transmontanus*). Aquaculture, 68: 353-360. DOI: 10.1016/0044-8486(88)90249-9.

Hung, S., 1989. Choline requirement of hatchery-produced juvenile white sturgeon (*Acipencer transmontanus*). Aquaculture, 78: 183-194. DOI: 10.1016/0044-8486(89)90031-8.

Kanazawa, A., S. Teshima, S. Tokiwa, M. Endo and F.A.A. Razek, 1979. Effects of short-necked clam phospholipids on the growth of prawn. Nippon Suisan Gakkaishi, 45: 961-965. http://www.journal-archive.jst.go.jp/jnlpdf.php?cdjournal=suisan1932&cdvol=45&noissue=8&startpage=961&lang=en&from=jnltoc.

Kean, J.C., J.D. Castell, A.G. Boghen, L.R. D'Abramo and D. Conklin, 1985. A reevaluation of the lecithin and cholesterol requirements of juvenile lobster (*Homarus americanus*) using crab protein-based diets. Aquaculture, 47: 143-149. DOI: 10.1016/0044-8486(85)90060-2.

Ketola, H.G., 1976. Choline metabolism and nutritional requirement of lake trout *(Sulvelinus namaycush*). J. Anim. Sci., 43: 474-477. http://jas.fass.org/cgi/reprint/43/2/474?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=ketola&searchid=1&FIRSTINDEX=0&volume=43&firstpage=474&resourcetype=HWCIT.

Ketola, H.G., C.E. Smith and G.A. Kindschi, 1989. Influence of diet and oxidative rancidity on fry of Atlantic and coho salmon. Aquaculture, 79: 417-423. DOI: 10.1016/0044-8486(89)90485-7.

Koven, W.M., S. Kolkovski, A. Tandler, G.W. Kissil and D. Sklan, 1993. The effect of dietary lecithin and lipase, as a function of age, on n-9 fatty acid incorporation in the tissue lipids of *Sparus aurata* larvae. Fish Physiol. Biochem., 10 (5): 357-364. DOI: 10.1007/BF00004502.

Meyers, S., 1990. Aquaculture diets with lecithin. Feed International, June, 17-20. http://www.scielo.br/scieloOrg/php/reflinks.php?refpid=S0103-8478200100040001900009&pid=S0103-84782001000400019&lng=en.

NRC, 1981. Nutrient requirements of coldwater fishes. Number 16, National Academy Press, Washington D.C., pp: 49. ISBN: 0-309-03187-7.

Pascual, F.P., 1986. Effects of supplemental lecithin and lipid sources on the growth and survival of *Penaeus monodon* juveniles. First Asian Fisheries Forum, Asian Fisheries Society, Manila, Philippines. http://www.seafdec.org.ph/aboutAQD_awards.html.

Poston, H.A., 1990a. Performance of rainbow trout fry fed supplemental soy lecithin and choline. Prog. Fish-Cult., 52: 218-225. DOI: 10.1577/1548-8640(1990)052<0218:PORTFF>2.3.CO;2.

Poston, H.A., 1990b. Effect of body size on growth, survival and chemical composition of Atlantic salmon fed soy lecithin and choline. Prog. Fish-Cult., 52: 226-230. DOI: 10.1577/1548-8640(1990)052<0226: EOBSOG>2.3.CO;2.

Poston, H.A., 1991. Response of rainbow trout to soy lecithin, choline and autoclaved isolated soy protein. Prog. Fish-Cult., 53: 85-90. DOI: 10.1577/1548-8640 (1991)053<0085:RORTTS>2.3.CO;2.

Shiau, S.Y. and P.S. Lo, 2000. Dietary choline requirements of juvenile hybrid tilapia,*Oreochromis niloticus* x *O. aureus*. J. Nutr., 130: 100-103. http://jn.nutrition.org/cgi/content/full/130/1/100.

Tung, P.H. and S.Y. Shiau, 1991. Effects of meal frequency on growth performance of hybrid tilapia, *Oreochromis niloticus* x *Oreochromis aureus*, fed different carbonhydrates diets. Aquaculture, 92: 343-350. DOI: 10.1016/0044-8486(91)90039-A.

Veronica, R., A. Kanazawa and S. Teshima, 1993. Effect of dietary phospholipids and n-3 highly unsaturated fatty acids on ovarian development of kuruma prawn. Nippon Suisan Gakkaishi, 59 (2): 345-351. http://www.journalarchive.jst.go.jp/jnlpdf.php?cdjournal=suisan1932&cdvol=59&noissue=2&startpage=345&lang=en&from=jnlabstract.

Vieira, I., J.E.P. Cyrino and L.E. Pezzato, 2001. Choline and betaine in purified diets for Nile tilapia (*Oreochromis niloticus*). Sci. Agric., 58 (4): 675-680 (Abstract). DOI: 10.1590/S0103-90162001000400004.

Viola, S., Y. Ariali and G Zohar, 1988. Animal protein-free feeds for hybrid tilapia (*Oreochromis niloticus* x *Oreochromis aureus*) in intensive culture. Aquaculture, 75: 115-125. DOI: 10.1016/0044-8486(88) 90026-9.