Abbassa Int. J. Aqua. Spiceal Issue 2010
The third scientific Conference, Al Azhar University, Cairo 17 –18 October 2010

EFFECT OF DIFFERENT DIETARY OIL SOURSES ON FISH PERFORMANCE, FEED UTILIZATION AND BODY COMPOSITION OF RED TILAPIA (*Oreochromis* sp.) FRY.

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ABSTRACT

This experiment aims to study the effect of different oil sources on growth performance, feed utilization and body composition of red tilapia (*Oreochromis* sp.) fry with initial body weight of 2.1±0.06 g. Six isocaloric diets (262 kcal metabolizable energy /100g) containing 28% crude protein, with different sources of dietary oils were used. Each diet was fed in triplicate to six groups of fish two times a day to apparent satiation for 70 days. Treatments were: fish oil (FO); corn oil (CO); soya oil (SO); linseed oil (LO); olive oil (OO) and sunflower oil (SFO). Results showed that fish fed diet containing fish oil or linseed oil were significantly higher ($P \leq 0.05$) in final body weight, weight gain, percent body weight increases and specific growth rate SGR, than fish fed on other diets. Also, values of feed conversion ratio FCR were improved significantly at fish maintained at FO and LO diets compared to other treatments. Survival did not differ significantly among the fish fed six different diets. Likewise, no significant differences were observed for body moisture or protein contents in all treatments. Lipid content concentrations were affected by dietary treatments. Fish fed diets contained olive oil and sunflower oil were significantly lower in body lipid contents than those fed on other diets ($P \leq 0.05$). Feed utilization parameters were affected by dietary treatments. Highest values of PER, PPV% and ER% were obtained with fish fed FO and LO diets. Economic evaluation results showed that the efficiency of replacement fish oil by linseed oil in red tilapia diet is more economic and sharply reduced the fish feed cost. Fish oil could be replaced by a linseed oil in red tilapia diet without any effect on growth performance or feed efficiency ratio.

Keywords: Red tilapia, Growth performance, Feed utilization, Oil sources.

INTRODUCTION

Interspecific variation in the ability of different species to utilize lipid as a source of energy is prevalent. Several studies have shown that providing adequate energy with dietary lipids can minimize the use of more costly protein as an energy source (Cowey and Sargent, 1979; Morris *et al.,* 1995; El-Dahhar and Lovell, 1995; Gatlin and Hardy, 2002; Piedecausa *et al.*, 2007; Kim and Lee, 2005; Ishikawa, 2007).

Lipids are added to diets to provide energy needed for growth and development of cells and tissues and reproduction and are sources of essential fatty acids (EFAs). In addition, they provide transport of fat-soluble nutrients and are involved in the synthesis of metabolically active compounds (Weirich and Reigh, 2001).

Lipid contents of most commercial aquaculture diets are less than 10 per cent, mainly due to processing problems. Though the optimum levels have not yet been determined, higher levels do not appear to result in higher growth. Excessive dietary lipid levels can cause nutritional diseases such as fatty liver (Pillay and Kutty, 2005). Recently; new processing technology has made it possible to use high lipid levels in aqua feeds for some species (Ishikawa, 2007).

The utilization of alternative dietary oils in aquaculture feeds without diminishing favorable growth traits is important. Because of global stagnation of marine fish oils, it is necessary to integrate different lipid sources in the formulation of diets to reduce the dependency of the aquaculture industry on,marine fish to achieve sustainability. However, it is also necessary that the oils used in diets provide adequate levels of EFAs needed by fish to sustain adequate growth rates as well as alter the fatty acid profile of the fillet in a way that is beneficial to the consumer. (O'Neal and Kohler, 2008).

Fish oil, rich in HUFA, is the main dietary lipid source for aquafeeds (Ng *et al.,* 2004). Fish oils are mostly imported from foreign countries, their price and production figures are dependent upon the wild catch of these oil-yielding species. So, Montero *et al.* (2003) reported that steady production and raising prices of fish oil encourage the inclusion of vegetable oils in fish feeds. Gatlin and Hardy (2002) stated that reduction of fish meal and fish oil inputs in feed is one of the prioritized goals for the aquaculture industry not only to increase profits, but also to minimize phosphorus loading to the environment.

Freshwater fish require dietary sources of polyunsaturated fatty acids of the n-6 (linoleic acid, 18:2 n-6) and n-3 (linolenic acid, 18:2 n-3) families for optimum growth. Based on their essential fatty acid requirements, cultured freshwater fish, are commonly fed grain–soybean meal feeds high in n-6 fatty acids. (Kim *et al.,* 2007; Yildirim-Aksoy *et al.,* 2009).

Fish oil could be at least partially substituted by vegetable oils in diets for marine species, being this substitution resulted in good feed utilization and maintenance of fish health. The use of vegetable oils in fish nutrition has been extensively studied. Izquierdo *et al.* (2005) reported that substitution by vegetable oils of up to 60% fish oil in diets for gilthead seabream does not affect growth and feed utilization even after a long feeding period. Piedecausa et *al.* (2007) showed that the replacement of fish oil with soybean or linseed oil in sharpsnout seabream diets does not affect growth or feed utilization after three months of feeding. On the other side Takeuchi *et al.* (1978) suggested possible use of palm and lard lipids for carp *Cyprinus carpio* and rainbow trout *Oncorhynchus mykiss* when the optimal amounts of dietary essential fatty acids were provided. Also, Aoki (1999) reported that growth and feed efficiency ratio were not affected by test diets containing palm and lard oils with a 50% replacement level of fish oil. However, Ishikawa (2007) stated that studies on fish oil replacement are still limited compared to those on fishmeal replacement.

This experiment goal is to evaluate the effect of different sources of dietary oils on growth performance, feed efficiency and body composition of red tilapia (*Oreochromis* sp.) fry and to study the ability to replace fish oil by vegetable oils in fish diets.

MATERIALS AND METHODS

This experiment was carried out at the Fish production Laboratory, Faculty of Agriculture (Saba Bacha), Alexandria University, Egypt.

The Experimental Fish:

The red tilapia, *Oreochromis* sp. fingerlings used in this study was a hybrid, descended of an original cross of female *O. mossambicus* x male *O. niloticus* and obtained from the Marine Fish Hatchery 21 Km, Alexandria, Egypt. Red tilapia were acclimatized to laboratory conditions for two weeks. Then, fry with an initial body weight of 2.1±0.06 g were divided randomly to 6 groups and three replicates for each group. The aquaria of dimensions 100 x 34 x 50 cm were filled with 100 l of water and supplemented with continuous aeration. Nearly half of water was exchanged daily by freshly stocked tap water and aquaria were cleaned every day before feeding. Water temperature was maintained constant at 27°C by means of electric aquarium heaters. Fish were stocked at ten fish per aquarium and fed twice daily to satiation, six days a week. Fish were weighed at the beginning of experiment and then biweekly for 10 weeks.

Diets formulation and preparation:

Six experimental diets were used in this study containing both animal and plant proteins sources. The composition and chemical analysis of the experimental diets are presented in Table 1. Diets were formulated from commercial ingredients of fish meal, wheat flour, wheat bran, soybean meal, yellow corn, Bone meal, vitamins and minerals. Soybean meal to fish meal in a fixed ratio (2: 1) was added to achieve 28 % dietary protein level with metabolizable energy level 262 kcal/100 g diet (air – on dry basis) based on feedstuff values reported by NRC, (1993). Six different sources of dietary oils were used in this study: Treatments were: T1, fish oil; T2, corn oil; T3, soya oil; T4, linseed oil; T5 olive oil and T6, sunflower oil. Oil was added with the rate of 3.5% with equal amount of water using 0.7% phosphatediyl choline (lecithin) according to El-Dahhar and El-Shazly (1993) few drops at the time of mixing. Dry ingredients were passed through a sieve (0.6 mm diameter hole) before mixing into the diets. Mixtures were homogenized in a food grinder mixer. Boiling water was then blended into the mixture at the ratio of 50%

for pelleting. The diets were pelleted using meat grinder with a 1.5 mm diameter.

Analytical methods:

At the end the experiment, samples of three fish were selected randomly and were frozen for body composition analysis. Frozen samples were dried at 70°C for 72 h and passed trough a meat grinder into one composite homogenate per aquarium. Chemical analysis of homogenized fish and experimental diets were carried out according to the methods of AOAC (1990) for protein (macro-keldahl method), fat (ether extract method) and moisture (oven drying). The analysis of variance (ANOVA) and Duncan's multiple range tests were made according to Snedecor and Cochran (1981).

Table 1. Composition and proximate analysis of diets used in this experiment.

Ingredients	Experimental diets					
	Fish oil	Corn oil	Soya oil	Linseed oil	Olive oil	Sun flower oil
Wheat flour	25.0	25.0	25.0	25.0	25.0	25.0
Wheat bran	15.0	15.0	15.0	15.0	15.0	15.0
Soybean meal	30.0	30.0	30.0	30.0	30.0	30.0
Yellow corn	9.2	9.2	9.2	9.2	9.2	9.2
Oil	3.5	3.5	3.5	3.5	3.5	3.5
Fish meal	15.0	15.0	15.0	15.0	15.0	15.0
Bone meal	2.0	2.0	2.0	2.0	2.0	2.0
Vit & Min Mix*	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100
Proximate analyses %						
Moisture	9.81	9.83	9.80	9.79	9.85	9.78
Crude protein	27.83	27.86	27.89	27.75	27.90	27.86
Crude fat	10.45	10.43	10.47	10.38	10.27	10.33
Crude fiber	4.11	4.08	4.23	3.98	4.22	4.20
NFE	38.16	38.07	38.17	38.57	38.05	38.18
Ash	9.64	9.73	9.44	9.53	9.71	9.65

* Content/kg of Vitamin & minerals mixture (P- Fizer, Cairo, Egypt). Vitamin A, 4.8 MIU; Vitamin D, 0.8 MIU; Vitamin E, 4.0 g; Vitamin K, 0.8 g; Vitamin B_1, 0.4 g; Vitamin B_2, 1.6 g; Vitamin B_6, 0.6 g; Vitamin B_7, 20.0 mg; Vitamin B_{12}, 4.0 g; Folic acid, 0.4 g; Nicotinic acid, 8.0 g; Pantothenic acid, 4.0 g; Colin chloride, 200 g; Zinc, 22 g; Cooper, 4.0 g; Iodine, 0.4 g; Iron, 12.0 g; Manganese, 22.0 g; Selenium, 0.04 g.

RESULTS

Data of Table 2 show that final body weight (FBW), weight gain (WG), percent body weight increases (% BWI), feed conversion ratio (FCR) and specific growth rate (SGR%/day) of red tilapia (*Oreochromis* sp) were significantly ($P < 0.05$) affected by different dietary lipid sources. Moreover, the highest significant ($P < 0.05$) values of FBW, WG were obtained in fish fed fish oil diet (FO) and linseed oil diet (LO) without significant differences between the two treatments, Followed by fish fed on corn oil (CO), olive oil (OO) and soya oil (SO) diets and finally the least ($P < 0.05$) FBW, WG was recorded at fish fed sunflower oil diet SFO. Similarly, percent body weight increases (% BWI) had the same trend of both FBW and WG. With respect to feed conversion ratio (FCR) results indicated that the best ($P < 0.05$) values were obtained by fish fed on FO or LO diets (1.51 ± 0.02 and 1.59 ± 0.03, respectively), followed by fish fed on OO and CO (1.87 ± 0.03 and 1.90 ± 0.01) while the worst ($P < 0.05$) FCR values were observed by fish fed on SFO and SO diets (2.18 ± 0.16 and 2.16 ± 0.02, respectively). At the same time, highest ($P < 0.05$) SGR was reported in fish fed FO diet and LO diet while fish fed SFO diet showed the lowest value ($P < 0.05$). They were 2.93 ± 0.10 , 2.89 ± 0.11and 2.35 ± 0.13, respectively. Survival rate at the end of experiment showed that there were insignificant differences ($P > 0.05$) among treatments. It's ranged between 90 to 100 %. With respect to protein efficiency ratio (PER) data in Table 3 indicated that best PER ($P < 0.05$) was obtained by fish fed on FO (2.37±0.04) or LO diets (2.27±0.04) followed by fish fed on OO (1.92±0.05) and CO diets (1.89± 0.03). While the worst ($P < 0.05$) PER values were observed by fish fed on SFO and SO diets (1.65 ± 0.04) and (1.66 ± 0.02), respectively. Results of protein productive value (PPV%) demonstrate that the highest PPV% (35.35 ± 0.4 and 33.81 ± 0.6) was achieved by the fish fed on FO or LO diets which were significantly ($P \leq 0.05$) higher than those of fish fed on CO and OO diets (values were 28.01 ± 0.1 and 27.77 ± 0.14, respectively). While the worst ($P < 0.05$) PPV% values were observed by fish fed on SO and SFO diets. Data of energy retention (ER%) as shown in Table 3 indicated that fish maintained on FO or LO diets retained significantly ($P \leq 0.05$) higher energy than other treatments (28.60 ± 0.34 and 27.20 ± 0.63%, respectively), followed by fish fed CO, SFO, OO diets and finally fish fed SO diet.

Table 2. Means ± standard error (SE) of initial body weight (IBW), final body weight (FBW), weight gain (WG), Percent body weight increases (%BWI), Feed conversion ratio (FCR), Specific growth rate (SGR) of Red Tilapia (*Oreochromis sp.*) fed at six different dietary oil sources.

Treatments	IBW(g)	FBW(g)	WG(g)	BWI %	FCR	SGR%/day
Fish oil	2.16 ± 0.01	16.75 ± 1.0 a	14.59 ± 1.0 a	675.65 ±49 a	1.51 ±0.02 c	2.93 ± 0.10 a
Corn oil	2.16 ± 0.02	13.55 ± 0.2 b	11.40 ±0.27 b	528.85 ±41 b	1.90±0.01 b	2.63 ± 0.04 b
Soya oil	2.18 ± 0.01	11.60 ± 0.4 bc	9.43 ± 0.40 bc	433.25 ±37 c	2.16 ±0.02 a	2.40 ± 0.05 bc
Linseed oil	2.15 ± 0.01	16.20 ± 1.0 a	14.05 ± 1.01 a	653.7 ± 50 a	1.59 ±0.03 c	2.89 ± 0.11 a
Olive oil	2.17 ± 0.02	13.15 ± 0.1 b	10.99 ±0.14 b	507.35 ±15 b	1.87±0.03 b	2.58 ± 0.01 bc
Sun flower oil	2.14 ± 0.01	11.10 ± 1.0 c	8.97 ± 1.01 c	420.05 ± 46 c	2.18±0.16 a	2.35 ± 0.13 c

Means in each column followed by different letter are significantly different ($P < 0.05$).

Table 3. Means ± standard error (SE) of body composition and feed utilization of Red Tilapia (*Oreochromis sp.*) fed at six different dietary oil sources.

Treatments	Moisture%	Fat%	Protein%	PER	PPV%	ER%
Fish oil	70.70 ± 0.98	9.38 ± 0.07 a	14.43 ± 0.12	2.37 ± 0.04 a	35.35± 0.4 a	28.60±0.34 a
Corn oil	71.43 ± 0.35	9.00 ± 0.08 a	14.27 ± 0.08	1.89 ± 0.03 b	28.01± 0.1 b	22.36±0.13 b
Soya oil	70.77 ± 0.6	9.21± 0.02 a	14.16 ± 0.21	1.66 ± 0.02 c	24.62± 0.2 c	20.09±0.04 b
Linseed oil	70.60 ± 0.35	9.30 ± 0.04 a	14.48 ± 0.14	2.27 ± 0.04 a	33.81± 0.6 a	27.20±0.65 a
Olive oil	71.83 ± 1.31	7.95 ± 0.05 b	13.93 ± 0.12	1.92 ± 0.05 b	27.77± 0.14 b	20.96±0.15 b
Sun flower oil	71.57 ± 0.56	8.26 ± 0.04 b	13.98 ± 0.08	1.65 ± 0.04 c	24.25± 0.7 c	20.61±0.51 b

Means in each column followed by different letter are significantly different ($P < 0.05$).

Body composition of red tilapia in table 3 showed that no significant differences were observed with fish moisture contents (P > 0.05) in all treatments. It ranged between 70.70 ±0.98 and 71.83 ±1.31% in fish maintained at FO and OO diets, respectively. On the other hand, lipid content in fish body showed that there were significant differences among treatments (P < 0.05). Fish maintained at FO, LO, SO and CO diet were highest (P < 0.05) in body lipid content than fish maintained at the other two treatments, (SFO and OO diets). Generally, the highest lipid content was found at fish fed FO with the value of 9.38± 0.07% followed by fish fed LO diet, 9.30± 0.04% then fish fed SO diet and CO diet 9.21± 0.02 and 9.00± 0.08%, respectively. The lowest lipid content was found at fish fed SFO and OO diets with the values of 8.26± 0.04 and 7.95± 0.05%, respectively. With regard to protein content of fish body, results in Table 3 showed that, there were insignificant differences between treatments (P > 0.05). Higher protein content of fish body was obtained at fish fed LO diet. It was 14.48 % followed by fish fed FO, CO, SO and SFO diets (values were 14.43, 14.27, 14.16 and 13.98 % respectively), while the lowest treatment was 13.93 % at fish maintained at OO diet.

With respect to economic evaluation, results showed that replacement fish oil by linseed oil in fish diet is more economic and sharply reduced the oil cost in fish feed more than 87% (fish oil cost was about 200 L.E/kg while linseed oil cost was 26 L.E/kg).

DISCUSSION

Results of the present study indicate that growth performance of red tilapia fed FO diet was not significantly different from that of fish fed LO diet (Tables 2; 3). Values of FBW, WG were 16.75, 14.59 g and 16.20, 14.05 g in fish fed FO diet and LO diet respectively, without significant differences between the two treatments.

Similar results have been reported in different species such as common carp (freshwater) (Geurden *et al.,* 1997), and turbot, *Scophthalmus maximus* (marine) (Geurden *et al.,* 1998). In addition, other studies reported better growth performance were obtained in catfish fed diets containing vegetable oils as sources of lipid than those fed cod liver oil diet (Hoffman and Prinsloo 1995; Martino *et al.,* 2002; Ng *et al.,* 2003; Arslan *et al.,* 2008) and with hybrid tilapia, (*Oreochromis niloticus x Oreochromis aureus*) (Huang *et al.,* 1998; Ng *et al.,* 2001). In sharpsnout seabream diets Piedecausa *et al.* (2007) showed that the replacement of fish oil with soybean or linseed oil didn't affect growth or feed utilization after three months of feeding.

Also, Montero *et al.* (2003) found that fish oil can be replaced by a blend of different vegetable oils like soybean oil, rapeseed oil or linseed oil without affecting gilthead seabream health for a medium period. Arslan *et al.* (2008) demonstrated that feeding soybean lecithin diet (high in PLs 18:2n-6) had a growth-promoting effect on juvenile surubim, while feeding cod liver oil diet (high in n-3 PUFA) caused poor growth in the early life stage in this species. Martino *et al.* (2002) demonstrated that vegetable oils such as soybean oil, corn oil, and linseed oil were readily used by surubim fingerlings and no difference in growth of fish was found.

In the present study oil was added to fish diet by 3.5 % which in agreement with what Yildirim-Aksoy *et al.* (2009) observed. they found that fish fed commercial diet (5.6% lipid) supplemented with fish oil at levels of 0, 3, 6, and 9% had similar growth, feed consumption, feed efficiency, and survival.

The difference between growth performance of fish fed FO and LO diet and fish fed other experimental diets in the present study can be considered a consequence of using different type of lipids in the diets and may be related to dietary lipid class as well as fatty acid composition of the diet itself.

Previous studies (Henderson and Tocher, 1987; Sargent *et al.,*1995) have indicated that polyunsaturated fatty acids (PUFA), linoleic acid (LA, 18:2n-6) and linolenic acid (LNA, 18:3n-3), which are also essential fatty acids (EFA) for fish, can be converted to these longer chain, more unsaturated, and physiologically important HUFAs by freshwater fish. So, results of present study suggest that the efficiency of linseed oil used in diet which contain linoleic acid (LA, 18:2n-6) and linolenic acid (LNA, 18:3n-3 provide adequate levels of essential fatty acids needed by fish to sustain adequate growth rate.

In the present study survival rate showed that there were insignificant differences ($P > 0.05$) among treatments. It ranged between 90 to 100 %. This result is nearly similar to what Arslan *et al.* (2008) had found with juvenile surubim. They suggested that, the replacement of fish oil with linseed oil and olive oil in diets did not cause any negative effect on growth performance or survival rate.

With respect to specific growth rate (SGR%/day) results in the present study indicated that there were insignificant differences between fish fed FO and LO diet, 2.93 ± 0.1 and 2.89 ± 0.1%, respectively. While fish fed SFO diet showed the lowest ($P < 0.05$) SGR, (2.35 ± 0.13 %). Sener *et al.* (2005) found that replacing fish oil with sunflower oil, resulted in no statistically significant difference in specific growth rate (SGR).

Fish moisture and protein contents in the present study don't differ significantly ($P < 0.05$) in all treatments. While the lipid content in fish body revealed that, there were differences among treatments ($P < 0.05$). Fish fed FO, LO, SO and CO diet were highest ($P < 0.05$) in body lipid content compared with fish maintained at SFO and OO diets. These results are nearly similar with those reported by Arslan *et al.* (2008). They found that fish moisture contents did not differ significantly among dietary treatments, which were olive and linseed oil LO, cod liver oil (CLO), soy-refined lecithin (LE), at the same time crude protein did not differ significantly among treatments except soy-refined lecithin (LE) diet which was the highest. Also they found that the concentrations of saturated fatty acids were higher in fish fed CLO and LE diets ($P< 0.05$) than in those fed LO-diet. Piedecausa *et al.*(2007) found that crude lipid content in fish that had consumed linseed oil (LO) diet were significantly lower than fish fed fish oil diet. Moreover, feeding studies have shown that fish fed diets supplemented with fish oil had body fatty acid composition, and the ratio of n-3 to n-6 fatty acids positively correlated to their levels in the diets (Abdel-Aty Mohamed 1989; Li *et al.,* 1994; Fracalossi and Lovell 1995; Manning and Li 2002). Subhadra *et al.* (2006) have arrived at similar results with largemouth bass. Differences between results may be back to different kind of fish or age.

In the present study data of protein efficiency ratio (PER) in Table 3 indicated that best PER ($P < 0.05$) was obtained by fish fed on FO 2.37±0.04 or LO diets 2.27±0.04 followed by fish fed on OO, 1.92±0.05 and CO diets, 1.89± 0.03. While the worst ($P < 0.05$) PER values were observed by fish fed on SFO and SO diets 1.65±0.04 and 1.66± 0.02 respectively. The same trend was found with protein productive value (PPV). Balance between dietary protein and energy is essential in fish feed formulation. At inadequate energy levels dietary protein will be used as an energy source (Cowey, 1980), more protein is used for energy, the more ammonia is produced, and the more energy is lost as heat. But at an adequate energy level, dietary protein will be spared for growth (El-Sayed, 1987).

In terms of economic performance, results of our study showed that replacement fish oil by linseed oil in fish diet is more economic. It reduced the oil cost in fish feed more than 87% without any effect on growth performance or feed utilization. These results are nearly similar with those reported by Piedecausa *et al.* (2007) who noted that, consumption of vegetable oils reduced feed costs of sharpsnout seabream.

In conclusion, the obtained results showed that the replacement of fish oil with linseed oil as a vegetable oil in diet of red tilapia (*Oreochromis* sp.) fry did not cause any negative effect on growth performance or feed utilization, suggesting the addition of this oil to red tilapia feed since it's more efficiency economic, available and sharply reduced the oil cost of red tilapia diet.

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تأثير مصادر مختلفة من الزيوت على أداء الأسماك وكفاءة الاستفادة من الغذاء وتركيب الجسم فى صغار أسماك البلطى الأحمر

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الملخص العربى

أجريت هذه التجربة بمعمل إنتاج الأسماك بكلية الزراعة (سابا باشا) جامعة الإسكندرية بهدف دراسة تأثير مصادر مختلفة من الزيوت الحيوانية والنباتية على أداء الأسماك وكفاءة الاستفادة من الغذاء وتركيب الجسم في صغار اسماك البلطى الأحمر ذات وزن ابتدائى (2.1) جم . تم إعداد ستة علائق متساوية في الطاقة ٢٦٢ كيلو كالورى طاقة ميتابوليزمية 100/جم ونسبة بروتين 28% . تم اختيار ستة مصادر مختلفة للزيوت لتضاف للغذاء. كل معاملة موزعة على ثلاثة مكررات وتتم التغذية مرتين يوميا حتى الإشباع لمدة عشرة أسابيع ، و كانت المعاملات كالتالى : زيت سمك ، زيت ذرة ، زيت صويا ، زيت كتان ، زيت زيتون ، زيت عباد الشمس . أوضحت النتائج ارتفاع معدلات النمو وأداء الأسماك والوزن النهائى معنويا في الأسماك المغذاة على العليقتين المحتويتين على كل من زيت السمك و وزيت الكتان مقارنة بباقى المعاملات مع عدم وجود فرق معنوي بين المعاملتين . أيضا أظهرت النتائج أن معدل تحويل الغذاء في الأسماك قد تحسن معنويا فى نفس المعاملتين عن باقي المعاملات . أما نسبة الإعاشة فلم تكن هناك أى فروق معنوية بين المعاملات ، كذلك أظهرت التحليلات المعملية عدم وجود أى فروق معنوية بين المعاملات في كل من محتوى الجسم من الرطوبة و من البروتين . من ناحية أخرى تأثر محتوى الدهن في جسم الأسماك معنويا بالمعاملات الغذائية المستخدمة في التجربة حيث ظهر أن الأسماك المغذاة على العلائق المحتوية على زيت الزيتون وزيت عباد الشمس كانت الأقل معنويا في نسبة تركيز الدهن فى الجسم عن باقى المعاملات.كما أفادت النتائج المتحصل عليها أيضا أن القياسات الخاصة بكفاءة استخدام الغذاء قد تأثرت معنويا بالمعاملات فبالنسبة لمعدل الاستفادة من البروتين وإنتاجية البروتين والطاقة المحتجزة بالجسم كانت جميعها لصالح الأسماك التى تغذت على علائق تحتوي على زيت السمك وزيت الكتان. كما أشارت نتائج التقييم الاقتصادي للتجربة أن استخدام زيت الكتان في العليقة كان أكثر كفاءة اقتصادية .مما سبق وتحت ظروف التجربة فيمكن التوصية باستخدام زيت الكتان بدلا من زيت السمك في علائق صغار البلطى الأحمر بدون أى تأثير على أداء الأسماك أو كفاءة استخدام الغذاء بالإضافة إلى كونه أكثر كفاءة اقتصادية وخفضاً في تكلفة علائق الأسماك.