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Research Article
Effects of Enrichment Commercial Feed with Different Fat Sources on Survival and Growth of Bonylip Barb (*Osteochilus vittatus* Cyprinidae) Fingerlings

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Abstract

Background and Objective: Bonylip barb (*O. vittatus*) is a freshwater fish which have economic value. This study was carried out to evaluate the effect of oil enriched commercial feed on the survival and growth of *O. vittatus*. **Methodology:** Feed enriched with 9% of Shark Liver Oil (SLO), Fish Oil (FO), Corn Oil (CO) and Soybean Oil (SO) which had total fatty acid were 68.18, 86.57, 48.19 and 31.16%, respectively. The addition of different source of fat had influence on fatty acid composition of feed. The *O. vittatus* fingerlings performance was evaluated based on the survival and growth parameter. **Results:** Feed enriched with CO and SO obtained the lowest survival rate. The enrichment commercial feed with SO also displayed the lowest of weight, total length and percentage weight gain. Specific rate growth of *O. vittatus* fingerlings was highest with feed enriched with FO and SLO, followed by feed enrichment with CO and SO. Meanwhile, feed enrichment with SO produced the highest feed conversion ratio. **Conclusion:** Feed enriched with 9% of FO is good for survival, growth and feed conversion ratio of *O. vittatus* fingerlings.

Key words: *Osteochilus vittatus*, fingerlings, nutrition, survival, growth, feed conversion ratio

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Bonylip barb (*Osteochilus vittatus* Cyprinidae), locally name asang is a native freshwater fish in Indonesia[1]. This species live in Singkarak, Antokan river and Koto Panjang reservoir[2-4]. This species have strategic value as a source of food with non cholesterol and its good for rural and urban community[5]. Bonylip barb is also a source of income for rural community around Antokan river, Singkarak lake and Koto Panjang reservoir[2], Arang-Arang lake[6] and Kampar Kanan river[7]. This species is successfully used as biological agent to reduce blooming of phytoplankton[5].

Recently, *O. vittatus* has been rare in Maninjau lake[8-10,2], Arang-Arang lake[6], Koto Panjang reservoir[11,7] due to blocking of the migration routes and sedimentation on the spawning ground area in Maninjau lake[12]. The fluctuation of water level cause loss of their native habitat, spawning area and food supply at Singkarak lake[13]. In Kampar Kanan river, the dam activity and sand mining were the major threats for *O. ittatus*[7].

The *O. vittatus* is a highly demanded fish and since it is near extinction, efforts have been made to culture this species to prevent overexploitation of the fish from the natural environment. The aquiculture activity starts from domestication[14,15]. The database for domestication of *O. vittatus* is already available among others morphological characterization[2], genetic variation[3], growth model[16], food habits[17], aspects of reproduction[4], growth and survival of larvae[15]. The domestication starts from fingerlings. Then, diets is one of the main factor that can effect the growth and survival of fingerlings[18-20]. This study focus on the enrichment commercial feed with SLO, FO, CO and SO on the survival and growth performance of *O. vittatus* fingerlings.

MATERIALS AND METHODS

Experimental animals: Three hundred *O. vittatus* fingerlings (1758.33±52.88 mg) were produced from Hatchery Laboratory, Faculty of Fisheries and Marine Sciences, Bung Hatta University. The samples were acclimatized for 45 days prior the experiment. The sample were placed in concrete tank with the capacity 5,600 L. During the acclimatization, fingerlings were fed with commercial feed which have proximate composition (dry weight %), moisture content 10%, crude protein 41%, lipid 5%, crude fiber 6% and crude ash 16%. Feeding was done twice daily and fish were fed predetermined ratio of 5% b.wt., day^{-1}. Continuous aeration was provided along with 50% replacement of water with fresh borewell water.

For amino acid analysis, methods of Cohen[21] were employed. Duplicates samples were hydrolysed with 6 N hydrochloric acid for 24 h at 11°C. Amino acid analysis was determined by using High Performance Liquid Chromatography (HPLC) system which consisted of Waters 1525 binary HPLC pump, 717 Plus autosampler (Water®) and water 2475 multi λ fluorescence detector optics (the wavelength, 250 nm for excitation and 395 nm for emission).

Fatty acid analysis was carried out in triplicate according to a modified Folch method (1957) as described by Rajion[22], using a chloroform:methanol (2:1, v/v) solvent system. Transmethylation was carried out using 14% methanolic boron trifluoride.

Preparation of experimental diets: Commercial float feed size 1 mm which have protein content of enriched with SLO, FO, CO and SO were 39.24±0.07, 39.77±0.60, 39.50±1.14 and 39.44±0.49, respectively as much as 9% feed per treatment. The oil was poured into each tube, then sprayed evenly to 1 kg of feed, then dried in the open air. Proximate composition, amino acid and fatty acid in each feed are listed in Table 1 and 2.

Experimental design: The experiment was conducted for 60 days in Wet Laboratory, Faculty of Fisheries and Marine Science, Bung Hatta University, Padang, West Sumatera Indonesia. Three hundred *O. vittatus* fingerlings (1758.33±52.88 mg) were distributed randomly in four different experimental groups with three replicates using Completely Randomized Design (CRD). Twelve nets framed with the size 60×60×50 cm, PVC pipe (75 L capacity) were placed inside the concrete tank with the size 400×200 cm with water volume 5,600 L. Each nets contained 25 fish. Fish was fed twice a day at 09.00 am and 16.00 pm. The aeration was provided for 24 h. The water quality parameters were measured for temperature (26-28°C), dissolved oxygen (6.5-7.0 mg L^{-1}) and pH 6.5-7.0 twice daily.

Total length was measured by sliding caliber metal with 0.01 mm precision, weighed on a balance with a precision 0.1 mg. The amount of feed per group was recorded every 15 days during 60 days of the experiment and was used to calculate feed efficiency ratio. Twenty-five fish was taken at every 15, 30, 45 and 60 days in every nets during 60 days the experiment. Proximate composition, moisture, crude protein, crude lipid and ash content were analyzed in duplicate using AOAC method[23].

Table 1: Proximate composition and amino acids profile of the diets

Proximates composition (g 100 g^{-1}), (dry base)	Shark Liver Oil (SLO)	Fish Oil (FO)	Corn Oil (CO)	Soybean Oil (SO)
Crude protein (%)	39.24±0.07[a]	39.77±0.60[a]	39.50±1.14[a]	39.44±0.49[a]
Crude fat (%)	8.63±0.15[a]	8.78±0.45[a]	8.58±0.40[a]	8.79±0.12[a]
Carbohydrate (%)	30.96±0.23[a]	30.33±5.70[a]	30.70±0.21[a]	30.56±0.33[a]
Moisture (%)	11.33±0.02[a]	11.21±0.0[a]	11.41±0.012[a]	11.40±0.012[a]
Ash (%)	9.84±0.02[a]	9.91±0.02[a]	9.81±0.01[a]	9.81±0.06[a]
Calorie (kcal 100 g^{-1})	4348±2.0[a]	4355.66±2.08[a]	4351.33±2.51[a]	4351±2.64[a]
Amino acids (mg kg^{-1})				
Arginine	2.48	2.56	2.14	2.01
Histidine	1.21	1.20	1.03	0.95
I-leucine	1.74	1.71	1.46	1.41
Leucine	3.14	3.20	3.68	3.55
Lysine	2.65	2.52	2.22	2.12
Methionine	0.77	0.66	0.61	0.61
Phenylalanine	1.96	1.98	1.68	1.59
Threonine	1.47	1.63	1.27	3.23
Valine	2.21	2.19	2.87	1.78
ΣEAA	17.63	17.65	16.96	16.25
Alanine	2.24	2.26	2.93	2.83
Aspartic acid	3.81	3.83	3.24	3.09
Glutamic acid	6.27	6.37	6.13	6.89
Glycine	2.32	1.12	1.97	1.92
Serine	1.32	1.59	1.17	1.18
Tyrosine	1.09	1.19	0.96	0.91
ΣNEAA	17.04	16.35	16.40	16.82
ΣAA	34.67	34.00	33.36	33.07

Table 2: Fatty acids profile of the diets

	Result (% w/w)			
Fatty acid	Shark Liver Oil (SLO)	Fish Oil (FO)	Corn Oil (CO)	Soybean Oil (SO)
Lauric acid, C12:0	0.02	0.06	0.03	0.04
Tridecanoic acid, C13:0	nd	0.02	nd	nd
Myristic acid, C14:0	1.04	4.82	1.00	0.96
Pentadecanoic acid, C15:0	0.11	0.31	0.09	0.10
Palmitic acid, C16:0	4.37	13.06	10.68	10.13
Heptadecanoic acid, C17:0	0.15	0.31	0.15	0.17
Stearic acid, C18:0	0.95	2.77	2.83	3.24
Arachidic acid, C20:0	0.08	0.17	0.27	0.38
Heneicosanoic acid, C21:0	nd	0.03	0.04	0.04
Behenic acid, C22:0	0.11	0.12	0.31	0.28
Tricosanoic acid, C23:0	0.09	0.04	0.05	0.07
Lignoseric acid, C24:0	0.20	0.03	0.18	0.16
Total SFA	7.12	21.72	15.63	15.57
Myristoleic acid, C14:1	0.02	0.03	0.02	0.02
Palmitoleic acid, C16:1	1.82	5.12	1.63	1.55
Elaidic acid, C18:1n9t	0.06	0.11	0.09	0.04
Oleic acid, C18:1n9c	21.51	19.15	10.74	5.23
Cis-11-eicosenoic acid, C20:1	0.75	0.70	1.04	0.73
Erucic acid, C22:1n9	0.22	0.24	0.31	0.17
Nervonic acid, C24:1	0.12	0.13	0.32	0.20
Total MUFA	24.50	25.48	14.15	7.94
Linolelaidic acid, C18:2n9t	nd	0.05	0.02	nd
Linoleic acid, C18:2n6c	32.26	35.02	6.65	1.64
Cis-11,14-eicosedienoic acid, C20:2	0.13	0.09	0.15	0.07
Cis-13,16-docosadienoic acid, C22:2	nd	0.04	0.03	0.03
Cis-8,11,14-eicosetrienoic acid, C20:3n6	0.03	nd	0.11	0.04
Cis-11,14,17-eicosetrienoic acid, C20:3n3	nd	nd	nd	nd
Arachidonic acid, C20:4n6	0.19	0.23	0.45	0.38
EPA, C20:5n3	2.04	1.90	7.01	2.28
DHA, C22:6n3	1.91	2.04	3.99	3.21
Total PUFA	36.56	39.37	18.41	7.65
Fatty acid total	68.18	86.57	48.19	31.16

nd: No detection

Procedures analysis, e.g., moisture content was measured by drying samples overnight at 105°C, protein content was measured by Kjeldahl method, lipid was analyzed by ether extraction using a Soxhlet system and ash content was analyzed by heating sample in a muffle furnace 550°C for 5 h. The following parameters were analyzed according to the following equations:

$$\text{Survival (\%)} = \frac{\text{No. of survive fish}}{\text{Total number stock}} \times 100$$

$$\text{Weight gain (mg)} = \text{Final weight (Wt)-Initial weight (Wi)}^{24}$$

$$\text{Total length increase} = \text{Final total length-Initial length}^{25}$$

$$\text{Relative weight gain (\%)} = \frac{\text{Weight increase}}{\text{Initial weight}^{25}} \times 100$$

$$\text{Specific Growth Rate (SGR) (\% b.wt., day}^{-1}\text{)} = (\text{LnWt-LnWi}) \times 100/t^{26}$$

$$\text{Weight gain (\%)} = \frac{\text{Weight increase}}{\text{Initial weight}^{25}} \times 100$$

$$\text{Coefficient of variation (CV\%) for SGR} = \frac{\text{SD}}{\text{Mean}^{27}} \times 100$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Total feed fed (g)}}{\text{Total wet weight gain (g)}^{26}}$$

Statistical analysis: At the end of the experiment, the number of survived fish was recorded and used for calculate the mortality. All fish in each nets framed was pooled for weigh and growth evaluation. Diet effects on survival, SGR and protein content were analyzed using one-way ANOVA. Duncan's procedure was applied for multiple comparisons. Statistical analysis (version 9) was used for windows. Result was considered significant at the 5% level.

RESULTS

The survival rate of *O. vittatus* fingerlings fed enriched SLO, FO, CO and SO after 15 days of experiment were 88.00±6.92, 86.66±10.06, 80.00±12.00 and 76.00±10.58%, respectively. After 60 days, the highest survival rate (79.66±4.50%) was recorded in FO and the lowest survival rate (66.66±8.32%) was recorded in SO (Table 3, Fig. 1) and the survival rate between treatment did not show significant difference (p>0.05).

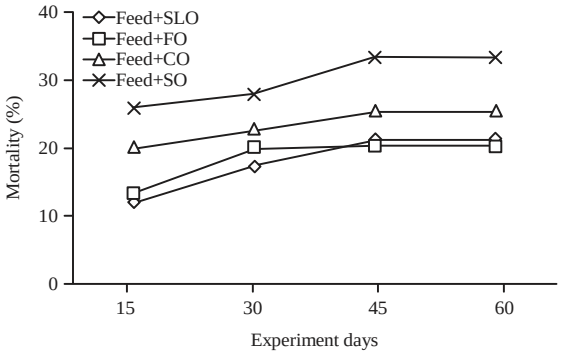

Fig. 1: Effect of different fat sources on the survival of *O. vittatus* fingerlings during the experiment

Table 3: Survival of *O. vittatus* fingerlings (fed different diets from first-feeding period for 15 and 60 days)

	Survival (days) (%)			
Treatments	15	30	45	60
SLO	88.00±6.920[a]	82.66±4.61[a]	78.66±8.32[a]	78.66±8.32[a]
FO	86.66±10.06[a]	80.00±10.58[a]	79.66±4.50[a]	79.66±4.50[a]
CO	80.00±12.00[a]	77.33±10.06[a]	74.66±2.30[a]	74.66±2.30[a]
SO	76.00±10.58[a]	72.00±10.58[a]	66.66±8.32[a]	66.66±8.32[a]

Values are Means±SD (n = 3) within columns values with different superscripts are significantly different (p<0.05)

After 60 days of rearing, the different growth was showed significantly increase (p<0.05) among difference feed. At the end of rearing period (60 days), *O. vittatus* fingerlings fed with enriched SLO and SO showed better growth than other feeds.

The results showed that the average weight in each experiment during 60 days were 6446.67±30.55 mg for SLO, 6716.66±240.06 mg for FO, 5518.33±141.14 mg for CO and 4315.00±50 mg for SO, respectively. Then, the average total length in each experiment during 60 days were 109.89±1.73 mm for SLO, 117.76±1.73 mm for FO, 95.28±1.60 mm for CO and 92.07±1.23 mm for SO, respectively. Meanwhile, the percentage weight gain in each experiment during 60 days were 270.49±5.33% for SLO, 281.56±27.78% for FO, 214.75±15.92% for CO and 140.22±21.53 mg for SO, respectively (Table 4).

The results of BWG per day (%) in each treatment during 15 days ranged between 0.59±0.15 to 0.93±0.05%. Meanwhile, during 60 days of the experiment, BWG per day (%) ranged from 1.69±0.15 to 2.56±0.08% (Table 5). After 60 days of the experiment, the highest specific growth rate 8.54±0.02% was recorded in FO and the lowest specific growth rate (6.19±0.02%) was recorded in CO. The CV of SGR (%) at 60 days experiment showed significant different (p<0.05).

Table 4: Average weight and total length*, percent weight gain, of fish fed various dietary treatments

Treatments	Average initial weight (mg)	Average weight (mg) 15 days	Average weight (mg) 60 days	Average total length (mm) at 60 days	Percentage weight gain 0-15 days	Percentage weight gain 0-60 days
SLO	1736.67±23.09	1974.61±27.37[a]	6446.67±30.55[a]	109.89±1.73[a]	13.53±0.42[a]	270.49±5.330[a]
FO	1756.66±30.55	2012.33±41.18[b]	6716.66±240.06[b]	117.76±1.73[b]	14.99±.017[b]	281.56±27.78[b]
CO	1753.33±72.34	1970.60±10.28[c]	5518.33±141.14[c]	95.28±1.60[c]	12.39±0.60[c]	214.75±15.92[c]
SO	1793.33±75.05	1957.72±43.83[d]	4315.00±50[d]	92.07±1.23[d]	9.50±0.40[d]	140.22±21.53[d]

Values are Mean±SD (n = 3) within columns values with different superscripts are significantly different (p<0.05), *Initial lengths of *O. vittatus* fingerling 58.69±1.23 mm

Table 5: Percent Body Weight Gain (BWG) per day*, feed conversion ratio and coefficient of variation for SGR of fish fed various dietary treatments

Treatments	BWG per day (%) 0-15 days	BWG per day (%) 0-60 days	CV of SGR (%) at 60 days	FCR 0-15 days	FCR 0-60 days
SLO	0.85±0.03[a]	2.49±0.06[a]	7.66±0.02[a]	0.66±0.00[a]	1.40±0.07[a]
FO	0.93±0.05[a]	2.56±0.08[a]	8.54±0.02[b]	0.65±0.00[a]	1.38±0.05[a]
CO	0.81±0.25[a]	1.72±0.02[b]	6.19±0.02[c]	0.66±0.03[a]	1.72±0.08[b]
SO	0.59±0.15[a]	1.69±0.15[b]	6.67±0.02[d]	0.68±0.02[a]	1.68±0.04[b]

Values are Mean±SD (n = 3), columns values with different superscripts are significantly different (p<0.05), *BWG per day = e^{GW}-1 .100, where, GW is instantaneous growth rate (Ln final weight-Ln initial weight)/time in days

The FCR after 15 days of the experiment shows ranged between 0.65±0.00 to 0.68±0.02 and not significant different between the treatments (p>0.05). After 60 days, the lowest FCR shows in FO samples. Meanwhile, the highest FCR shows in CO and SO samples. However, feed conversion ratio was slightly lower in FO compared than SLO (Table 5) and showed significant different in CV for SGR during the experiment (p<0.05). Fingerlings feed enriched with SO showed significant increase of CV for SGR and the lowest CV was in feed enriched with CO (Table 5).

DISCUSSION

In the present study, feed enriched 9% of SLO, FO, CO and SO significantly improved the average weight, average total length, percentage weight gain, CV of SGR and feed conversion ratio of *O. vittatus* fingerlings. The adding of SLO, FO, CO and SO as live diets has been successful to increase the growth performance and survival of some fish species[20,28-32].

There is no significant different in proximate and amino acid composition. However, total fatty acid tend to change with the addition of different fat sources. It may be explained that different fat sources is required for body protein synthesis in early stages and may support the fast growth of *O. vittatus* fingerlings. Fatty acid is one of the most important components in fish diet[20,28,33,34]. The higher fatty acid composition in feed had a positive effect on the growth of fish larvae and fingerlings[18,35,36].

After 60 days of the experiment, feed enriched with FO and CO shows significant difference (p<0.05) on BWG, CV of SGR and feed conversion ratio. Meanwhile, *O. vitatus* fingerlings feed enriched with SLO and FO obtained the higher growth rate and body weight. This condition is due to SLO and FO contains total fatty acids higher than CO and SO (68.18, 86.57, 48.19 and 31.16%), respectively. Several studies have been reported that the used of SLO, FO and vegetable oils can be used for enrichment feed for freshwater and saltwater fish[20,28,30-32,36,37]. Furthermore, diets enriched with 9% of SLO, FO, CO and SO was not negative impact on the growth and survival of *O. vittatus* fingerlings. According to Caballero *et al.*[33] that rainbow trout diet with up to 80-90% of vegetable oils (e.g., soybean, rapeseed, olive and palm oils) can be used without compromising their growth. Nine percent of oil added to feed was the best growth for common carp in fertilized tanks[18].

In the 15 days of the experiment, the mortality rate of *O. vittatus* fingerlings ranged from 12±5.56-24±8.12%, after 45 and 60 days the mortality rate tend to increase with ranged from 20.34±5.60-33.34±7.50%. The mortality may cause the handling activity and water quality. The water quality parameters in all experimental in nets framed within the normal range (temperature 26-28°C, dissolved oxygen 6.5-7.0 mg L^{-1} and pH 6.5-7.0).

CONCLUSION

In conclusion, feed enrichment with 9% of FO is good for survival, growth and feed conversion ratio of *O. vittatus* fingerlings.

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REFERENCES

1. Kottelat, M., A.J. Whitten, S.N. Kartikasari and S. Wirjoatmodjo, 1993. Freshwater Fishes of Western Indonesia and Sulawesi. Periplus Editions (HK) Ltd., Hong Kong, Pages: 221.
2. Syandri, H., Azrita and Junaidi, 2014. Morphological characterization of asang fish (*Osteochilus vittatus*, Cyprinidae) in Singkarak lake, Antokan river and Koto Panjang reservoir West Sumatra province, Indonesia. J. Fish. Aquacult., 5: 158-162.
3. Azrita, H. Syandri and Junaidi, 2014. Genetic variation among asang fish (*Osteochilus vittatus* Cyprinidae) populations using Random Amplified Polymorphic DNA (RAPD) markers. Int. J. Fish. Aquat. Stud., 1: 213-217.
4. Syandri, H., Azrita and Junaidi, 2015. Fecundity of bonylip barb (*Osteochilus vittatus* Cyprinidae) in different waters habitats. Int. J. Fish. Aquat. Stud., 2: 157-163.
5. Syandri, H., 2004. The use of asang fish (*Osteochilus vittatus*) and tawes fish (*Puntius javanicus*) as an agent of biological in Maninjau Lake. J. Nature Indonesia, 6: 87-91.
6. Samuel, S. Adjie and Z. Nasution, 2002. Environmental and biological aspects of fish in Arang-Arang lake Jambi province. J. Res. Fish. Indonesia, 1: 1-13.
7. Aryani, N., 2015. Native species in Kampar Kanan river, Riau province Indonesia. Int. J. Fish. Aquat. Stud., 2: 213-217.
8. Syandri, H., 2003. Cages culture and problems in Maninjau lake, West Sumatra province. J. Fish. Ocean, 8: 74-81.
9. Sulastri, D.I. Hartoto and I. Yuniarti, 2012. Environmental conditon, fish resources and management of Maninjau lake of West Sumatera. Indonesia Fish. Res. J., 18: 1-12.
10. Uuslichah, U. and H. Syandri, 2003. Reproduction aspects of sasau (*Hampala* sp.) and lelan (*Osteochilus vittatus*) in Singkarak lake. J. Ichtiol. Indonesia, 1: 41-48.
11. Warsa, A., A.S. Nastiti, Krismono and A. Nurfiarini, 2009. Fisheries resources in Koto Panjang reservoir. Bawal, 2: 93-97.
12. Junaidi, H. Syandri and Azrita, 2014. Loading and distribution of organic materials in Maninjau lake West Sumatra province-Indonesia. J. Aquacult. Res. Dev., Vol. 5. 10.4172/2155-9546.1000278.
13. Syandri, H., Azrita and N. Aryani, 2013. [Size distribution, reproduction and spawning habitat of Bilih fish (*Mystacoleucus padangensis* Blkr.) in lake Singkarak]. Bawal, 5: 1-8, (In Indonesian).
14. Azrita, Y. Basri and H. Syandri, 2015. EA preliminary study on domestication of bluespotted snakehead (channa lucius, channidae) in concrete tank. J. Aquacult. Res. Dev., Vol. 6. 10.4172/2155-9546.1000309.
15. Syandri, H., Azrita, Niagara and Junaidi, 2015. Preliminary study on the feeding schedule of laboratory reared of bonylip barb larva, *Osteochilus vittatus* Cyprinidae. J. Aquacult. Res. Dev., Vol. 6. 10.4172/2155-9546.1000368.
16. Syandri, H., Azrita and Junaidi, 2014. Biological parameters of bonylip barb, *Osteochilus vittatus* Cyprinidae. Proceedings of the National Seminar on Incentive Research SINas, Ministry for Research and Technology, Republic of Indonesia.
17. Syandri, H., Azrita and Junaidi, 2014. Food habits of bonylip barb (*Osteochilus vittatus* Cyprinidae). Proceedings of the Annual National Seminar XI Fisheries and Marine Research, (ANSFMR'14), Department of Fisheries-Faculty of Agriculture, University of Gajahmada.
18. Manjappa, K., P. Keshavanath and B. Gangadhara, 2011. Influence of sardine oil supplemented fish meal free diets on common carp (*Cyprinus carpio*) growth, carcass composition and digestive enzyme activity. J. Fish. Aquat. Sci., 6: 604-613.
19. Masiha, A., E. Ebrahimi, N.M. Soofiani and M. Kadivar, 2013. Effect of dietary vegetable oils on the growth performance and fatty acid composition of fingerlings of rainbow trout, *Oncorhynchus mykiss*. Food Sci. Technol., 1: 21-29.
20. Jiang, X., L. Chen, J. Qin, C. Qin, E. Li and H. Jiang, 2013. Effects of dietary soybean oil inclusion to replace fish oil on growth, muscle fatty acid composition and immune responses of juvenile darkbarbel catfish, *Pelteobagrus vachelli*. Afr. J. Agric. Res., 8: 1492-1499.
21. Cohen, S.A., 2003. Amino Acid Analysis using Pre-Column Derivatization with 6-Aminoquinolyl-N-Hydroxysuccinimidyl Carbamate. In: Protein Sequencing Protocols, Smith B.J. (Ed.). 2nd Edn., Vol. 211, Humana Press Inc., Totowa, NJ., ISBN: 9781592593422, pp: 143-154.
22. Rajion, M.A., 1985. Essential fatty acid metabolism in the fetal and neonatal lamb. Ph.D. Thesis, The University of Melbourne, Australia.
23. AOAC., 2000. Official Methods of Analysis. 17th Edn., Association of Official Analytical Chemistry, Arlington, Virginia, USA.
24. Hevroy, E.M., M. Espe, R. Waagbo, K. Sandnes, M. Ruud and G.I. Hemre, 2005. Nutrient utilization in Atlantic salmon (*Salmo salar* L.) fed increased levels of fish protein hydrolysate during a period of fast growth. Aquacult. Nutr., 11: 301-313.
25. Kim, M.K., J.P. Dubacq, J.C. Thomas and G. Giraud, 1996. Seasonal variations of triacylglycerols and fatty acids in *Fucus serratus*. Phytochemistry, 43: 49-55.
26. Chong, A.S.C., S.D. Ishak, Z. Osman and R. Hashim, 2004. Effect of dietary protein level on the reproductive performance of female swordtails *Xiphophorus helleri* (Poeciliidae). Aquaculture, 234: 381-392.

27. Wang, C., S. Xie, K. Zheng, X. Zhu, W. Lei and Y. Yang, 2005. Effects of live food and formulated diets on survival, growth and protein content of first-feeding larvae of *Plelteobagrus fulvidraco*. J. Applied Ichthyol., 21: 210-214.
28. Ochang, S.N., O.A. Fagbenro and O.T. Adebayo, 2007. Influence of dietary palm oil on growth response, carcass composition, haematology and organoleptic properties of juvenile Nile tilapia, *Oreochromis niloticus*. Pak. J. Nutr., 6: 424-429.
29. Yanes-Roca, C., N. Rhody, M. Nystroma and K.L. Main, 2009. Effects of fatty acid composition and spawning season patterns on egg quality and larval survival in common snook (*Centropomus undecimalis*). Aquaculture, 287: 335-340.
30. Sagne, M., A. Loum, J. Fall, D. Ndong, M. Diouf, A. Sarr and O.T. Thiaw, 2013. Effects of different types of oils on growth performance, survival and carcass composition of Nile tilapia (*Oreochromis niloticus*). J. Biol. Life Sci., 4: 1-12.
31. Asadpour, Y.A., M. Seidgar and F. Mohebbi, 2015. Application of shark liver oil for Artemia enrichment and its comparison with imported selco. Int. J. Fish. Aquat. Stud., 2: 120-124.
32. Yilmaz, H.A. and O.T. Eroldogan, 2015. Effects of fish oil substitution with two different vegetable oil classes on fatty acid digestibility in juvenile European sea bass, *Dicentrarchus labrax*. Turk. J. Fish. Aquat. Sci., 15: 1-12.
33. Caballero, M.J., A. Obach, G. Rosenlund, D. Montero, M. Gisvold and M.S. Izquierdo, 2002. Impact of different dietary lipid sources on growth, lipid digestibility, tissue fatty acid composition and histology of rainbow trout, *Oncorhynchus mykiss*. Aquaculture, 214: 253-271.
34. Lin, Y.H. and S.Y. Shiau, 2007. Effects of dietary blend of fish oil with corn oil on growth and non-specific immune responses of grouper, *Epinephelus malabaricus*. Aquacult. Nutr., 13: 137-144.
35. Gholami, M., 2010. Effects of n-3 HUFA enriched *Daphnia magna* on growth, survival, stress resistance and fatty acid composition of white fish fry (*Rutilus frisii kutum*). J. Fish. Aquat. Sci., 5: 49-55.
36. Ozsahinoglu, I., T. Eroldogan, P. Mumogullarında, S. Dikel and K. Engin *et al*., 2013. Partial replacement of fish oil with vegetable oils in diets for European seabass (*Dicentrarchus labrax*): Effects on growth performance and fatty acids profile. Turk. J. Fish. Aquat. Sci., 13: 819-825.
37. Arslan, M., N. Sirkecioglu, A. Bayir, H. Arslan and M. Aras, 2012. The influence of substitution of dietary fish oil with different vegetable oils on performance and fatty acid composition of brown trout, *Salmo trutta*. Turk. J. Fish. Aquat. Sci., 12: 575-583.