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The Effects of Three Diets on Some Growth Performance of Whitefish (*Coregonus lavaretus*) Fry

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Abstract: In a 3 months experiment, the effects of three different kinds of food rations including culture rotifers, commercial food and the equal amount mixture of these two foods were studied on some growth specifications and survival of the whitefish (*Coregonus lavaretus*) fry. The initial average weight and length of the fry were 0.009 g and 4 mm, respectively. The period of experiment was among April to July 2003. The assessed characteristics variance analysis showed that the different food treatments caused very significant differences among the all averages ($p<0.01$). Comparing the characteristics averages showed that during the first month of experiment, the best results of weight (0.029 g), total length (8.78 mm), specific growth rate (5.36%) and food efficiency (63.48%) were obtained in live food treatment, whereas the weakest averages of referred characteristics were observed in commercial food treatment. During the last month of experiment, some of the above results reversed so that the best averages of specific growth rate (3.73%) and food efficiency (44.3%) were observed in commercial food treatment. The results of this study showed that the use of rotifer as live food for fry has provided better survival rate than the other two treatments. However, this food could not provide the best results for the all measured characteristics in all of the experiment period, for the reason that during the third month of experiment period, using commercial food treatment which consist of more miscellaneous nutrient components, created better results for some fry's characteristics than the live food.

Key words: Whitefish, rotifer, commercial food, live food

INTRODUCTION

The species of Coregonidae family live in brine and freshwater (Huet, 1998) and depending on seasons possess different biodiversity and nutrition. During warm season migrate to cold water of depths and during other season approach to surface of water so their diet depending on different season and the depth they live is different (Amtstaetter, 2000). Most of them feed on zooplankton and their feeding activity in water body can increase intensity of phytoplankton in environment (Berg *et al*., 1994). Special ability of some species of this family in compatibility with sluggish rivers has provided good opportunity for them to be indigenous to other regions (Rissanen, 1995). On the other hand commercial value of coregonid fishes have paved the way for exploiting their resource in countries of central and northern Europe, Russia, north America and have caused that the aforementioned countries by executing of comprehensive and long-term programs take necessary measures for preservation and restocking of coregonidae population (Lasenby and Kerr, 2001). Production of freshwater species of coregonidae for restocking usually is being done until fry stage, therefore this species possess small portion in world aquaculture and vice versa they possess considerable portion in fishing of freshwater fishes (FAO, 2002). Among this family, European whitefish (*Coregonus lavaretus*) and Lake Whitefish (*C. clupeaformis*) constitute the most production in Europe and North America respectively (FAO, 2002). European whitefish (*C. lavaretus*) is one of the exotic species that has been introduced to Iran in 1968 as fry in lake behind Amir Kabir dam located in Tehran province. From then on this species has had good compatibility with environmental condition, but successive drought of recent years and decreasing the depth of aforementioned lake caused that appropriate beds for spawning of this fish gradually be out of water after spawning season so that a great deal of released seeds were destroyed in this region. This problem has brought menace to its population in Amir Kabir Lake. This lake is the only habitat of whitefish in Iran which rotifer is one of

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abundant zooplankton in it. As the *C. lavaretus* is a filter feeder it was thought that rotifer is one of its important food which has a good effect on whitefish survival and growth. The research and study of this theory along with artificial propagation of referred species formed two main objects of whitefish restocking project.

MATERIALS AND METHODS

This study was conducted in Khojir Natural Resource Research Station in Tehran province from April to July 2003. The fry for this study was provided by Mahisara Fish Propagation of Jajrood Institute. The fry were transferred to Khojir station and introduced to culture environment after yolk sac absorption.

Three food treatments were used in this study: 1-Live diet including Rotifer (*Brachionus plicatilis*) which was produced in Khojir station. Production of this food was based on alga (*Chlorella vulgaris*) culture as the rotifer food which was provided in three 250 L tanks (3×10^7 cells cm^{-3}). The rotifer stock (10 rotifer cm^{-3}) introduced to one of these tanks in this stage. Harvesting the rotifer was begun gradually when its density reached to 120 cm^{-3}. The rotifer blooming took 5 days and was available during the experiment period. During this time the alga was produced in the 2 other tanks and introduced to rotifer tank by an electric pump after daily harvest of needed rotifer. 2-Trout starter food with trade name of 000 starter including protein 50%, fat 12%, ash 11%, raw fiber 16%, phosphor 1.3% humidity 10% that this diet had been produced by Chineh Company in Iran. 3-Mixture of equal proportion of first and second diets. Calculating of this diet was done based on dry weight of both commercial and live foods.

Culture environment was being consisted of 30×30×40 cm cages with plastic net bag. The net mesh size was 0.50 mm in all cages. These cages were stationed in one of the natural basin of Khojir Natural Resource Research Station and floated in surface of water by plastic pieces. Water current was circulated through the cages from the bottom and the walls.

During the study Sartorius digital scale (model PT-120) was used (0.001 accuracy) for weighing of food and fry. In order to measure the fry length common ruler was applied. Moreover for desiccating of live food, Doma desiccator (model RC-100) was used.

The three used rations in this experiment consisted of triple treatments that three repetitions were intended for each of them. Hence nine culture cages (three treatments in three repetitions) were prepared in the form of Randomized complete block design and were installed in the basin for conducting experiment; moreover 150 fry were introduced to each cage. Average weight of fry was 0.009 g and average length of them was 4 mm.

However according to Troschel and Rosch (1990) for a short period study that take only two weeks, the number of fry could be increased to 30 pieces per litter but due to the needed time for this experiment that was relatively long, for rearing of fry the increasing of fry intensity was refrained. The place for installing of cages was a natural basin with dimension of 12×3 m and depth of 0.8 m. Water entered into the cages through bottoms and walls in the direction of west to east and exited from a gate at the end of the basin. After introducing of fry to culture cages and before complete absorption of yolk sac, in order to prevention of mortality resulting from starvation, first feeding was carried out 5 h after introducing of them in 10th April 2003. the amount of food was 200% of fry biomass weight and feeding had been done every 2 h among 7 am and 9 pm. Feeding rate in this study were the same amount that Troschel and Rosch (1990) suggested. This amount caused that food be available in surrounding of fry and at the same time prevented from over feeding that resulted in contamination of environment and food wastage. The amount of consumed food in each cage were calculated weekly after biometry operation, so for doing that, 6 pieces of fry were separated from each cage in random weekly and their average weight considered as the fry average weigh. The gained amount multiplied by the number of fry in that cage for calculating the total weight of fry in it. Then 200% of gained amount, determined as the weight of necessary food for fry in that cage for each day of next week. This procedure was being done for fry of each cage separately.

For harvesting of live food, at first some cultured rotifer were taken form mass culture environment with the aid of 150 micron filter. Then the amount of needed food for each ration was separated by means of digital scale. Since in Food Conversion Rate formula, dry weight of food is as yardstick, so in order to determination of dried matter amount in live food, 10 g of cultured rotifer were harvested from mass culture environment before beginning of fry rearing and were placed in the proximity of 50°C in the desiccators for 24 h to lose its humidity. Then dried rotifer was weighed again and weight proportion of dried rotifer to live rotifer was used as yardstick for weight conversion of live food in formulae. In this study weight, total length, weight increment percent, length increment percent, Specific Growth Rate (SGR), survival rate and food efficiency of fry were calculated with triple food treatments weekly.

Feeding indexes: In order to determination of feeding indexes, following formulae has been used (EIFAC, UINS and ICES, 1982):

$$\text{Weight increment percent} = \frac{\text{Final weight (g) - early weight (g)}}{\text{Early weight (g)}} \times 100$$

$$\text{Specific growth rate} = \frac{\text{ln final weight - ln early weight}}{\text{Days of experiment}} \times 100$$

$$\text{Food conversion rate} = \frac{\text{Dry weight of consumed food (g)}}{\text{Wet weight increment (g)}}$$

Statistical analysis: This experiment was conducted in the form of Randomized complete block design and in natural environment. Characteristics of aforementioned design were: separation of effects of treatments, repetitions and errors of experiment in analysis of variance. In order to surveying existence or non-existence of significant differences between averages of characteristics of fry fed on triple food treatments, one tailed analysis of variance, was done through M-STAT-C software and for averages comparing with each other in statistical levels of 0.01 and 0.05 Duncans Test was used. So the treatment that produced the best averages for fry characteristics acquired a rank and the treatment that produced the weakest averages, acquired c rank. The order of ranking between a and c is as follow:

a>b>c

RESULTS

The gained observations during this study imply that rotifer as live food has provided better growth and survival than commercial food in fry.

As the amounts of F_s in Table 1 indicate, triple food treatments have resulted in occurrence of very significant differences between averages of characteristics and coefficient of variance in Table 1 testify the reliability of F_s amount in levels of 0.01 and 0.05, because in none of characteristics, the amount of coefficient of variance have not reached to 25%. Table 1 indicates that live food treatment have produced the best averages in all of fry characteristics and have acquired a rank among all treatments.

Study of Table 2 indicates strong similarity of live food treatment ranking during second and first months of experiment. But in this period the average of the length increment percent in fry fed on live diet is less than this average in fry fed on commercial diet. So live food treatment during this period of experiment and only about length increment percent in fry have acquired second rank (b) and about the other characteristics live food treatment has been as first rank.

Table 1: Analysis of variance and comparing the averages of characteristics during first month of experiment

			Amount and rank of characteristics in treatment of								
			Live food			Commercial food			Mixed food		
Measured characteristics	F_s	Coefficient of variance (%CV)	Early	Final	Average	Early	Final	Average	Early	Final	Average
Weight (g)	105.50**	4.08	0.009	0.05	0.029^{a}	0.009	0.02	0.014^{c}	0.009	0.03	0.019^{b}
Weight increment percent	716.34**	2.31	22.00	74.00	48.00^{a}	22.00	40.67	31.33^{b}	22.00	46.88	34.44^{b}
Total length (mm)	8.41*	14.64	4.00	13.57	8.78^{a}	4.00	6.27	5.13^{b}	4.00	12.90	8.45^{ab}
Length increment percent	6420.58**	2.16	5.00	42.30	23.65^{a}	5.00	34.27	19.63^{c}	5.00	42.17	23.58^{b}
Specific growth rate	77.23**	6.02	2.80	7.93	5.36^{a}	2.80	5.33	4.06^{c}	2.80	5.50	4.15^{b}
Food efficiency	66.97**	5.39	58.27	68.70	63.48^{a}	38.45	65.00	51.72^{c}	38.50	66.63	52.56^{b}
Survival rate	25.29**	9.92	97.41	88.33	92.57^{a}	93.16	82.89	88.02^{b}	96.13	81.78	88.95^{ab}

**Very significant difference in 0.01 level, *Significant difference in 0.05 level, a: First rank, b: Second rank, c: Third rank

Table 2: Analysis of variance and comparing the averages of characteristics during second month of experiment

			Amount and rank of characteristics in treatment of								
			Live food			Commercial food			Mixed food		
Measured characteristics	F_s	Coefficient of variance (%CV)	Early	Final	Average	Early	Final	Average	Early	Final	Average
Weight (g)	118.36**	16.60	0.05	0.26	0.15^{a}	0.02	0.06	0.04^{b}	0.03	0.09	0.06^{b}
Weight increment percent	395.90**	3.39	74.00	30.56	52.28^{a}	40.67	28.75	34.71^{b}	46.88	21.43	34.15^{b}
Total length (mm)	227.85**	2.59	13.57	28.40	21.00^{a}	6.27	18.90	12.58^{c}	12.90	28.43	18.63^{b}
Length increment percent	47.69**	8.40	42.30	6.20	24.25^{b}	34.27	14.78	24.57^{a}	42.17	6.67	24.42^{b}
Specific growth rate	148.58**	4.30	7.93	3.77	5.85^{a}	5.33	3.13	4.23^{ab}	5.50	2.57	4.03^{b}
Food efficiency	51.00**	5.64	68.07	48.07	58.38^{a}	65.00	41.23	53.11^{b}	66.63	34.78	50.75^{b}
Survival rate	22.63**	4.66	88.33	87.26	87.79^{a}	82.89	79.91	81.40^{b}	81.78	80.49	81.13^{ab}

**Very significant difference in 0.01 level, a: First rank, b: Second rank, c: Third rank

Table 3: Analysis of variance and comparing the averages of characteristics during third month of experiment

			Amount and rank of characteristics in treatment of								
		Coefficient of variance	Live food			Commercial food			Mixed food		
Measured characteristics	F_s	(%CV)	Early	Final	Average	Early	Final	Average	Early	Final	Average
Weight (g)	99.47**	11.35	0.26	0.58	0.42^a	0.06	0.18	0.12^b	0.09	0.25	0.17^b
Weight increment percent	35.57**	6.31	30.56	18.09	24.32^b	28.75	35.83	30.29^a	21.43	29.67	25.55^a
Total length (mm)	229.11**	1.91	28.40	34.60	31.50^a	18.90	24.40	21.65^c	28.43	33.40	31.00^b
Length increment percent	68.50**	6.60	6.20	2.80	4.50^b	14.87	6.87	9.67^a	6.67	11.20	8.93^a
Specific growth rate	23.60**	6.39	3.77	2.47	3.12^b	3.13	4.33	3.73^a	2.50	4.00	3.25^a
Food efficiency	42.13**	4.65	48.07	33.10	40.58^b	41.23	47.37	44.30^a	34.87	49.67	42.27^a
Survival rate	18.34**	0.94	87.26	87.00	87.13^a	79.91	78.27	79.09^b	80.49	80.32	80.40^a

**Very significant difference in 0.01 level, a: First rank, b: Second rank, c: Third rank

Table 4: Analysis of variance and comparing the averages of characteristics during all months of experiment

			Amount and rank of characteristics in treatment of								
		Coefficient of variance	Live food			Commercial food			Mixed food		
Measured characteristics	F_s	(%CV)	Early	Final	Average	Early	Final	Average	Early	Final	Average
Weight (g)	118.36**	11.43	0.009	0.58	0.29^a	0.009	0.18	0.094^b	0.009	0.25	0.129^b
Weight increment percent	151.16**	2.47	22.00	59.44	40.72^a	22.00	21.00	21.50^b	22.00	26.00	24.00^b
Total length (mm)	296.04**	1.95	4.00	34.63	19.30^a	4.00	24.40	14.20^c	4.00	33.40	18.70^b
Length increment percent	65.08**	1.50	5.00	74.00	39.50^a	5.00	51.00	28.00^b	5.00	71.00	38.00^a
Specific growth rate	104.74**	2.42	2.80	4.33	3.56^a	2.80	2.47	2.63^b	2.80	3.60	3.20^b
Food efficiency	94.70**	1.93	58.27	33.10	45.71^a	38.45	47.37	42.91^b	38.50	49.67	44.08^b
Survival rate	62.98**	3.16	97.41	87.00	92.20^a	93.16	78.27	85.71^c	96.13	80.32	88.22^b

**Very significant difference in 0.01 level, a: First rank, b: Second rank, c: Third rank

The obtained result from third month of experiment (Table 3) suggested more noticeable differences in the results of this period with the other periods. In this period the averages of weight increment percent, specific growth rate and food efficiency in fry fed on commercial diet had been better than fry fed on two other food treatments while the best averages of weight, total length and survival rate has obtained from live food treatment. Achieving the best fry survival rate (rank a) in live food treatment was the most prominent point in third month of experiment and it may be a reason for guarantee of fry survival in using of live food in all stages of growth.

Comparing of the results in Table 4 with the other tables indicate that ranking in aforementioned table bear strong similarity to Table 1 about live food treatment. So in both of them, aforementioned treatment have caused best results in all characteristics and have acquired a rank. This matter indicates that if three months period of experiment had not been divided into smaller periods (monthly periods), it would have been impossible to survey the effects of live food and commercial food on growth and survival of fry effectively.

DISCUSSION

Separating the experiment time to 3 monthly period and comparing their results to each other revealed the statistical differences levels (0.01 and 0.05). These differences were not recognizable when all 3 months of experiment were considered totally (Table 4).

The results of comparison of fry characteristics averages during first month of experiment indicate acquiring best averages in live food treatment and weakest averages in commercial food treatment. Mixture food has presented intermediary averages but these averages were approximate to the averages of live food treatment. These results are concerned with the absence or lack of necessary development of digestive enzymes for digesting of food in fry and according to Kuzminski *et al.* (1996) for overcoming this problem, live food should be utilized so its internal enzymes prepare the ground for digesting of food by fry, then with completion of digestive system development when fry reach to 0.2 g, trout starter food could be utilized. Maybe the reason for approximation of averages in mixed food treatment to live food treatment is the same subject, viz., present of some live food in this diet (mixed food) that as a result of autolysis prepare the ground for better growth of fry and survival in proportion to commercial food. The evidence for this claim could be increasing of food efficiency and survival rate in mixture diet in proportion to commercial food. The results in second month to some extent bear similarity to results of first month. The only difference is that in this period the averages of length increment percent in commercial food treatment exceed in proportion to the other treatments and average of specific growth rate in commercial food treatment has been better than referred characteristic average mixture diet treatment. About other averages of fry characteristics, the status was exactly similar to first month. So we can conclude that

during second month and passing 8 weeks since starting of fry rearing, the evolution process of digestive system for fry have progressed in the direction of using commercial food. The evidence of this matter is that the amounts of averages of characteristics in fry has been more approximate to each other in commercial and mixed food treatments and their blatant difference with averages of live food treatment. Moving away the amounts of averages of characteristics in live diet treatment from averages obtained from the other two treatments during second month of experiment indicates obvious effects of live food on developing of digestion and assimilation of food in digestive system of fry fed on this treatment. The results obtained during first two months of fry rearing in this project is comparable with Enz *et al.* (2002) study results from a 6 weeks period of whitefish fry rearing in 2002. Aforementioned investigators indicated that feeding the fry on Artemia napuli during 6 early weeks of fry life, have provided better growth and survival in proportion of feeding on commercial along with live food and when only live food has been used, they have reported maximum rate of mortality as 45%, while in this study the mortality rate of the fry fed on live food treatment has been less than 13% after two months (survival rate, Table 2) that this matter perhaps is a reason for superiority of rotifer over artemia napuli for feeding of whitefish fry.

The results of Duncans Test during third month of experiment (Table 3) have indicated that commercial and mixture food treatments were compeer in producing some averages of fry characteristics. In this period, like previous monthly periods, best averages of weight, total length and survival rate of fry has been obtained from live food treatment, while weight increment percent, length increment percent, specific growth rate and food efficiency contrary to previous periods have acquired best averages in commercial food treatment. Also mixture food treatment about these characteristics has been compeer with commercial food treatment but weaker than it. Perhaps the reason for occurrence of difference in the results of Duncans test in third month of experiment with previous periods is the expose of fry fed on commercial diet treatment in a stage that most of weight increment percent and specific growth rate occur in that stage. At the same time decrease in effect of live food on producing best averages of some characteristics could be attributed to lack of providing all nutritional demands of fry by this diet especially in post stages of growth. The results of Duncans test during all months of experiment (Table 4) indicate complete superiority of live food in producing best averages over the two other treatments and occurrence of weakest averages by commercial food. None of commercial diet advantages which had been recorded in second and third months of experiment, were not seen in results of Duncans test through all months (Table 4) of experiment. The best average of weight growth (0.29 g) during this experiment and after three months belonged to live food treatment (Table 3). This very slow growth closely corresponds to the results of Heikinheimo *et al.* (2000). They had estimated very slow growth in European whitefish fry fed on zooplankton diet in their two early years of life. At the same time the Survival Rate resulted from live food treatment in current study closely corresponds to the presented results by Luczynski *et al.* (1996), stated that feeding of coregonid fishes on zooplankton is a reason for more survival in proportion to feeding on commercial ration. The least obtained survival rate during this three months study obtained from commercial diet treatment (less than 79%). This result is weaker than the results of Harris (1992), study in who had examined trout commercial ration in early feeding of whitefish fry during first 8 critical weeks of their life and announced final survival rate as 95%. Such result also had obtained from whitefish propagation station in Ontario state in Canada which whitefish fry fed on commercial food during early 28 weeks of their life had survival rate as 95%. However the aforementioned results do not correspond to the results of current study. In spite of disagreement and some justification in using live and commercial diets that exist in some miscellaneous sources, rearing of aforementioned fish currently confines to appropriate natural environments and preliminary propagation of this fish is being performed with the aim of increasing its population or restocking. So using natural foods and making fry acquaintance to the diets that they should contend with them in future is in priority for study of this species. So obtained results from current study should be construed as a measure for realization of fishery development and diversifying of exotic species in the country.

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REFERENCES

Amtstaetter, F., 2000. Lake trout and lake whitefish summer diet study, 1999. Lake Simcoe Fisheries Assessment Unit Update N. 2000-1. Ontario Ministry of Natural Resources. Sutton West, Ontario, pp: 2.

Berg, S., E. Jeppesen, M. Sondergaard and E. Mortensen, 1994. Environmental effects of introducing whitefish (*Coregonus lavaretus*) in Lake Ring. Hydrobiologia, 276: 71-79.

EIFAC, UINS and ICES, 1982. Report of working group on standardization of methodology in fish nutrition research. EIFAC Technical, pp: 36.

Enz, C.A., E. Schaffer and R. Muller, 2002. Growth and Survival of Lake Hallwil whitefish (*Coregonus* spp.) fry reared on dry and live food. Arch. Hydrobiol., 148: 499-516.

FAO, 2002. Annual Report of World Fishing and Aquaculture.

Harris, K.C., 1992. Techniques used for fully-intensive culture of lake whitefish (*Coregonus clupeaformis*) fry and yearling in Ontario, Canada. Proceedings of the Fourth International symposium: Biology and Management of Coregonid Fishes-1990. Plaskie Archiwum Hydrobiologii, 39: 713-720.

Heikinheimo, O., M. Minalainen and H. Peltonen, 2000. Diet, growth and competitive abilities of sympatric whitefish forms in a dense introduced population: Results of a stocking experiment. J. Fish Biol., 57: 808-827.

Huet, M., 1998. Textbook of Fish Culture (Breeding and Cultivation). 2nd Edn., England, pp: 160-162.

Kuzminski, H., S. Dobosz, W. Pelczarski and M. Koziol, 1996. An attempt to determine the suitability of three artifical foods for the feeding of Baltic whitefish fry (*Coregonus lavaretus* L. *Forma baltica*) in the conditions of salmonid research laboratory in Rutki. Inland Fisheries Institute, Poland.

Lasenby, T.A. and S.J. Kerr, 2001. Lake whitefish culture and stocking: An annotated bibliography and literature review. Fisheries Section Fish and Wildlife Branch Ontario Ministry Natural Resources.

Luczynski, M., P. Majkowski, R. Bardega and K. Dabrowski, 1986. Rearing of fry of four coregonid species using dry and live food. Aquaculture, 56: 179-185.

Rissanen, L., 1995. The favourable feeding rate of *Coregonus lavaretus* in first feeding at 11°C Temperature. J. Fish Biol., 3: 325-331.

Troschel, H.J. and R. Rosch, 1990. Daily ration of juvenile *Coregonus lavaretus* (L.) fed on living zooplankton. J. Fish Biol., 38: 95-104.