Comparison between live food and artificial diet on survival rate, growth and body chemical composition of *Oncorhynchus mykiss* larvae

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Received: September 2007 Accepted: March 2008

Abstract

This study was conducted to evaluate the efficacy of live food (*Artemia urmiana)* and commercial diet in rearing of *Oncorhynchus mykiss* larvae. Experiment started when larvae were 0.12g in weight. Triplicate groups of fish were offered one of four treatments: (1) a commercial starter food; (2) live *Artemia urmiana* nauplii (for 3 days); (3) live *Artemia urmiana* nauplii (for 7 days); and (4) combination of live *Artemia* nauplii (5% of food) and the commercial starter food. They were fed four times daily starting at the onset of exogenous feeding, for 1 week. After 1 week, the fish of all groups were shifted to the commercial diet for an additional 3-weeks period to determine the impact of any differences in weight of fish. The result of the present study showed that those larvae fed with combination of *Artemia* nauplli and a commercial starter food grew significantly faster than other groups for 4 weeks. Larvae fed with other composition were similar in length and weight ($P>0.05$). Survival rates of the trout larvae ranged 86-96% after 1 week and 67-84% after 4 weeks. Larvae survival after 1 and 4 weeks were significantly higher ($P<0.05$) in trout larvae fed only on *Artemia* nauplii (treatments 2 and 3) than other treatments. The body chemical composition analysis of trout larvae showed only small differences, with the exception of the crude protein and lipid at 4 weeks. The data were analyzed to determine significant differences among treatments by one-way ANOVA. (Statistica v.9, StatSoft Inc.).

Keywords: *Oncorhynchus mykiss, Artemia* nauplii, Live food, Commercial starter food, Body chemical composition

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[DOR: 20.1001.1.15622916.2010.9.1.1.3]

Introduction

For many fish species, the larval period is considered critical in life history. Success of larval rearing depends mainly on the availability of suitable diets that readily consumed, efficiently digested and that provide the required nutrients to support good growth and health (Giri *et al*., 2002). Diet particles must be chosen with consideration to the small mouth size of fish larvae. The selection of a very small feed particle can lead to nutrient leaching problems caused by very high ratio of surface area to volume (Kim *et al*., 1996).

Many investigators have shown that *Artemia* represents an interesting food source for carnivorous larval and juvenile stages of many species which show an absolute requirement for live prey during their early development (Koueta *et al*., 2002).

Species reared successfully in aquaculture generally larvae phase with fully developed digestive systems at the first feeding stage, e.g., salmon, trout and catfish. Live prey organisms, primarily zooplankton, have been used to raise the larvae of fish species which cannot be reared on prepared feeds (Kim *et al*., 1996). Among zooplankton, brine shrimp (*Artemia* spp.) and rotifers (*Brachionus plicatilis*) have been used most extensively as a live food for rearing of marine and freshwater fishes (Leger *et al*., 1986; Bengtson *et al*., 1991). The use of *Artemia* nauplii is well established due to its many advantages: year-round availability as on the shelf cysts; good nutritional value for some fish; and relatively easy improvement through simple enrichment techniques (Leger *et al*., 1986). Salmonids have a fully developed digestive system at the first feeding stage and they are normally fed prepared diet from first feeding. Growth rates of salmon fry fed prepared diets are generally acceptable for nearly all applications and attempts to replace commercial feed with *Artemia* nauplii as food for pink salmon fry have resulted in lower growth rates due to inadequate production of *Artemia* nauplii (Wang *et al*., 2005).

Growth and survival data are powerful tools for understanding the effects of both live and manufactured diets on first-feeding fish larvae (Wang *et al*., 2005). In the present study, growth and survival data were evaluated therefore to show the effects of live food and artificial diet on fry of *Oncorhynchus mykiss*. Body chemical composition measurement has been used to estimate nutritional conditions and growth of fish larvae (Gwak & Tanaka, 2002).

Artemia is still the most preferred and reliable live food in rearing fish and crustacean larvae (Dhont *et al.,* 1993). However, *Artemia* is not cost-effective in most developing countries. Therefore, the use of *Artemia* is limited in aquaculture and the use of live *Artemia* nauplii for feeding trout larvae has never been reported in the literature. Yet, the nutritional value of correctly fed *Artemia* is higher than commercial starter food (Segner *et al*., 1993; Kim *et al*. 1996; Girri *et al*., 2002).

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Intensive rearing trout fry under controlled or semi-controlled environmental conditions may be a valuable alternative to traditional production of stocking of species in outdoor pond. However, the very slow growth of trout fed on dry feed makes rearing very inefficient. The addition of live food, such as *Artemia* to a dry feed may enhanced either growth or survival rates of trout fry when compared with fish receiving only starter (Kim *et al*., 1996).

Several researchers have studied the effects of live food on survival rate and growth of *Tinca tinca* (Wolnicki *et al*., 2003), *Plelteobagrus fulvidraco* (Wang *et al*., 2005) and *Wallago attu* (Girri *et al*., 2002). *Oncorhynchus mykiss* has a promising market potential in Europe, East and South Asia. It is also an important aquaculture species in Iran. The purpose of this study was: 1) to determine whether first feeding trout larvae fed *Artemia* nauplii would exhibit higher growth rates than trout fed a commercial starter food and 2) to determine if any primary differences in growth would be lost when fish were shifted to a granulated trout larval feed.

Materials and methods

Four treatments, including: (1) Biodiet starter #2 or #3 (Bioproducts, Inc., France, OR); (2) Live *Artemia* nauplii (*A. uromiana*), hatched daily and fed as first instars for 3 days; (3) Live *Artemia* nauplii, hatched daily and fed as first instars for 7 days; (4) combination of artificial food and live *Artemia* nauplii, were fed to triplicate groups of rainbow trout fry. Each diet was fed about 5% dry body weights per day (Kim *et al*., 1996). After 3 days treatment 2 was gradually shifted to a granulated trout larval feed and after 1 week, fish fed diets 3 and 4 were shifted to Biodiet starter (58% protein, 15% lipid and 11% ash) and fed to apparent satiation for an additional 3 weeks period. All groups receiving diets were fed 4 times per day. The feeders were operational each time for 5 min. An excess of food was always offered to assure satiation. The daily ration was adjusted according to larvae weight after 7 to 14 days of rearing. Trout larvae (*Oncorhynchus mykiss*) at the first feeding stage (swim-up) were obtained from Gorgan Aquaculture of *Oncorhynchus mykiss* Center, Golestan, Iran). The experiment was performed at the Shahid Marjani Fish Rearing and Propagation Complex, Gorgan, Iran. A batch of 1200 uniformly sized yolk-sac larvae (120.63± 13.50mg SD) was randomly divided into 12 groups (four treatments, three replicates) of 100 individuals and each group was placed into a 35L tank with micromesh screens replacing the side of two tank's walls. Tank flow-through rate was set 0.5L h^{-1}, compressed air was introduced into tanks from a number narrow pipes opening on bubblier and these tanks cleaned daily, to avoid pollution involved by over feeding or diet particles. Water quality was monitored either daily or weekly; Temperature was maintained at 9.3±1.36ºC (measured daily; n=29) and oxygen varied between 7.8 and 8.6mg L^{-1} (determined weekly in the morning). Total ammonia-nitrogen [(NH_4^+ + NH_3)-N] was always maintained below

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0.5mg L^{-1} and the pH value 8 to 8.2. Residual chlorine was determined weekly whereby levels stayed below 0.05mg L^{-1}. The photoperiod for this indoor experiment was set at 12L:12D cycle (light period from 08.00 to 20.00 hours) and light intensity was kept at 40lux at the tank surface. Physical and chemical variables were maintained constant by continual renewals of oxygenated water, and by removing dead larvae, dead prey and food remains (siphoning) each morning before feeding; dead larvae were removed twice daily and counted. Prior to sampling fish for growth measurements and chemical analysis, larvae went hungry for 6 hours. At the start of the study and at weekly intervals, each group of fish was bulk-weighed and counted after being anesthetized in water containing 100ppm clove oil (*Syzygium aromaticum*) (Anderson *et al*., 1997; Keen *et al*., 1998). At the start of study and at weekly intervals, each group of fish was weighted (10 fish per replicate of treatment). Total length was measured with a sliding caliber with a precision of 0.01mm, weighed on a balance with a precision of 0.1mg. The amount of feed fed per group was recorded weekly and used to calculate feed efficiency ratios. Thirty fish were taken at the 1 week and ten fish per replicate tank after 4 weeks of feeding, as were samples of the feeds and *Artemia*, for determination of proximate composition; moisture, crude protein, crude lipid and ash were measured in duplicate using AOAC (1990). Procedures, e.g., moisture by drying samples at 105ºC overnight, protein by measuring Kejeldahl nitrogen, lipid was analyzed by ether extraction using a Soxhlet system, and Ash by heating for 5h at 550ºC in a muffle furnace. Results were expressed as % total body dry weight.

Feed conversion ratio (FCR) = Feed fed (g dry weight)/ fish weight gain (g wet weight), (Kim *et al.,* 1996).

Weight gain (mg) = Final weight – initial weight, (Hevroy, 2005).

Total length increase = Final total length-initial length, (Kim *et al.,* 1996).

Relative weight gain (%) = (weight increase x100)/ initial weight, (Kim *et al.,* 1996).

Growth rate was expressed as "Specific Growth Rate" (SGR):

SGR (%Body weight/day) = (Ln*W2* – Ln*W1*) x 100/t,

where *W2* and *W1* are respectively, final and initial weight (mg) of each fish, *t* the duration of the experiment in days, (Wang *et al*., 2005).

Weight gain (mg/day) = Weight increase/ day (Kim *et al.,* 1996).

% Coefficient of variation for SGR (CV) = 100 x SD/mean,

where mean is average of SGR and SD is standard deviation of SGR (Wang *et al*., 2005)

At the end of experiment the number of surviving fish was recorded and used for calculating mortality. All fish in each tank were pooled for weighing 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.

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Statistica (version 9) for windows was used. Result was considered significant at the 5% level.

Result

The chemical composition analysis of trout larvae carcass of each treatment (Table 1) showed that the crude protein level changed after either 1 week or 4 weeks of sampling. The lowest level of the crude protein level was 65.60% and 68.70% in treatment 1, after 1 week and after 4 weeks, respectively. The highest crude protein level was 66.70% (after a week) and 70.37% (after 4 weeks) in treatment 2. The level of moisture did not change between treatments (with the exception of treatment 1) ($P<0.05$) and the highest moisture was found in treatment 1. At 4 weeks, the level of crude lipids and ash in the carcass of larvae in different treatments, like the protein level, changed the highest level of lipids 14.64% (Table 2) was found in treatment 1 and the lowest level, 13.32% in treatment 4. For ash the highest content of 7.61%, was observed in treatment 3, and the lowest, 7.02% in treatment 4. But ash level in treatment 1 and 2 changed only slightly ($P>0.05$). At 1 week, the level of lipid, moisture (with the exception of treatment 1) and ash in carcass of larvae did not show significant difference between treatments ($P>0.05$).

For the first week, the survival rate was 96% for the group of trout larvae fed *Artemia* nauplii during 7 days (treatment 3), 86% when fed commercial starter food and 91% when fed combination of *Artemia* nauplii commercial starter food (treatment 4) and 95% when fed *Artemia* nauplii during 3 days (Fig. 1). During 14 days experiment, survival was 91% for trout larvae fed *Artemia* nauplii during 7 days (treatment 3), 82% for those fed combination of *Artemia* nauplii and commercial starter (treatment 4), 75% for trout larvae fed granulated food (treatment 1) (Fig. 1). In 4 weeks, the highest survival (84%) was recorded in treatment 3 and the lowest survival (67%) was showed in treatment 1 (Fig. 1). Cumulative mortality of larvae (Fig. 2) indicated that the mortality peak occurred around 15 days in larvae fed granulated diet (treatment 1) and 22 days in larvae fed live food. After 4 weeks the cumulative mortality, in all treatments (with the exception of treatment 2 and 3) were significantly different ($P<0.05$).

After 4 weeks rearing the difference in growth was not significant among groups fed with *Artemia* nauplii (treatments 2, 3 and 4) ($P>0.05$). At the end of the rearing period (4 weeks) trout larvae fed with combination of *Artemia* nauplii and commercial starter granules (treatment 4) showed better growth than either group fed on commercial starter granules (treatment 1) or only on *Artemia* nauplii (treatments 2 and 3) but the difference in growth between treatments 2, 3 and 4 was not significant ($P>0.05$). The weight and length increase obtained during the 4 weeks, showed significant difference between treatment 4 (fed combination of *Artemia* nauplii and commercial starter granules) and treatment 1 (fed with commercial starter granules)

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(Table 4; (P<0.05)). The Specific Growth Rates of groups were different during 4 weeks of rearing, with enhanced growth for the treatment fed with the combination of *Artemia* nauplii and commercial starter food (Table 5). During the experiment, the highest weight gain and Specific Growth Rate (SGR) for 4 weeks was found in treatment 4 (fed mixture of *Artemia* nauplii and commercial starter food; Table 4). The feeding rate was lower in treatment 4 than the group fed commercial starter food (treatment 1) and the lowest feeding rate after 7 days was found in treatment 4 but after 4 weeks the lowest feeding rate was showed in treatment 3 and between treatments 1, 2 and 4 was not significant difference (P>0.05), however, feeding rate was slightly lower in treatment 4 than treatment 1 (Table 5), , showed significant difference in the CV for SGR over the course of the experiment (P<0.05). Larvae fed commercial starter food showed significant increase in CV for SGR and the lowest CV was in treatment 4 (fed mixture of *Artemia* nauplii and commercial starter food) (Table 5).

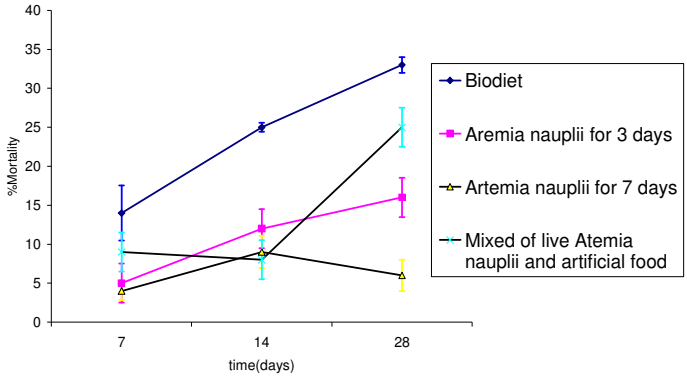


Figure 1: Effect of different diets on survival during trout larval rearing

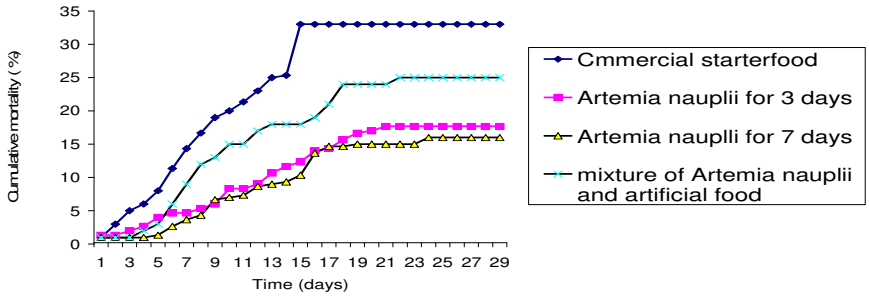


Figure 2: Cumulative mortality of *Oncorhynchus mykiss* (mean per treatment)
The difference between trout larvae fed commercial starter food and groups fed *Artemia* nauplii was significant after 4 weeks of rearing (P<0.05).

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Table 1: Proximate analysis, expressed in percent dry weight (mean ±SD) of trout larvae carcass sampled at first week.

Treatments	Humidity (%)	Proteins (%)	Lipids (%)	Ash (%)
1	81.11±0.10^{a}	65.60±0.25^{d}	12.05±0.56^{a}	7.07±0.40^{a}
2	81±0.26^{a}	66.70±0.38^{b}	11.7±0.14^{b}	6.84±0.30^{a}
3	81.02±0.44^{a}	66.99±0.13^{a}	11.3±0.07^{b}	6.75±0.68^{a}
4	81.04±0.37^{a}	66.10±0.37^{c}	11.31±0.28^{b}	6.96±0.37^{a}

Within columns values with different superscripts are significantly different (P<0.05).

Table 2: Proximate analysis, expressed in percent dry weight, (mean ±SD) of trout larvae carcass sampled after 4 weeks.

Treatments	Humidity (%)	Proteins (%)	Lipids (%)	Ash (%)
1	83.61±0.53^{a}	68.70±0.55^{c}	14.67±0.46^{a}	7.31±0.79^{ab}
2	82.25±0.35^{b}	70.37±0.86^{a}	13.67±0.30^{c}	7.4±0.45^{ab}
3	82.25±0.60^{b}	70.08±0.77^{ab}	13.32±0.31^{d}	7.61±0.29^{a}
4	82.13±0.31^{b}	69.68±0.47^{b}	14.15±0.35^{b}	7.02±0.37^{b}

Within columns values with different superscripts are significantly different (P<0.05).

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Table 3: Survival [a] of *Oncorhynchus mykiss* larvae (fed different diets from first-feeding period for 1 week), values are means ±SD (n=3)

Diet	Survival (%)	
	1 week	4 weeks
1	86±3.51[b]	67±1[c]
2	95±2.50[a]	82±2.50[a]
3	96±1.15[a]	84±2[a]
4	91±2.01[a b]	75±2.51[b]

Within columns values with different superscripts are significantly different (P<0.05).

Table 4: Average weight and total length[a], percent (%) weight gain, of fish fed various dietary treatments[e]. Values are mean ±SD (n=3)

Diet	Average weight (mg)		Average total length (mm) at 1 week	% weight gain	
	1 week	4 weeks		0-1 week	0-4 weeks
1	180.1±7.68[c]	568.3±20.74[b]	26.59±0.32[c]	52.57±17.11[b]	381.37±51.58[a]
2	201.33±8.49[b]	558.86±22.11[b]	27.53±0.39[b]	67.76±13[a]	365.66±35.43[a]
3	202.76±8.38[a b]	560.63±21.35[b]	27.72±0.43[b]	70.96±16.8[a]	375.42±45.27[a]
4	207.13±11.12[a]	596.52±17.25[a]	27.97±0.54[a]	71.64±9.21[a]	393.79±22.70[a]

Within columns values with different superscripts are significantly different (P<0.05).

a) Initial weights and lengths of trout larvae 120.63 (mg) ± 13.50 SD and 23.26 (mm) ± 0.90 SD, respectively.

Table 5: Percent body weight gain (BWG) per day[a], feed conversion ratio and coefficient of variation for SGR of fish fed various dietary treatments. Values are mean ±SD (n=3) [b]

Diet	% BWG per day		CV of SGR (%) at 4 weeks	feed conversion ratio	
	0-1 week	0-4 weeks		0-1 week	2-3 weeks
1	5.95±1.52[b]	5.40±0.35[a b]	6.50±0.41[a]	1.14±0.18[b]	0.67±0.03[a]
2	7.35±1.05[a]	5.29±0.24[b]	4.54±0.20[c]	0.86±0.00[a]	0.67±0.07[a]
3	7.59±1.34[a]	5.34±0.31[b]	5.84±0.31[b]	0.73±0.04[a]	0.79±0.01[b]
4	7.69±0.75[a]	5.50±0.15[a]	2.72±0.077[d]	0.80±0.08[a]	0.63±0.03[a]

b) Within columns values with different superscripts are significantly different (P<0.05).

a) BWG per day = e^{GW}-1 ∗100, where GW is instantaneous growth rate (ln final weight – ln initial weight) / time in days.

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Discussion

Larvae first feeding on live food, while early application of inert diets may enable easy weaning onto dry feed (Szlaminska & Przybyle, 1986; Segner *et al*., 1993; Watanabe & Kiron,1994; Girri *et al*., 2002). The possibility of replacing live food with manufactured diets from the onset of exogenous feeding was investigated in several studies (Jones *et al*., 1993; Person–Le Ruyet *et al*., 1993). Recent advances have led to the development of inert diets for first–feeding fish larvae, because it is very difficult to obtain satisfactory results when feeding first-feeding larvae solely with formulated diets. Research on rearing techniques for *Argyrosomus hololpidotus* larvae showed good growth and development of larvae gradually weaned to micro particulate diet when provided with live food (rotifers) for 5 days of feeding (Holt, 1993). This result similar to our study, in the first week, first-feeding *Oncorhynchus mykiss* fed *Artemia* nauplii diet solely, obtained higher growth rate and body wet weight than those fed artificial diet (treatment 1). In the present study, the proximate composition of the *Artemia* nauplii was: 61.07% protein; 11.44% lipid; and 6.78% ash, on a dry weight basis (DWB). It may be explained that the higher dietary protein level can meet the requirements of body protein synthesis in early stages and then support fast growth of the larvae (Watanabe *et al.*, 1987a,b; Bengston *et al*., 1991). After 4 weeks, treatments 1, 2 and 3 did not show significant difference (P>0.05) on growth, however, trout larvae fed combination of *Artemia* nauplii and artificial diet (treatment 4) obtained higher growth rate and body wet weight (P<0.05). This result is similar to *Clarias gariepinus* (Appelbaum & Van Damme, 1998), *Cyprinus carpio* (Szlaminska & Przybyle, 1986), *Clarias macrocephalus* (Fermin & Bolivar, 1991), *Clarias batrachus* (Giri *et al*., 2002), *Pleteobagrus fulvidraco* (Wang *et al.*, 2005). Research on these species presented evidence that feeding the larvae solely on dry diets or on a combination of live and dry diets resulted in increased survival and growth when compared with live food alone. In our study, after 4 weeks, that larvae fed live food (*Artemia*) exhibited not significantly the lower growth than artificial diet (P>0.05), and significantly the lower growth than combination of live and dry diet (P<0.05). The mortality of larvae which fed on live food was significantly lower than larvae fed on artificial diet. Thus, larvae fed live food a smaller space per individual than those larvae fed artificial diet. It was therefore not difficult to understand that larvae fed artificial diet obtained the better growth than fed *Artemia* nauplii solely. In our study, the CV in final SGR was affected by dietary regimes. Larvae fed live food showed the lowest CV for SGR while larvae fed treatment 1 showed the highest CV for SGR. In fact, at the end of the experiment both extremely large and small larvae could be found in the treatment fed artificial diet. Such size ranges may be explained by aggressive behavior of

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fast–growing dominant individuals. Further, because of the higher mortality in the treatment 1.

Mortality of first-feeding *Oncohynchus mykiss* fed artificial diet was significantly higher than those fed live food (in the first week), This result is similar to most research on feeding larvae with artificial diets. The poor response to artificial diet may be due to a poorly developed digestive system with low digestive enzyme activity during the early feeding period (Awaiss *et al*., 1993; Holt, 1993; Segner *et al*., 1993).

Considering the effects live food, combination of live and dry diet and artificial diet on both survival, growth and body chemical composition of first–feeding larvae of *Oncorhynchus mykiss* it was found that although the artificial diet (treatment 1) showed not significantly higher growth than larvae fed *Artemia* nauplii solely after 4 weeks ($P>0.05$), but also resulted in higher mortality and higher size respectively, indicating that artificial diet supported fast but not healthy growth thus in aquaculture it is more desirable to feed larvae with live food especially when that larvae fed on combination of live and dry diet.

At the first week, after 3 days, the highest crude protein was observed in treatment 3 and the lowest was showed in treatment 1. Then until the end of the experiment (28 days), protein content of larvae fed *Artemia* nauplii and combination of *Artemia* nauplii and inert feed has been increased.

The period of intake after feed distribution may have been longer for *Artemia* than microparticle diet (granules) because their movement may have elicited a longer feeding response. As a result, *Artemia* consumption and thus growth might have been higher. In both rainbow trout (Ware, 1973) and Atlantic salmon (Rimmer & Power, 1978; Holm & Moller, 1984), prey motion has been shown to be major importance in triggering feeding response. Passively transported pellets are less attractive to young salmon than wild prey and may not be consumed even when they pass very closely to the fish (Stadmeyer & Thorpe, 1987). While the movement of prepared feeds depends on sinking speed and water currents, *Artemia* nauplii can remain alive and motile in freshwater for several hours depending on water temperature (Bengtson *et al*., 1991). It was observed in this experiment that *Artemia* nauplii were still alive and swimming after 4h in freshwater.

Improved growth of fish fed combination of live and dry diet compared with artificial diet was likely related to the differences in percentage of lipid and protein in feeds. Body chemical composition of trout larvae which fed on artificial diet had a higher percentage of lipids and lower percentage of protein than larvae fed on combination of live and dry diet.

The proteolytic enzymes in *Artemia* may play a significant role in contributing to the digestion process, in addition to digestion brought about by the proteolytic enzymes of the fry itself (Bengston *et al*., 1991). According to some calculations, the contribution of proteolytic activity in

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natural food may even be equal to that of the digestive system in larval fish (Dabrowski & Glogowski, 1977).

Prolonged use of live food to rear fish larvae is often impractical and costly, and conversion to artificial feed is necessary. During the conversion period of the experiment, the trout larvae adapted very quickly to the granulated feed. The growth benefit observed in the combination of live and artificial dietary treatment, which included true growth as demonstrated by increased length in fish, was sustained after the fish were weaned to commercial starter feed. Until the third week of feeding, percentage growth of fish fed combination of live and artificial diet was higher than fish fed on the other feeds. Therefore, replacing combination of live and artificial diet with an artificial feed from the first rearing week onward will shorten the grow out period (larvae to harvest) and result in larger fish at hatchery release as well.

Acknowledgements

This study was supported by the Faculty of Fisheries Sciences, Agriculture Sciences and Natural Resources of Gorgan University (UASNR 45163). We would like to thank personnel of the Shahid Marjani Fish Rearing and Propagation Complex, Gorgan, Iran. Special thanks are expressed to laboratory experts for valuable help.

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[DOR: 20.1001.1.15622916.2010.9.1.1.3]

مقایسه اثر غذای زنده و غذای کنسانتره بر میزان بقاء، رشد و ترکیبات شیمیایی بدن لارو قزل‌آلای رنگین کمان (***Oncorhynchus mykiss***)

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تاریخ دریافت: شهریور ۱۳۸۶ تاریخ پذیرش: اسفند ۱۳۸۷

چکیده

این تحقیق جهت مقایسه اثر غذای زنده (*Artemia urmiana*) و غذای کنسانتره در لاروهای تازه به تغذیه افتاده قزل‌آلای رنگین کمان با وزن ۰/۱۲ گرم در چهار گروه مختلف و با سه تکرار در هر تیمار به مدت یک هفته انجام گرفت. لاروهای تازه به تغذیه افتاده ماهی قزل‌آلا بصورت تصادفی از حوضچه‌های پرورش انتخاب شدند و با چهار تیمار غذایی که عبارت بودند از ۱- غذای کنسانتره تجاری، ۲- ناپلئوس آرتمیا (در مرحله Instar I)(به مدت ۳ روز)، ۳- ناپلئوس آرتمیا (در مرحله Instar I)(به مدت ۷ روز) ۴- آرتمیا و غذای کنسانتره (به مدت ۷ روز) تغذیه شدند. بعد از یک هفته، همه تیمارها به مدت سه هفته جهت بررسی حفظ میزان رشد مناسب بدست آمده از ناپلی آرتمیا تا پایان دوره آزمایش با غذای کنسانتره تغذیه شدند. نتایج نشان داد که لاروهای تیمار ۴ رشد سریعتری نسبت به بقیه تیمارها داشته و این اختلاف اندازه تا پایان دوره آزمایش (۴ هفته) حفظ شد و میانگین طول و وزن بدست آمده در بقیه تیمارها اختلاف معنی‌داری را نشان نداد ($P>0/05$). بعد از یک هفته آزمایش، درصد بقاء در بین تیمارهای مختلف ۹۶-۸۶ درصد و بعد از چهار هفته ۸۴-۶۷ درصد گزارش شد که بیشترین میزان بقاء در کل دوره آزمایش مربوط به لاروهایی بود که تنها از ناپلی آرتمیا به مدت یک هفته تغذیه نمودند (تیمارهای ۲ و ۳) و کمترین میزان بقاء در لاروهای تغذیه شده از غذای کنسانتره (تیمار ۱) مشاهده شد. آنالیز ترکیبات تقریبی بدن در کل دوره آزمایش اختلاف اندکی را در بین کلیه تیمارها از نظر درصد رطوبت و خاکستر به استثنای درصد پروتئین و چربی خام نشان داد ($P<0/05$). جهت تجزیه و تحلیل آماری، از روش آنالیز واریانس یکطرفه استفاده شد تا اختلاف یا عدم اختلاف معنی‌دار در سطح اطمینان ۹۵ درصد تعیین گردد.

کلمات کلیدی: قزل‌آلای رنگین کمان، ناپلئوس آرتمیا، غذای زنده، غذای کنسانتره، ترکیبات شیمیایی بدن لارو

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