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The potential of russian sturgeon (*Acipenser gueldenstaedtii*) in exploitation of *Artemia urmiana* in comparison with *Daphnia* sp. and its mixture

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Abstract

Experiments were conducted to evaluate two types of live food for Russian Sturgeon larvae, *Acipenser gueldenstaedtii*. Russian sturgeon larvae with initial weight 57.44±6.65 mg were transferred to 9 circular fiberglass tanks with a volume 50 liters and a density of 2 pieces per liter. The larvae were fed on different diets: (A) *Artemia urmiana* nauplii, (D) *Daphnia* sp., and a mixture of 50% Artemia+50% Daphnia (A+D) were fed, respectively. After a 28-day rearing period, the highest survival rate was obtained with the larvae receiving mixture feed (A+D). Feeding of the larvae with *Daphnia* sp. resulted in a significantly lower survival rate compared to the other groups. The obtained results showed that using a mixture of *Artemia urmiana* and Daphnia indicated to the best growth and feeding parameters for *Acipenser gueldenstaedtii* larvae.

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Introduction

In the early times of the 20th century, most studies were being conducted on systematic and biology of sturgeons but rearing of the sturgeons in fish farms for meat consumption was less successful. In 1970s, *A. transmontanus* and *A. ruthenus* were successfully reproduced and some developments were made in the technology to breed. *A. baerii* was fully established in USSR and later exported to other countries such as France, USA, Italy, Japan, Germany and Poland. Sturgeon farming in western countries began during the 1980s, mainly as a consequence of conservation efforts for threatened wild populations. In 1999, the dominant specis reared for production in Western Europe was white sturgeon (*A. transmontanus*). The relative importance of Siberian sturgeon as well as Russian sturgeon will increase because they are either most widespread species or already subject to several on-growing projects. There is considerable information available on the growth of white sturgeon and other sturgeon species; however, information of Russian sturgeon farming is quite limited in English (Nathanailides *et al.*, 2002). Protein and carbohydrate requirements and utilization by these fish have been studied by some researchers (Williot *et al.*, 2001; Xu *et al.*, 1993; Hung *et al.*, 1998; Deng *et al.*, 1998) as well as the dietary lipids in farmed sturgeon *A. transmontanus* (Xu *et al.*, 1993; Czesny *et al.*, 2000; Gawlicia *et al.*, 2002). Dietary lipids and retention of lipids, particularly in fillet, are parameters often discussed with respect to quality. Production of marine fish juveniles in commercial hatcheries still depends on the supply of live prey, such as rotifers, *Artemia* and *Daphnia*. Dehghan *et al.* (Dehghan *et al.*, 2011) reported that *Artemia urmiana* has a high potential of enrichment with *Bacillus* and bakery yeast probiotic. In previous experiment on larvae *Rutilus frisii kutum* the lowest survival rate was observed in larvae fed artificial dry feed compared with larvae fed Artemia nauplii and larvae fed mixed diet (Artemia nauplii + artificial dry feed) (Hossein *et al.*, 2011). *Daphnia magna* is also one of the most important food animals which have attracted the attention by fish nutrition is around the world (Jafaryan *et al.*, 2007). In another previous experiment on Persian sturgeon larvae fed with *Daphnia magna* bioencapsulated with probiotic was the best growth and survival (Faramarzi *et al.*, 2011) and the best resistance in against challenge test obtained (Lashkarbolooki *et al.*, 2011; Faramarzi *et al.*, 2012). Optimization of zootechnical, nutritional factors can promote the growth and feeding parameters of sturgeon larvae. The brine shrimp *Artemia* sp. are common live food organism's use for the rearing of sturgeon fish larvae. *Daphnia magna* is one of the most important animals which has attention by fish nutritionistis around the wourld. *Artemia urmiana* nauplii**,** *Daphnia* sp. and its mixture are commonly employ as starting food for larviculture of sturgeon larvae in sturgeon centers of Iran. The main species used in aquaculture production worldwide are white (*A. transmontanus*) Siberian (*A. baerii*), Russian sturgeons (*A. gueldenstaedtii*), sterlet and bester (Mims *et al.*, 2002). The Russian sturgeon (*A. gueldenstaedtii*) is one of the most important species of sturgeon fish in Iran. The aims of this study were to evaluate the exploitation of Russian Sturgeon (*Acipenser gueldenstaedtii*) from *Artemia urmiana* nauplii, *D. magna* and its mixture.

Materials and methods

Experimental diets

A 28-days feeding experiment was conducted with the *Acipenser gueldenstaedtii* larvae, using two live foods, *D. magna*, *Artemia urmiana* and the mixture of them (*Daphnia* 50% w/w + *Artemia* 50% w/w) with 6 times feeding frequencies per day. The cysts of *Artemia urmiana* were obtained from the Center of Artemia in Urmia (Iran). The *D. magna* was obtained from intensive production ground ponds. The *A. gueldenstaedtii* larvae were fed on *Artemia urmiana* nauplii in treatment A, *Daphnia magna* in treatment D and in treatment of D+A by mixture of *A. urmiana* + *D. magna* respectively.

Experimental design and maintenance of fish

Fish larvae in three treatments (A, D and D+A) having three replicates (100 fish per tank) were scheduled and fed based on the 30 percentage of body weight in a day. The capacity of circular Fiberglas tanks were 50 liter and the density of fish larvae was 2 larvae/L. The proximate compositions of samples of fish (initial and final), *Artemia urmiana* nauplii, *Daphnia magna* and mixture of them were determined. The water temperature was 17.5± 0.5 °C, optimal pH of water was 7.5-8.5 and the oxygen level in the water during this period was maintained above 7 mg/l (Mims *et al.*, 2002; Dettlaff *et al.*, 1993). All tanks were maintained under natural photoperiod (LD 12:12).

Table 1. Proximate composition of *A. urmiana* nauplii and *D. magna*.

Body composition	Dry matter %	Moisture %	Crude protein %	Crude lipid %	Crude energy (kcal/g)	Ash %
Artemia urmiana nauplii	9.09	90.91	56.83	21.2	4727.49	3.75
Daphnia magna	4.99± 0.25	94.24± 0.88	39.68± 2.14	24.99± 3.7	4805± 205	28.15± 2.6

Analyses and measurements

The fish was weighed individually at the beginning and the end of the experiment. The proximate composition of samples of fish, *Artemia urmiana* nauplii, *Daphnia magna* and mixture of them were determined and analyzed according to the standard methods of AOAC (AOAC., 1990) for moisture, protein, fat and ash. Some growth and feeding parameters such as weight gain (WG), food conversion ratio (FCR), food conversion efficiency (FCE) and survival of the fish were calculated based on the data biometry of Russian sturgeon larvae. The growth parameters of the studied fish were calculated by using the following formulas:

Weight gain= W2-W1

Food conversion ratio (FCR) = food intake (g) / living weight gain (g)

Food conversion efficiency (FCE) = [living weight gain (g)/food intake (g)]

Protein efficiency ratio (PER) = living weight gain (g)/ protein intake (g)

Lipid efficiency ratio (LER) = living weight gain (g) / lipid intake (g)

Energy efficiency ratio (EER) = living weight gain (g)/ energy intake (kcal)

Statistical analysis

Data were analyzed by one-way ANOVA to test the effects of the dietary treatments. When a significant treatment effect was observed, Duncan's new multiple range test (Steel and Torrie., 1960) was used to compare means. Treatment effects were considered at $P<0.05$ level of significance. All statistical tests were performed using the SPSS, statistical package (SPSS, version 12, Chicago, IL).

Table 2. Proximate composition of *Acipenser gueldenstaedtii* larvae in different treatments.

Treatment composition	A Fed on *Artemia*	D Fed on *Daphnia*	D+A Fed on *Artemia + Daphnia*
Dry matter %	8.45± 0.21[a]	10.43± 1.18[b]	11.54± 0.90[b]
Moisture %	90.33± 0.86[a]	90.70± 0.86[a]	88.00± 1.27[b]
Crude protein %	73.37± 0.42[a]	73.21± 0.29[a]	75.68± 0.26[b]
Crude lipid %	9.16± 0.25[a]	6.77± 0.14[b]	7.15± 0.19[b]
Crude energy (kcal/g)	4843±30[a]	4623±22[b]	4563±48[b]
Ash %	8.73± 0.95[a]	7.35± 1.10[b]	7.55± 1.15[b]

-Refer to "Materials and Methods" for the definitions of the treatments A, D and D+A.

-In each row, data having the same alphabetic letter are not significantly different (p>0.05)

Results

With use proximate compositions of *Artemia urmiana* nauplii and *Daphnia magna*, the highest dry matter and crude protein in Artemia and highest moisture, crude lipid, crude energy and ash were determined in Daphnia (Table 1). The best survival rate in treatment D+A (93%) and D (91%) observed (Figure 1). According to Table 2 the maximum of carcass crude lipid (9.16%) and energy (4843cal/g) was obtained in treatment of A (Russian Sturgeon larvae fed on *Artemia urmiana* nauplii) and significant difference was observed with treatment of Daphnia (6.77%, 4626 cal/g) and mixture of them (7.15%, 4568 cal/g) (p<0.05). while the highest crude protein (75.68%) and carcass dry matter (11.54%) obtained in treatment of mixture of Artemia and Daphnia. The best lipid gain (0.19 mg day $^{-1}$) was observed in treatments of *Artemia urmiana* and mixture of Artemia and Daphnia (A+D) while the highest of protein gain (2.02 mg day $^{-1}$) was obtained in *Acipenser gueldenstaedtii* larvae were fed on Artemia +Daphnia(A+D) (Table 3). The highest energy gain was in Russian Sturgeon larvae fed on mixture of Artemia and Daphnia (A+D) and had the significant difference with treatments of A and D (p<0.05). The maximum of body weight (815 mg) were observed in treatment A (Table 3).

Table 3. Growth and feeding parameters of *Acipenser gueldenstaedtii* larvae in different treatments.

Treatment / Parameters	A Fed on *Artemia*	D Fed on *Daphnia*	D+A Fed on *Artemia + Daphnia*
Final body weight (mg)	815.73±131.20[a]	510.64±101.73[b]	764.94±148.76[a]
Food Conversion Ratio (%body weight. day -1)	3.22± 0.58[b]	5.26± 1.33[a]	3.45± 0.70[b]
Food Conversion efficiency (%)	31.93± 5.14[a]	19.99± 3.98[b]	30.12± 6.05[a]
Lipid gain (mg day -1)	0.19± 0.03[a]	0.10± 0.02[b]	0.19± 0.04[a]
protein gain (mg day -1)	1.58± 0.27[b]	1.14±0.25[c]	2.02± 0.41[a]
Energy gain (Cal day -1)	9.96± 1.71[b]	7.14± 1.58[c]	12.20± 2.52[a]

-Refer to "Materials and Methods" for the definitions of the treatments A, D and D+A.

-In each row, data having the same alphabetic letter are not significantly different (p>0.05)

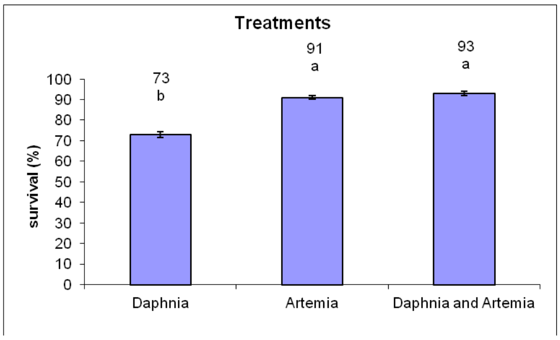

Fig. 1. Mortality rates of Persian sturgeon larvae fed three different diets for 28 days.

Discussion

Nauplii of *Artemia urmiana*, *Daphnia magna* and the mixture of them are well used for larviculture of Russian Sturgeon larvae. Feeding by Artemia cysts to young fish larvae is essential as first feeding in hatchery operation of *Acipenser persicus* but Artemia are poor in some essential fatty acid, 20:5n-3 (eicosapentaenoic acid; EPA) and 22:6n-3 (docosahexaenoic acid; DHA) (Yousefian and Najafpour., 2011). The *Daphnia magna* is common live food organisms used for the rearing of marine fish larvae. Some authors (Dabrowski and Glogowski., 1977; Lauff and Hoffer., 1984; Munilla-Moran *et al.*, 1990; Kolkovski., 1993; Walford and Lam., 1993) have suggested that fish larvae initially have a low endogenous digestive enzyme production, and that live zooplankton provides an exogenous source of enzymes, which may increase the digestion of food. The different results obtained from two live food organisms and their mixture. The better exploitation of Russian Sturgeon larvae resulted by feeding of *Artemia urmiana* Nauplii. In the larviculture of sturgeon larvae and fingerlings have been raised on live food organisms e.g. oligochaetes (*Enchytraeus* sp., *Tubifex* sp.) and zooplanktonic organisms, such as *Daphnia* (*Daphnia* sp. and *Moina* sp.) or *Artemia* sp. (Gisbert and Williot., 2002). The Proximate composition, feeding and Growth parameters of Russian Sturgeon larvae are affected by the quality of live food. We found a significant different among treatments of A, D and A+D suggested that feeding rate for Russian sturgeon larvae should be 30% of fish biomass per day and in this study we employed the 30 percentage of body weight in a day and we had the good results. Similar results were evaluated when use *Artemia urmiana* Nauplii for feeding of Russian Sturgeon larvae and for *Acipenser persicus* by feeding of *Daphnia magna* (Jafaryan *et al*., 2008; Jafaryan *et al*., 2007). The results demonstrated that the exploitation ability of *Acipenser gueldenstaedtii* larvae using *Artemia urmiana* nauplii and mixture of Artemia and Daphnia had almost the best feeding efficiency.

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