Journal of Applied Ichthyology

J. Appl. Ichthyol. 27 (2011), 781–786

ISSN 0175–8659

Received: July 1, 2010
Accepted: November 30, 2010
doi: 10.1111/j.1439-0426.2010.01647.x

Feeding *Acipenser persicus* and *Huso huso* larvae with *Artemia urmiana* nauplii enriched with highly unsaturated fatty acids and vitamin C: effect on growth, survival and fatty acid profile

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Summary

This study aimed at evaluating the effects of enriching *Artemia* nauplii with the essential fatty acids docosahaexanoic acid (DHA) and eicosapentaenoic acid (EPA), and vitamin C (ascorbyl-6 palmitate) on growth and survival of early life history stages of *Acipenser persicus* and *Huso huso*. The fish larvae were fed with *A. urmiana* either in the form of decapsulated cysts, newly-hatched nauplii, or nauplii enriched with saturated lipid or highly unsaturated fatty acid (HUFA) emulsions supplemented with vitamin C, (0, 10 and 20% w/w) during a 15-days culture period. The zootechnical parameters were measured every alternate day in order to determine larval survival and growth. Larvae fed on decapsulated cysts of *A. urmiana* had significantly lower growth and survival compared to other treatments. Survival of larvae fed on HUFA + 20% vitamin C was significantly better than the larvae fed only with vitamin C. Maximum increase in growth parameters was observed in larvae fed *Artemia* nauplii enriched with HUFA + 20% vitamin C.

Introduction

Economically, sturgeons are very important in Caspian Sea fisheries. *Acipenser persicus* and *Huso huso* are endemic to the Caspian Sea; the latter is the largest fish in the Caspian Sea producing the most costly roe. Because of the highly endangered status of both species the need for restocking of sturgeons in the Caspian Sea and the increased interest in local sturgeon aquaculture, appropriate methods for rearing sturgeon larvae are needed. To use *Artemia* nauplii as starter food seems to be one of the methodological choices to enhance sturgeon larviculture.

Brine shrimp *Artemia* is widely used in larviculture of a wide range of freshwater as well as marine fish either as non-hatched decapsulated cysts, freshly-hatched nauplii, or nauplii enriched with highly unsaturated fatty acids, vitamin C and E (Sorgeloos et al., 2001).

The positive effect of enrichment of live food on the growth performance of various aquaculture species is well documented, e.g. striped bass (*Morone saxatilis*) and palmetto bass (*M. saxatilis* × *M. chrysops*) larvae fed with HUFA-enriched *Artemia* nauplii exhibited better growth and survival compared to those fed unenriched nauplii (Tuncer and Harrell, 1992; Ozkizilcik and Chu, 1994; Webster et al., 1994; Harel and Place, 2003). Agradi et al. (1993) also reported similar effects of dietary n-3 HUFA on growth of *Acipenser naccarii* especially when the diet was supplemented with both fish oil and vitamin E as an antioxidant.

Findings of Merchie et al. (1995, 1997) and Gapasin et al. (1998) demonstrated significant improvements in the growth of European sea bass (*Dicentrarchus labrax*), African catfish (*Clarias gariepinus*), and milkfish *Chanos chanos* larvae fed on *Artemia* nauplii supplemented with vitamin C. Juvenile parrot fishes *Oplegnathus fasciatus* fed with high level of vitamin C showed better growth as compared to those fed low levels Wang et al. (2003).

Based on these literature data, it was assumed that feeding larvae of *H. huso* and *A. persicus* with *A. urmiana* nauplii, adequately enriched with highly unsaturated fatty acids and vitamin C, would have a beneficial effect on survival, growth and overall stress tolerance of the fish larvae. To test this hypothesis, a number of larviculture experiments with both sturgeon species were run. This paper reports on the effect of the enrichment strategy on growth and survival, whereas the effect on stress tolerance is the subject of a separate study.

Materials and methods

Experimental design and maintenance of fish larvae

Twelve thousand 3-days old post-hatch yolk-sac larvae of both *A. persicus* and *H. huso* were obtained from a local hatchery and transported in oxygenated plastic bags to the *Artemia* and Aquatic Animals Research Institute, Urmia University. They were then stocked in a big tank containing UV-treated underground freshwater.

Three hundred randomly-collected larvae (in four replicates) of each species were distributed into 32 rectangular polyethylene tanks (43 cm length, 30 cm width, 35 cm height, 45 L total volume) containing 25 L underground water. All tanks were connected to a flow-through system with a flow rate of 1 L min^{-1} $tank^{-1}$. Using a central heating system water temperature was kept at 20 ± 1 and 19 ± 1°C for *A. persicus* and *H. huso* respectively. Each tank was equipped with an airstone for gentle aeration throughout the culture period. Water flow was stopped for 30 min at the time of feeding in order to avoid food losses and clogging of the outlet filter.

Eight feeding treatments (Table 1) were tested for both species; the larvae were fed at 25% body weight per day (BW day^{-1}), with a feeding frequency of six times per day. The pH (7.3–7.5), temperature (19–20 ± 1°C) and dissolved oxygen