Applications of Fairy Shrimps in ornamental fish feeding

Seidgar M.[*1]

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Abstract

Fairy shrimps (Freshwater Anostraca) offer a variety of applications in aquaculture. They are very important live food in the culture of various aquatic larvae, growth, survival and resistance in different aquatic species especially, freshwater ornamental fish, sturgeon fish, salmon, carp, freshwater crayfish. Fairy shrimps can be used as a suitable live food in order to improve growth and the reproductive performance and enhance skin color of ornamental fish due to its high nutritional value and no harmful effects on the environment. Fresh-fairy shrimp, frozen, freeze-dried or flakes, decapsulated cysts and newly hatched larvae can be successfully used as an alternative live food in cultured species.

Keywords: Freshwater Anostraca, Nutritional value, Ornamental fish, Aquaculture

1-National Artemia Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization, Urmia, Iran

[*]Corresponding autor's Email: seidgar21007@yahoo.com

Introduction

Fairy Shrimps (Crustacea: Branchiopoda: Anostraca) with more than 21 genera and 258 species live in temporary ephemeral pools with stressful harsh environments. They produce desiccation resistant diapausing cysts during the dry period. During each wet period, only a small part of cysts hatch, while the majority of them remains viable for decades in the soil as dormant cysts to assure the long-term survival of the populations (Brendonck and De Meester, 2003, Dumont and Munuswamy, 1997). Temporary pools characteristics by extreme environmental conditions such as flooding and periods of severe drought (Calhoun et al., 2017). Fairy shrimps live in such a temporary lentic water with a fossil record dating back to the middle Jurassic (>150 million years). Some species have a geographically restricted distribution while others are widely dispersed (Lopes da Cunha *et al.*, 2021). They are widely distributed in Iran so that 5 species of Anostracans have been identified alone in East Azarbaijan, Iran including *Chirocephalus skorikowi* (Chirocephalidae), *Branchinecta orientalis* (Branchinectidae), *Streptocephalus torvicornis* (Streptocephalidae), *Branchinella spinosa* (Thamnocephalidae) and *Artemia* spp. (Artemiidae). The number of cysts per female fairy shrimp were 305-477, indicating their high fecundity with cyst diameter ranging from 307 µto 356 µ referring their proper size for fish larvae feeding (Seidgar *et al*., 2007). Thanks to the large genetically diverse egg banks remaining in the soil of temporary pools the survival of the species is guaranteed to cope with changing environment (Lopes da Cunha *et al.*, 2021). Their demand increased as live food in aquaculture in the last 2 decades. They enjoy high nutritional value including crud protein, lipid content and even higher amino acids value and higher amount of unsaturated fatty acids especially, DHA and DHA/EPA ratio than *Artemia*, that are essential for the metabolism, survival and growth of their predators (Pratama *et al*., 2020, Shu *et al*., 2015). At first, these species were considered by fish farmers as a pest and competitor in fish ponds (Pratama *et al*., 2020).

Biology of fairy shrimps

The order Anostraca includes two suborders of Artemiina like *Artemia* spp. which live in salt water and Anostracina which resident of freshwater (Timms, 2015). Fairy shrimps live exclusively in temporary pools without presence of fish. They can be eaten by invertebrate predators, but a proportion of them prevail by first and fast development and high fecundity. Drought resistant eggs guaranties their survival in the surface sediments during dry periods for several years. Only a proportion of dormant eggs hatches 12-48 hours after each filling, a bed hedging strategy to ensure sufficient water to reach rapid growth, maturity within 2-3 weeks, produce a batch of ca 200-300 cysts during one to several days' intervals and live up to 3 months. Their cysts sink on the bottom mud unlike the

Artemia cysts that float on the surface of water. Fairy shrimps are filter feeders and ingest algae, bacteria, clay particles and organic matter. Reproduction is usually sexual and sexes are separate (Timms, 2015).

Fairy shrimp as live feed in aquaculture

Larvae or adult live fairy shrimps can be used as live food for feeding of all kinds of freshwater fish and sturgeon. Fairy shrimp cysts contain 45-50% protein, 5-6% fat, essential fatty acids and are necessary to meet the nutritional need of aquatic animal larvae. Also, the produced biomass can be used as food item in culture and maturation stages of ornamental fish and freshwater brood stocks. Fairy shrimps contain carotenoid compounds with large amounts of Astaxanthin, canthaxanthin and anthraxanthin (Velu and Munuswamy, 2003, Munuswamy, 2005, Seidgar and Azari Takami, 2014). Fairy shrimps, due to their color are of special importance as decorative animals, medium sized species such as *Streptocephalus torvicornis* and *S. proboscedeus* have a life span of one year in laboratory condition (Dumont and Munuswamy, 1997). Like *Artemia*, fairy shrimps nauplii can easily ingest fats and significantly increase their HUFA content. The enrichment of fairy shrimps with SELCO-DHA commercial product, in 3-hour incubation, increased the amount of EPA and DHA (Munuswamy, 2005). Larval stages of tilapia (*Oreochromis* sp.) were successfully fed with fairy shrimp S. *proboscideus* nauplii (Pratama *et al*., 2020, Prasath *et al*., 1994). Skin color of ornamental fish plays a key role in successful fish marketing (Ramamoorthy *et al*., 2010). Carotenoids are responsible for pigmentation of fish skin and muscle, also, work as an anti-oxidant, multiplier of immune response, growth, reproduction and photo protection, but cannot be made by fish (Velasco-Santamaria and Corredor Santamaria, 2011).

live food enhanced skin color of *Carassius auratus*, compared to concentrate diet. As in concentrate, concentrate and freezed fairy shrimp and *Artemia* diets amounts of total carotenoids were equal to 1.09, 3.90 and 2.07 mg g-1and astaxanthin were equal to 84.57, 205.82 and 102.24 mg g-1 of fish skin, respectively (Seidgar *et al.*, 2015). Also, fairy shrimps as a live food improved skin color of ornamental fish broodstocks such as presence of green stripes on the head, redness of tail, dorsal and pectoral fins of green terror (*Aequidens rivulatus*), presence of black wavy distinct spots, snaky skin of gourami (*Trichopodus trichopterus*) and corydoras (*Corydoras aeneus*) and presence of red pink strips on the head of severum (*Heros severus*) (Seidgar, 2015). The use of decapsulated cyst of *S. dichotomus* improved the weight gain and growth of angelfish (*Pterophylum scalare*) larvae (Velu and Munuswamy, 2003). Mass cultured *S. proboscideus* cyst has been suggested for feeding the

Persian sturgeon *Acipenser persicus* larvae (Namin *et al*., 2007). Fairy shrimp nauplii with high nutritional value improved carotenoid content, growth and survival rate of *Macrobrachium rosenbergii* (Saengphan *et al*., 2015). Brine shrimp *Artemia* will die soon in freshwater and accumulate in the bottom of the pond causing deterioration of water quality and illness of freshwater fish, while using freshwater live food can reduce the frequency of feeding and water toxicity (Anaya-Soto *et al*., 2003). The diet containing fairy shrimps is effective in improving reproductive indicators, increasing number of eggs, number of spawning times, reducing spawning intervals and improving carotenoid pigments, skin color and marketability of fresh water ornamental fish (Seidgar, 2013). Despite the numerous species and a wide global distribution, only limited species such as *Streptocephalus proboscideus*, *Thamnocephalus platyurus*, *Streptocephalus torvicornis* and *S. simplex* have the ability to be cultured on a laboratory scale (Dumont and Munuswamy, 1997).

Advantages and disadvantages of using fairy shrimps in aquaculture are summarized in table1.

Table 1: A summary of the advantages and disadvantages of using fairy shrimps in aquaculture

	Advantages	**Disadvantages**
Fairy shrimps	It is possible to produce or harvest cysts from natural resources, they are bisexual, mostly filter feeders, and produce desiccated resistant diapausing cysts, reaching maturity in 2-3 weeks with an increase of 10000 folds. High fecundity (up to 4000 cysts per female), cysts sink to the bottom of the pond and easy to harvest, unlike *Artemia* cysts that usually flout (Dumont and Munuswamy, 1997). High nutritional value, especially in terms of essential fatty acids and proteins, the ability to live in different and stressful environments, high biomass production, having slow movement and easy hunting ability for hunters, ease of digestion and help in digestion of concentrated food due to presence of coenzymes, sufficient growth of reproductive gonads and more productive ability of broodstocks and offspring, mass production of resistant and persistent cysts, the possibility of bioencapsulation with PUFA, other nutrients and drugs to transfer to the receiving organism and introduce immunogenic factors such as Vit C into the body, a rich source of carotenoid pigments, ability to change body color, improving the color of the ornamental and edible fish, suitable size, using fairy shrimps as an ornamental (seidgar *et al*., 2007, Dumont and Munuswamy, 1997)	Economic cost, limitation of laboratory bulk culture, presence in small to medium volume waters while *Artemia* exist in large lakes, so that the natural *Artemia* cyst production on an industrial scale reaches 1000 tons per year, the cyst density in the pond is different, for example, it may be 25 mg per square meter, which requires soil washing, labor and high cost. Due to the protective mechanism of female fairy shrimps from their cysts, the hatching rate of the cysts each time the pond is filled is different and usually low. It is difficult and expensive to keep fairy shrimp biomass in retail aquarium shops, sensitivity to physico-chemical factors of water and enrichment costs (Dumont and Munuswamy, 1997, Seidgar, *et al*., 2007).

Although unlike *Artemia*, large scale production of fairy shrimps is difficult, small-scale production is achievable. With higher nutritional value and reproductive pattern, fairy shrimps are considered as a suitable alternative live feed for small scale local fish farming (Pratama *et al*., 2020).

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