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Growth and Survival of African Catfish (*Clarias gariepinus*) Larvae Fed Decapsulated *Artemia*, Live Daphnia, or Commercial Starter Diet

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Abstract

The effects of three diets (decapsulated *Artemia*, live Daphnia spp., and commercial starter diet) on the growth and survival of *Clarias gariepinus* larvae were investigated in the laboratory for seven days using a completely randomized block design. Larvae were hatched by the hypophysation technique and, immediately after resorption of the yolk sac, randomly distributed into nine tanks at a stocking rate of 180 larvae per experimental plastic tank. Triplicate groups were fed treatment diets *ad libitum* twice daily, in the morning and in the evening. The highest growth values were obtained in larvae fed decapsulated *Artemia* ($p<0.05$), while the survival rate was similar in fish fed decapsulated *Artemia* and live daphnia. It is concluded that feeds of animal origin are more suitable for first feeding of *C. gariepinus* larvae than inert diets.

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Introduction

Larval fish nutrition in aquaculture is predominantly dependent on the use of brine shrimp (*Artemia* spp.), particularly for first feedings. However, the cost of brine shrimp is prohibitive for resource-poor farmers in the developing world, which has necessitated investigation into alternative feeds.

Workers have used formulated feeds or combinations of formulated feeds and live feeds in feeding trials with different species of fish larvae (Yilmaz et al., 2003; Panagiotis et al., 2004). In most studies, live foods (e.g., *Artemia*, rotifers, copepods) produced better results in terms of growth and survival than inert diets (Dabrowski, 1984). The use of small rotifers significantly improves initial feeding performance of turbot and, especially, sea bream larvae during early development stages (Polo et al., 1992; Cunha and Planas, 1995).

Attempts have been made to improve the quality of live foods, especially of *Artemia* by enriching it with ascorbic acid (Merchie et al., 1997). There have also been attempts at the biochemical manipulation of live prey, with greater attention to lipids and n-3 HUFA (Le Millinaire et al., 1983; Estevez, 1996). Feeding trials using formulated diets have had little success and some workers recommend regular supplementation of formulated feeds with live feeds (Fernando et al., 1991; Kruger et al., 2001).

Clarias gariepinus is a popular species for aquaculture in sub-Saharan Africa, with fry readily produced in captivity using the hypophysation technique. Decapsulated *Artemia* cysts have been successful for larval rearing of *C. gariepinus* (Verreth et al., 1987; Pector et al., 1994), in addition to other feeds (Adeyemo et al. 1994). This paper aimed to compare the growth of *C. gariepinus* larvae fed decapsulated *Artemia*, live daphnia, or formulated diet.

Materials and Methods

Fry were obtained through the hypophysation technique. On the fourth day after hatching, fry were randomly distributed into nine plastic 10-l bowls in a flow-through system at a density of 210 fish per tank. At the onset of the feeding trials, thirty fry were removed from each experimental tank and batch weighed, leaving 180 fry per tank. Larvae were fed one of the treatment diets (decapsulated *Artemia*, live daphnia, a commercial formulated feed) *ad libitum* in the morning and evening, using the completely randomized block design. Each diet was tested in triplicate.

Temperature and pH were measured daily while ammonia and nitrite values were recorded weekly. Temperature ranged 25-28°C with a mean of 25.4°C and pH ranged 7.0-7.2 with a mean of 7.0. Ammonia (NH_3) remained at 0.0 mg/l and nitrite (NO_2^-) below 0.3 mg/l, values that were negligible. Tanks were cleaned daily before feeding by siphoning off feces and uneaten food. Dead larvae were siphoned and counted to estimate survival.

At the end of the 7-day experiment, thirty fry were removed from each tank and batch weighed. The growth rate (%/day) was determined as

100[final wt (mg) - initial wt (mg)]/time (days) x initial wt (mg), and the specific growth rate (mg/day) as ln final wt (mg) - ln initial wt (mg)/day. Survival (%) was calculated as 100 x (no. survived fish)/(no. initial fish).

Data were analyzed using one-way analysis of variance (Steel and Torrie, 1960), and differences in means were compared using the Duncan's multiple range test at $p = 0.05$.

Results

Growth performance and survival are shown in Table 1. The final weight, growth rate, and specific growth rate were significantly affected by diet, with the highest values obtained in larvae fed decapsulated *Artemia*. Survival was also significantly affected by diet. It was higher in fish fed decapsulated *Artemia* or live daphnia than in those fed the commercial diet.

Table 1. Growth and survival (means±SE) of *Clarias gariepinus* larvae fed decapsulated *Artemia*, daphnia, or a commercial starter diet.

	Diet		
Parameter	*Decapsulated Artemia*	*Daphnia spp.*	*Commercial diet*
Initial wt (mg)	4.0±1.4	4.1±0.5	5.0±0.6
Final wt (mg)	18.6±3.1[a]	10.4±0.3[b]	9.1±0.9[b]
Growth rate (%/day)	58.2±16.8[a]	22.8±4.4[b]	12.7±4.4[b]
Specific growth rate (mg/day)	0.228±0.023[a]	0.135±0.012[b]	0.089±0.017[b]
Survival (%)	80.7±3.9[a]	77.2±2.6[a]	62.9±1.3[b]

Means in a row with the same superscript are not significantly different ($p>0.05$).

Discussion

Growth and survival were highest in fish fed decapsulated *Artemia*, as previously reported for the same species (Verreth et al., 1987; Verreth and van Tongeren, 1989). Decapsulated *Artemia* cysts also produce larvae of superior quality in ornamental fish (Dhert et al., 1997). Apart from being directly available as an off-the-shelf product, the major advantage of decapsulated cysts is that cysts with poor hatching quality can still be used as a food source (Dhert et al., 1997). The same pattern of growth and survival has been documented with *Artemia* nauplii and adults in the first feeding of fish larvae (Sorgeloos et al., 2001). *Artemia* is generally well accepted by marine fish larvae. Live feeds other than *Artemia* have been used for the first feeding of fish larvae with some measure of success. Substantial growth was also witnessed with the use of live daphnia spp.

Artemia successfully provided growth and survival in the early larval stage of exogenous feeding in Atlantic halibut, but had negative effects on pigmentation later on (Naess et al., 1995). However, by introducing wild zooplankton prior to a critical stage (19 days of feeding), these effects could be eliminated. In *C. gariepinus*, *Heterobranchus bidorsalis*, and *Heteroclarias* reared on the cladoceran, *Moina dubia*, better growth and survival were obtained when fed mixed zooplankton and a commercial dry diet than when fed *Artemia* nauplii (Adeyemo et al., 1994).

The finding in this study that formulated diets resulted in the least growth and survival when used for first feeding of fish larvae is similar to findings in investigations conducted by other workers. In *C. gariepinus*, the earliest weaning time from *Artemia* to crumbles of a commercial trout diet is between 1.8 and 4.1 days (Verreth and van Tongeren, 1989). Growth and survival of Dover sole (*Solea solea*) was best on an artificial diet when live *Artemia* nauplii were offered for the first ten days (Appelbaum, 1985). Survival and growth were lower in grass carp (*Ctenopharyngodon idella*) fed inert diets than in those fed live foods (Rothman et al., 1991). In most cases, inert diets are fed to marine fish larvae only after being fed live foods for some weeks (Person Le Ruyet et al., 1993; Fernandez-Diaz and Yufera, 1997; Takeuchi et al., 1998).

Freshwater species can be fed formulated diets as early as mouth opening (Cahu and Zambonino Infante, 2001). However, obtaining feeds that satisfy the nutritional needs of larvae is difficult since mechanisms of digestion and absorption, as well as nutritional requirements, change during larval development (Dabrowski, 1984). Although inert diets are well ingested at the early stage, larvae can die with guts full of food, suggesting that they are unable to digest compound diets (Cahu and Zambonino Infante, 2001).

Young larvae may have insufficient digestive enzymes to thrive on compound feeds and, thus, exogenous enzymes provided from live prey are necessary for early stages (Dabrowski and Glogowski, 1977; Lauff and Hofer, 1984; Cahu and Zambonino-Infante, 2001). Nutrient leaching is also a major constraint in the production of suitable diets for fish larvae. Particles must be water stable, palatable, and digestible.

In conclusion, *C. gariepinus* larvae appear to grow best on feeds of animal origin and can be weaned to inert diets after a few days on live foods.

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