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PUFAs affect growth, pigmentation in Senegal sole larvae

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Suitable live feeds are difficult to acquire

Inconsistent pigmentation in Senegal sole juveniles can later cause consumer concerns regarding "unnatural" coloration.

Senegal sole (*Solea senegalensis)* are flatfish that live on the sandy bottoms of the Mediterranean and South Atlantic coasts. In the 1980s, the species was considered a prime candidate for diversifying Mediterranean aquaculture due to its high market value and easy domestication and capture. Now, over 20 years after the initial trials, some aspects of Senegal sole biology are still unknown and some phases of culture – such as weaning juveniles to artificial diets – need improvement.

Larval production

Ongrowing methods for Senegal sole are well known and mainly based on the capture of juveniles from the wild. However, relatively little is known about their larval biology.

As many other marine fish larvae, Senegal sole larvae are undeveloped at hatching, with unpigmented eyes, closed mouths and anuses, and very small yolk reserves. When the yolk is depleted and mouths and intestinal tracts open, the animals' stomachs are still not functional. The larvae are unable to eat artificial diets, and live preys are needed.

In the wild, Senegal sole larvae ingest mollusk larvae and copepods, but these are difficult to supply in large amounts and must be replaced in aquaculture operations by easy-to-culture live preys such as *Brachionus* sp. rotifers and artemia nauplii. Rotifers are fed during the first 10 days after hatching, whereas artemia nauplii are used from four or five days after hatching until weaning to inert diets.

Both rotifers and artemia are lacking in the polyunsaturated fatty acids essential for marine fish larval development. Therefore, live prey need to be enriched using fatty acid-rich emulsions that provide the essential fatty acids to the developing larvae.

Importance of polyunsaturated fatty acids

Retarded growth, delayed metamorphosis, pigmentation problems, and high mortalities are the results of inadequate levels of polyunsaturated fatty acids in sole diets, which results in high economic losses for fish farmers.

The essential polyunsaturated fatty acids for marine fish larvae belong to the omega-6 and omega-3 families. Arachidonic acid (ARA) is an omega-6, whereas docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are omega-3s. Marine fish cannot synthesize these fatty acids, so they consequently must be provided in diets.

Several experiments to determine the roles of different dietary concentrations of ARA, DHA, and EPA on Senegal sole larval development were carried out by the author in Spain. Promising results were obtained, and feed that produces high survival and fewer unpigmented juveniles may be available soon.

Study setup

Mixtures of commercial oils rich in the fatty acids were prepared with olive oil and vitamin supplements to produce emulsions with zero, low, medium, and high levels of each fatty acid. The oil mixtures were emulsified using soy lec-ithin and equal amounts of water. For the studies on DHA and ARA, the EG strain of artemia was used, whereas *Artemia persimilis*, an Argentinean strain with low initial levels of EPA, was selected for the EPA requirement study.

Senegal sole eggs were obtained from broodstock held under natural pho-to and thermal periods. Newly hatched larvae were stocked at 50 larvae per liter into twelve 35-l, 150-μ mesh baskets distributed among four 1,500-liter holding tanks. The tanks were connected to a recirculation unit with mechanical, biological, and ultraviolet filters.

Water temperature was maintained at 19 ± 1 degrees-C and salinity was 34 ppt. Photoperiod was maintained at 18 hours of light per day, and mild aeration was provided. Standard length and dry weight were measured periodically. Survival and pigmentation success were determined at the end of the experiments, when samples for lipid analysis were also taken.

Results

A clear relationship was observed between the dietary content of ARA, the accumulation of ARA in larval tissues, and the pigmentation rate in Senegal sole larvae. Increasing ARA in the diet resulted in a higher proportion of unpigmented juveniles.

The results from the DHA experiment suggested a low requirement for this fatty acid for normal larval development. The endogenous reserves of the newly hatched larvae, rich in DHA, allowed successful development if the larvae were fed a DHA-deficient diet. Furthermore, the natural feeding of sole is based on polychaetes, which are poor in DHA but rich in EPA.

For EPA, however, low dietary levels produced adequate larval growth, although unpigmented juveniles were produced. This might be explained by considering that both ARA and EPA are involved in the synthesis of eicosanoids, which are involved in the development of pigmentation in flatfish.

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