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Sole show culture potential in Europe

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Common and Senegalese sole are credible candidates

High value and the mastery of breeding techniques for the species make sole a credible candidate for aquaculture.

The aquaculture industry has expanded extensively in Europe in the last decades, but the growth can mainly be attributed to the culture of a few marine species that already show signs of market saturation. Scientific and technical interests have focused on high-value native species whose biological cycles can be reproduced using currently available breeding techniques. From this point of view, common sole (*Solea solea)* and Senegalese sole (*S. senegalensis*) are credible candidates for marine culture.

The current market price for common sole in the European Union is U.S. $11.00-21.40/kg, depending on size and season, and around $10.40-18.15/kg for Senegalese sole. Consumer demand for both species – 30,000-45,000 metric tons (MT) per year during the last decade – has essentially been supplied by fisheries.

Annual catches fluctuate as a result of differences in year class strength, and it is hard to predict sole landings from fisheries in the long term. Current limited information indicates that catches are declining for Senegalese sole, and considering the increasing pressure to close down fishing in parts of the North Sea, fisheries production of sole is more likely to decrease than increase.

Sole culture issues

Thirty years ago, sole was already considered one of the most interesting and promising species for marine fish farming in Europe. However, its commercial culture did not develop because of technological and disease problems. In particular, a main problem was the disease black patch necrosis (BPN). It is now known that BPN is promoted by poor nutrition in the natural diets fed to the sole.

Another constraint for sole farming in Western and Northern Europe used to be water temperature control. Even the more northern of the two species (*S. solea)* requires relatively warm water near 20 degrees-C for optimal growth in the juvenile and growing stages. But suitable sites – near power plants, for example – were rare.

Today, recirculation technology is fully established and widely available. This means that optimal growth conditions for sole are now available year round, even in temperate areas. Combined with recent advances in feed technology for the weaning and grow-out stages, there has been renewed interest in sole as an aquaculture species.

Culture potential

Advances in recirculation and feed technology support the controlled raceway systems suitable for sole production.

Scientific reports published over the last three decades and several laboratory and pilot-scale experiments have generated useful knowledge on sole biology in captivity that is applicable to its commercial culture. Studies have investigated sole ecology, population genetics and biology in their natural environment.

The studies showed that sole spawn readily in captivity, and the buoyant fertilized eggs are easily collected. Stocking density during maturation should be 1-1.5 kg per square meter, and water temperature should be kept above 16 degrees-C for *S. senegalensis* or 8 to 12 degrees-C for *S. solea.* In nature, the onset of spawning is related to the rise in temperature that occurs during spring.

Salinity should be kept constant at 33 to 35 ppt. and the fish reared under simulated natural photoperiod. In other cultured flatfish species, a change in photoperiod is the key environmental signal used to manipulate and control maturation, but at the present, no published work verifies or contradicts this for *S. senegalensis* or *S. solea*.

A mixture of inert and live foods may increase the weaning success of sole fry. This can be further enhanced by using attractants in the dry feed. Future experiments are needed to determine the ideal time to commence weaning and determine the minimum duration of this period.

Since the effects of temperature and photoperiod on juvenile growth have not been studied systematically in the two sole species, the relative importance of a direct photoperiod effect on growth in sole therefore remains to be defined. Problems with malpigmentation in which the fish do not develop enough coloration on the dorsal surface have been solved with the

use of live food enrichments during the larval stage. Supply issues regarding volume and consistency still remain for fertilized eggs from *S. solea* broodstock.

High-density culture using shallow raceway technology has been demonstrated in research trials and pilot commercial production for both species. However, growth rates for *S. solea* remains slow compared to other commercial aquaculture species, which reduces their attractiveness for large-scale commercial production.

Wild catches of Senegalese sole are declining.

Challenges remain

Recent studies on the close phylogenetic relatedness of *S. solea* and *S. senegalensis* will be valuable for future genetic selection and selective breeding. Studies on sole have clearly indicated that, in contrast to other cultured marine fish, fingerling production is not a bottleneck for development of commercial culture, as this step already has been mastered at laboratory and pilot scales.

There are still needs for feeding and growout systems for sole culture, mainly due to the peculiar feeding behavior of the species. Sole require grow-out facilities that are a compromise between having self-cleaning capacity, feed residence time and feed distribution. Currently, no commercial feed fulfills the needs of sole.

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