EcoFish Ballan Wrasse Project
TECHNICAL LEAFLET 04

Microalgae Production Technology in Ballan Wrasse Hatcheries

This leaflet reports on the application of microalgae in aquaculture with a special focus on green water technology.

PROJECT SUMMARY

EcoFish is a three-year transnational project financed by the European Regional Development Fund/Northern Periphery Program and national private and governmental grants. The project focuses on developing methods for culture and use of Ballan wrasse as cleaner fish.

EcoFish has produced this series of summary technical leaflets on all the relevant practices covering the entire life cycle for the rearing and the production of Ballan wrasse. Readers can access and download more detailed, full-text, pdf versions of these technical leaflets at www.eco-fish.org

Introduction

- Microalgae are the basis of energy flow through the aquatic food chain and are highly regarded for their nutritional value.
- Microalgae are widely used in aquaculture and are some of the most important feed sources for different groups of commercially important aquatic organisms in both freshwater and marine aquaculture.
- Microalgae are frequently used as a food source for marine herbivores and in the first feeding process of some carnivorous larvae.
- Microalgae are consumed mostly whole as a basic diet component or as a food additive to supply basic nutrients.

The use of wild fish to feed farmed fish has been perceived as having negative ecological and social consequences. A strategy is therefore needed to reduce the pressure on fisheries resources. Microalgae as a source of PUFA, high quality proteins and other nutrients could partially be a substitute for fish proteins, fish oil in feeds and feed supplements.

The production of microalgae is often considered linked to the success of aquaculture and sufficient production is frequently regarded as a constraint and challenge to finfish and shellfish production. As the aquaculture industry develops, concepts such as engineering waste management in aquaculture systems, nutrients recycling and feed conversion have become of particular interest. The existing commercial production systems for microalgae are well established and are based on unsophisticated technology, even though new culture systems continue to be developed gradually as understanding of microalgae biology and the requirements of a large-scale algae culture system continue to improve. As the aquaculture industry develops, concepts such as engineering waste management in aquaculture systems, nutrients recycling and feed conversion have become of particular interest.

Microalgae in first feeding technology

Microalgae are used to produce live prey (rotifers, copepods, brine shrimp) that are the main feed of the early stages of carnivorous cephalopods, crustaceans and fish. Use of algae in the first-feeding process may enhance the rearing success, including survival, growth and larval quality, but it requires a fundamental knowledge of the mechanisms of algal-larval interactions at the various steps of first feeding. In the case of rotifers and *Artemia* enriched for a short term period, microalgae also need to be added as green water to enhance positive effects on growth and survival of fish larvae.

The “green water” technology

Microalgae used as “green water” have nutritional or probiotic effects as well as improving the water quality, light quality and microbial control. However, it is not fully understood why this “greening” process improves culture conditions for the larvae even though it is an essential procedure. Possible benefits of “green water” technology could include:

- Providing an additional food source
- Increasing the turbidity of the water and creating the better lighting conditions in the fish tank
- Maintaining water quality by removing excess nutrients and CO_2, and regulating the oxygen and pH level in the fish tank.
- Having a therapeutic and antibiotic affect
- Helping to stimulate the development of the larval digestive system
- Providing additional feeding for the live feed during their stay in the larval tank
- Improving the chances of larvae visually seeing live prey in the water and so improving the feeding success.

However, very little is known about the antibacterial effect of microalgae used for “green water” and no standard methods exist to test these antibacterial properties against fish pathogenic bacteria. The EcoFish project has developed a protocol for testing the effect of microalgae used as green water on fish pathogenic bacteria.

Batch culture in 250l towers with air supplied and supplemented with 2% CO2. Green tower: *Nannochloropsis oculata*; Brown tower: *Isochrysis glabana.*

Culture of microalgae in the hatchery

The culture of algae in aquaculture, with the exception of the large scale bivalve hatcheries, is considered secondary to the production of the target farmed animal. Surveys conducted in Australia have revealed that 30–40% (max. 70%) of marine hatchery operating costs can be attributed to microalgae culture. The cultures are often produced locally using different technology for immediate availability of live microalgae. The controlled production of microalgae is a complex and expensive procedure that requires cost-effective harvesting, processing and storage, as well as the need to employ scarce expertise. For example, the harvesting of species which are small in size (less than 20 µm) requires a combination of techniques for concentration with a high cost energy requirement (e.g.centrifugation, ultrafiltration) or combines treatment with chemicals that could harm the environment (e.g. flocculants). For further information on cultivation methods refer to the FAO "Manual on the production and use of live food for aquaculture" by Lavens and Sorgeloos (1996), the "Plankton Culture manual" by Hoff and Snell (2007) or "Algal culturing techniques" by Andersen (2005).

Management of the culture of microalgae

The culture of microalgae requires the highest levels of hygiene. The contamination of cultures can occur at any time, and this can give rise to a decline in the culture cell density. Bacteria, ciliates, protozoans, zooplankton and other species of algae (toxic/alien) can cause this contamination. The contaminants can have synergic effects on the chosen algae or can have a safety impact especially when microalgae are used as fodder. Contamination can get into the cultures from the water, the air or anything added to the cultures.

The nutritional composition of the microalgae will also vary through the growing phases. Microalgae grown to the late exponential phase usually contain 30–40% protein, 10–20% lipids and 5–15% carbohydrate. When cultures are continued through to the stationary phase the protein levels will drop drastically and the carbohydrate levels rise. Harvesting should ideally take place near the end of the exponential phase. By harvesting the algae in this phase and, by replacing the harvested volume by fresh new medium, the culture will maintain an active cell division. Growth rate estimation is therefore one of the daily routines in microalgae culture.

Alternatives to on-site culture of microalgae

Numerous products (frozen, fresh paste, freeze- dried/spray-dried microalgae) are available on the markets. Several providers exist worldwide and they offer supply in most of the algae which are needed for aquaculture purposes. Microalgal products for hatcheries are mainly used in Norway while on-site microalgae productions are used worldwide.

Advantages and constraints for the uses of microalgae in aquaculture

Production of microalgae plays an important part in the rearing of marine fish larvae:

- As co–element improving rearing conditions of the larvae when applying "green water" techniques.
- As a direct source of food or enrichment for live feed used during the first feeding of the larvae.

Despite the development of microalgae as a fodder source in aquaculture for over 50 years, their use in aquaculture does have some disadvantages:

- On-site production of microalgae is labor intensive and expensive.
- Specialist facilities are required as well as dedicated and well trained staff. Any short cuts are likely to end in disaster.
- Preventing contamination and "crashes" leading to fodder shortage is a constant concern in hatchery production.

Possible solutions to these problems could be the development of:

- On-site production of microalgae fresh concentrates with nutritional value adapted to the requirements of Ballan wrasse larvae. The production methods must be standardised to facilitate ease of use, cost-effectiveness and control of quality and quantity during microalgae production.
- Production by a specialised company of easy to use freeze/spray dried products. These dried products should be made from a species mix that meets the nutritional requirements of the Ballan wrasse larvae.
- Development of a user-friendly system for culture of microalgae in hatcheries.

Control of quality of the culture (i.e. contamination, density)

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Choosing techniques for the cultivation of the microalgae used in aquaculture is a matter of achieving balance between costs and intended application. For microalgae culture conditions, a balance has to be struck between the nutritional requirements of the microalgae feeder and the potential biochemical composition of the microalgae. Studies are currently underway to simplify hatchery operations by replacing microalgae produced on-site with biomass produced and preserved elsewhere. In hatchery production, the question of cost effectiveness of microalgae production remains for any culture systems.

Today, more than 32 genera of microalgae, isolated in different parts of the world, are cultured in intensive culture systems. The most important genera used in aquaculture production worldwide are: Bacillariophyta, Chlorophyceae, Cyanobacteria, Eustigmatphyceae Prasinophyceae. Prymnesiophyta. The list includes species ranging in size from a few micrometers to more than 200 µm. The most frequently used species in commercial mariculture operations are: *Chaetoceros calcitrans, C. gracilis, Chlorella* spp., *Cryptomonas* spp., *Isochrysis galbana, Monochrysis lutheri, Nannochloropsis* spp., *Nitzschia* spp., *Pavlova lutheri, Phaeodactylum tricornutum, Porphyridium* spp., *Pyramimonas* sp., *Skeletonema costatum, Tetraselmis suecica, Thalassiosira pseudonana, Rhodomonas* sp. and *Spirulina* sp.

The objectives of the EcoFish partnership project are:-

- To establish wrasse hatcheries with captive broodstocks in Ireland, Scotland and Norway
- To develop techniques for rearing wrasse at all life stages
- To produce eggs and larval wrasse
- To develop methods for culture and use of Ballan wrasse as cleaner fish

NORWAY
Oddvar H. Ottesen
University of Nordland
Mørkvedbukta Reseach Centre
P.O. Box 1490
8049 Bodø
Norway
oddvar.ottesen@uin.no
+ 47 75 51 74 85

Céline Rebours
Bioforsk Nord Bodø
Torggården
8049 Bodø
Norway
celine.rebours@bioforsk.no
www.bioforsk.no
+ 47 93 43 31 08

IRELAND
Julie Maguire
Indigo Rock Marine
Research Centre
Gearhies
Bantry
Co. Cork
Ireland
julie.maguire@dommrc.com
www.indigorock.org
+ 353 27 61 276

Richard Fitzgerald
Carna Research Station
Ryan Institute
NUIG, Galway
Ireland
richard.fitzgerald@nuigalway.ie
+353 95 32 201

SCOTLAND
Jim Treasurer
Viking Fish Farms Ltd.
Ardtoe Marine Laboratory
Ardtoe
Acharacle Argyll PH36 4LD
Scotland
jim.treasurer@vikingfish.com
www.ardtoemarine.co.uk
+ 44 1397 709272

www.eco-fish.org

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