news
FP6 Collective Research Projects
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fine fish

Improving sustainability of European fish aquaculture by control of malformations

In this issue

Colophon

The FineFish project aims to generate new practical knowledge on how to reduce the incidence of malformations in the major fish species used in European aquaculture production and to apply this to the professional sector. FEAP (Federation of European Aquaculture Producers), ten major European hatcheries and eight leading European scientific institutions participate in this Collective Research Project.

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New Protocol for Production of Cod Juveniles

In 2008, the cod breeding company 'MarineBreed' committed **Nofima Marin** to the task of producing their third generation of cod families. The FineFish group at Nofima used this experience to develop a suggested **BMP protocol for cod**. **The new protocol combines previous experience with knowledge gained in FineFish and other recent projects on cod. Critical research results include the relation between high water speed in tanks and lordosis and that moderate temperatures during the live feeding period are required to avoid axis deviation in the neck (Lein et al., 2006).** In applying these 2 major factors, as well as general improvements in hygiene and husbandry regimes, very good responses were obtained.

With an average 3% of deformities, recorded at 20 g. size in fish that were neither graded nor sorted, these are the best results ever seen in cod farmed in intensive hatchery systems. In addition, in tests on fish of 1 to 150 gram size, it was seen that these are growing at the same or even better rate than those reported on the growth table of BioMar, which is itself considered to be optimistic. **The production protocol, including stripping of brood fish, water treatment, tank rearing environment, and feeds and feeding was presented at the Atlantic cod training course held in Bergen in February 2009.** The protocol now needs to be validated by repeating the results and implementation on an industrial scale.

Training courses

The FineFish project will finish in June 2009. Activities will now be directed towards pulling together loose ends, summarizing results and making the knowledge generated known as widely as possible.

The FineFish training courses on prevention of malformations are being held during the first half of 2009.

The first, on **cod** malformations, was held in Bergen in February, as a satellite workshop to the national cod meeting "Sats på torsk".

In March and May, workshops on malformations in Atlantic **salmon** and rainbow **trout** will be held in Bergen, Norway and in Billund, Denmark. In April a single course on malformations in both **sea bass** and **sea bream** will be held in Patras, Greece.

The target groups for the courses are fish farmers, hatchery operators and fish health service providers. **The courses will combine knowledge from FineFish activities and other sources, providing practical recommendations on how to prevent malformations in commercial hatchery production**. Focusing on skeletal deformities, diagnostic methods and guidelines for classifying malformations will be an important part of the programme, including X-ray methodology and image evaluation.

In September, the FineFish project will arrange an international cross-species workshop in Gent, Belgium, where a full range of the project's results will be presented.

Training courses on salmon, bass & bream, trout

26th - 27th of March, Bergen - Norway: TC on prevention of malformations in Atlantic salmon
29th - 30th of April, Patras - Greece: TC on prevention of malformations on sea bass & sea bream
19th - 20th of May, Billund - Denmark: TC on prevention of malformations in rainbow trout

For further practical information and registration, please visit: **www.finefish.info**

Interview with Børge Sørås

Atlantic Cod Juveniles AS, started its activity in 2002 and is owned by the company Atlantic Cod Farms (www.atlanticcodfarms.no). At present its annual production rate has reached about 8-10 million juveniles.

Mr. Sørås participated at the FineFish course on cod, which gathered 60 participants, mainly scientists and cod farmers interested in new knowledge and techniques to prevent malformations in commercial hatchery production.

Mr. Sørås expressed his enthusiasm for the training and the communication of very useful results of the research made by Nofima in the FineFish project.:"Extremely interesting were the results of the trials (showing the relationship between water current and lordosis and temperature and neck malformations), since malformations are a major problem in cod farming at the present. The outcomes, if applied through the new protocol for the production of cod juveniles, can greatly improve production performance.

By looking at salmon, similar work has resulted in much higher quality fingerlings. The cod farming industry has to follow this example.

So far, Fine Fish has done an excellent job with initial results that point to specific factors which we cod farmers can now implement in our own facilities. I hope that this effort continues and that it will lead to further protocols that can improve our production of high quality cod."

finefish news
ISSUE Nº 05
March 2009

FineFish Guidelines for the classification of malformations

FineFish will prepare guidelines for the classification of malformations for each of the species examined; rainbow trout, sea bass and sea bream (combined), cod and Atlantic salmon. The approach will be adjusted to the level of available information for each species.

The first versions of these classification guidelines were prepared during the first years of the project and provided to project partners. A revised version will be presented during the training courses (see separate article) and a final compilation will be made available to all interested users at the end of the project.

Figure: cod with lordosis, stained with Alicarin Red

Manual of Best Hatchery Practices

A **manual of best hatchery practice** is also to be prepared, containing a summary of knowledge gained within the project and providing advice on measures to prevent malformations in hatchery production. Practical recommendations on rearing temperatures, nutrition, other environmental factors and husbandry will take the form of suggested protocols for each species.

The malformation classification guidelines and the best hatchery practice manual will be published in the middle of 2009. While FINE FISH itself cannot solve all problems faced, it is hoped that these publications will contribute to future improvements in commercial hatchery operation.

> "a manual of best hatchery practice is also to be prepared …providing advice on measures to prevent malformations"

PEPITe working in synergy with fish farms

One key objective of FineFish is the systematic collection and analysis of hatchery data concentrating on the incidence of malformations observed in commercial operations, hoping to identify key factors affecting the production of farmed fish and the underlying causes of malformations.
PEPITe has developed a web-based recording system so as to integrate all available information within one standardized database. This will enable the comparison and benchmarking of data on production methodologies applied in different hatcheries, followed by analysis and extraction of useful information to improve current practices.
After detailed analysis of different hatchery structures and procedures, including interactions of the different areas (water surface, tanks, lighting etc.), relationships between these components were used to design a data model contained within a relational database management system (RDBMS).
Access to data is made through a web based interface where a 'user' can design, define and update a hatchery's configuration (tanks, lighting areas…). Once the configuration is complete, the user can then enter monitoring data of the production cycle (temperature, pH, food, etc.).
Hatcheries can access directly an analysis of their data using **"PEPITo" software** and, in the future, it will be possible to extract comparative benchmarks and reports, moving toward identification of root causes of production variables.
Five hatcheries have configured their structural inputs and are registering production cycle data. PEPITe is working in synergy with these hatcheries, using the experience and knowledge of their technical and scientific staff, so as to improve the database features, making it more user-friendly and "clever". This facet of FINEFISH will expand with the development of knowledge from experiments and experience, but also from and from the data mining of the "common database" (data mining: the extraction of useful information from large datasets or databases).

> "in the future, it will be possible to extract comparative benchmarks and reports, moving toward identification of root causes of production variables"

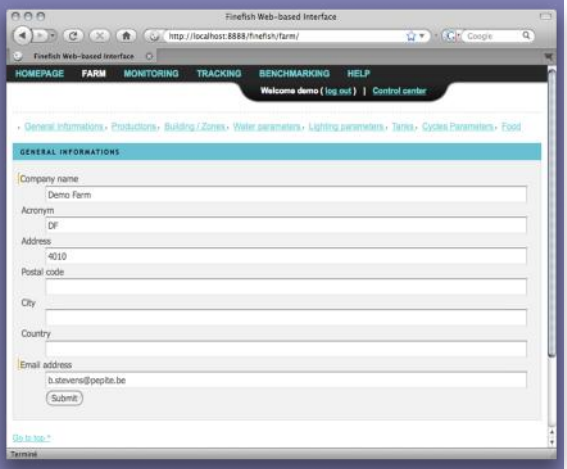


Figure: screenshot of PEPITe's web interface

An example: the database records all the conditions and movements of fish from one tank to another. For a given batch of fish produced by the hatchery, it is possible to extract - from historical data - all of the «paths» followed by individuals that terminate as a batch. Once enough batch data has been collected, it will be possible to identify correlations within the parameters of a «path» during a growth cycle and the malformation rate of the population.

By Philippe Mack
www.pepite.be

FineFish news
ISSUE Nº 05
March 2009

High CO_2 levels in hatchery water

A potential cause of increased malformation levels in rainbow trout fry

Brow Well Fisheries Ltd (BWF)

operates five trout farms in the UK producing both **rainbow and brown trout.**
Hatchery production of mainly 4.5 million fry and fingerlings are principally sold to other farms for on-growing for the table market, with the rest being used for internal production of approximately 280 tons of restocking fish for the angling sector, usually in the 1-5 kilo size range.

Minor malformations become far more pronounced in larger fish and will result in costly rejections and are therefore an issue of great concern to all trout farmers.

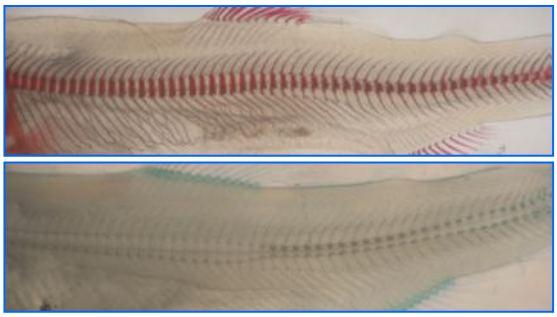
As a SME of the FineFish Project, potential causes of malformations' incidence have been investigated in a series of field trials held on commercial production facilities and further investigated by the RTD partners (Nofima marine).

Most farms that produce trout within the EU use groundwater for the early stages of hatching and rearing of the fry due to the purity and stability of the water's characteristics. This undoubtedly increases the hatching success and survival rates of fry destined for on-growing. It also enables the farmers to utilise the sterile nature of groundwater prevents the spread of disease and enhances bio-security on and between sites but induces the problem of gas super-saturation.
High nitrogen levels can result in "gas bubble" disease, which can easily be prevented by aeration and de-gassing procedures.
Unfortunately, low levels of CO_2 can remain, causing damage without being obvious to the farmer. On-farm monitoring, using the latest CO_2 meters, has shown that gas levels can vary significantly from day to day on a commercial unit. It is easy to forget that a large biomass of fish can produce significant levels of CO_2 that must be removed, particularly if water turnover frequency is low.
The increased use of oxygen injection and recirculation systems in many forms of aquaculture highlights the need to investigate further the potential damage that elevated CO_2 levels can pose to fish stocks, especially in relation to increased malformation rates.

In a small-scale field trial undertaken by BWF, a batch of eyed rainbow trout eggs were hatched and reared to first feeding at three different CO_2 levels.

The hatchery groundwater supply (30 mg/l CO_2 before treatment) was first degassed and then aerated to add oxygen.
Carbon dioxide was then dissolved into this water to produce three different water regimes. A low level was maintained at 3-5 mg/l (a level commonly found in surface waters where trout breed naturally), a medium level of 10-12 mg/l (commonly found in groundwater supplies after significant aeration and splashing prior to use) and 20mg/l (representing poorly degassed ground water).

The three different treatment groups were then grown to 0.5 gram before sampling, and then stained or x-rayed to determine the levels and incidence of malformations.



Figures: Variation in vertebral development in a bone stained and in a cartilage stained fish.

"The results indicated that fish hatched at the highest CO_2 levels showed an increase in fused vertebrae..."

RESULTS

The results indicated that fish hatched at the highest CO_2 levels showed an increase in fused vertebrae at 10.2 %, with the lower levels, 6% and 2% respectively.

An incidence of Scoliosis of 5% was also recorded on the batch reared at the highest level.

The fish sampled were still in the early stages of bone mineralization so it is not possible to determine the severity of these malformations at later life stages. **However, it strongly supports the need for all fish farmers to be aware of the dangers posed by gas super-saturation and the requirement to monitor and mediate the situation at all times.**

On the picture from the left: Ingrid Lein, Ian Jowett, Stephan Hofer, and Jonathan Jowett

By Jonathan Jowett

finefish news
ISSUE Nº 05
March 2009

Higher sensitivity of early developmental stages of rainbow trout to dietary lipid peroxidation

Stéphanie Fontagné (UMR Nutrition, Aquaculture et Génomique NuAGe - Pôle d'Hydrobiologie INRA)

"the dietary control of antioxidant defence system is less efficient during the early developmental stages of rainbow trout fry..."

Introduction

Lipid peroxidation is known to cause several pathologies which may lead to the development of malformations in fish larvae and juveniles. Lipid peroxidation can be induced by dietary antioxidant deficiency (vitamin E or vitamin C) or by dietary prooxidants such as oxidised lipid.
The aim of the study was to characterise the changes in antioxidant defence system of rainbow trout fry fed oxidised lipid during early development.

Experimental setup and results

Rainbow trout fry at swim-up stage or 8 weeks after this stage were fed semi-purified diets with 0% or 12% oxidised lipid for 4 weeks in the INRA experimental fish farm in Donzacq (Landes, France) supplied by spring water at 17°C.
Dietary supplementation with oxidised lipid resulted in depressed growth in both early and late developmental stages of rainbow trout fry. No external malformation was noticed. Dietary control of antioxidant enzymes and vitamins was low in 4-week fry whereas increased activities of antioxidant enzymes and decreased vitamin E contents were noted in 12-week fry fed oxidised lipid compared to fry fed fresh lipid. This resulted in higher content of lipid peroxidation products in 4-week fry fed oxidised lipid compared to fry fed fresh lipid.

Conclusion

The results suggest that the dietary control of antioxidant defence system is less efficient during the early developmental stages of rainbow trout fry which are thus more sensitive to dietary oxidative stress.

Figure: Rainbow trout

Abiotic Factors of Tank Environment:
Temperature limits in early development of sea bass

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"The best growth rates were recorded for those fish which were either reared constantly at 21°C or that started at 18°C and moved to 21°C..."

Introduction

The objective of this experiment, made by HCMR, was to **identify the effect of water temperature on sea bass rearing performance while looking at the malformation response under industrial conditions.** A three step approach was applied: 1) the culturing of sea bass under 6 different temperature schemes (with regard to larval stage of development), 2), the sampling at predefined developmental stages and 3) analysis of deformities at the University of Patras.

Methodology

The experiment was made in 12 500-L tanks. The ambient conditions were controlled electronically and adjusted to the desired levels, following the rearing protocol described in Divanach *et al* (1997).
Three schemes (in duplicates) were applied, using different temperatures at the autotrophic and exotrophic stages (e.g. fish starting at 15°C and going up to 18°C at first feeding, from 18 to 21°C and from 21 to 18°C), while three schemes with constant temperature (15, 18 and 21°C) for both the autotrophic and exotrophic stages served as reference controls. All fish were reared at the same temperature once reaching 16 mm total length, and the experiment finished once the fish had reached 1 g. individual weight.

Results

The best growth rates were recorded for those fish which were either reared constantly at 21°C or that started at 18°C and moved to 21°C, followed by those reared in 18°C, 15-18°C and 21-18°C. The lowest growth rate was for those maintained at 15°C. In terms of mortality, the best temperature scheme until the fish were put in common conditions (16-18 mm) was the one that used 15°C as a starting temperature and 18°C for the exogenous feeding while, once common conditions were applied, best survival was achieved by the fish grown constantly at 15°C.

The Institute of Aquaculture of the Hellenic Centre for Marine Research (HCMR) – www.hcmr.gr

has specialized laboratories (pathology, histology, biochemistry, hormonal and haematological analysis, chromatography, HPLC, etc) which permit all life stages of fish to be studied. The basic research activities focus on the definition, understanding and control of the biological mechanisms involved in the rearing process of marine organisms either already reared or with rearing potential (i.e. physiology, pathology, ethology, developmental biology, immunology, metabolism, etc).