BIOLOGICAL IMPLICATIONS OF INDUCTION TO TRIPLOIDY IN TURBOT

(Scophthalmus maximus)

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**Scophthalmus maximus**
(Improvement of the production)

**Solea senegalensis**
(Reproduction)

**Octopus vulgaris**
(Larval feeding)

**Pagellus bogaraveo**
(Nutrition)

**Merluccius merluccius**
(Larval culture)
Turbot culture

Some important features:

- **Survival rates** in the larval stages **over 20%**
- **High growth rates** (1.5 kg in 2 years) even with high density culture conditions (20-40 Kg/m²)
- **Low mortality** rates in adults (<5%)
- **High resistance to manipulation**
- **Easy tagging** (external tags or internal microchips)

The production system is fully implemented at industrial scale

- No **sex chromosomes** (polygenic model)
- The **sex determination system** is **ZZ** (male) / **ZW** (female)
- **Sex ratio** is usually **1M:1F**
- **Absence** of **sexual dimorphism** and secondary sexual characters
- **Females grow to 35% more** than males
- **First sexual maturation**: 2 years males and 2-3 years in females
- **Commercial size**: just before the first sexual maturation (age=20 months , weight=1.5 kg)
Gametes: hand-stripping

Artificial fertilization

Fertilized eggs: 1 mm

Incubation: 5 days (14°C)

Hatching: Larva 3 mm

Metamorphosis: 25-30 days
Triploidy in turbot

**Advantages**
- Not considered as GMO
- Straightforward methodology
- Decreasing size dispersion
- Decrease mortality post-spawning

**Effects on fish biology**
- Sterility (males and females)
- Increasing in cell size
- Lower tolerance to critical O₂ concentrations
- Some immune system disorders

**Applications**
- Obtaining bigger adult fish (> 1.5 Kg)
- Increasing number of females in the offspring
- Prevention of the genetic contamination (escapes from cages)
Assessing triploidy

Development and validation of a molecular tool for assessing triploidy in turbot

- The use of a set of 4 highly variable microsatellite (those loci proved to be a powerful method to evaluate the ploidy of the samples studied (5 families) with probabilities of triploidy detection of 100% in most of the crosses carried out.
Embryonic and larval development: Comparison of diploid and triploid turbot from fertilization to metamorphosis

- We found a slight **delay in embryonic development of triploids** compared to diploids
- **After hatching** the larvae of both ploidy have a **similar development**
- **No significant differences** were found in the **number and type of abnormalities** during embryonic and larval development between the two ploidy groups
The incidence of morphological and skeletal abnormalities in turbot was similar in diploids and triploids.

The types of skeletal abnormalities were similar in both ploidy groups:

- Posterior abdominal vertebrae fusion (A)
- Posterior caudal vertebrae torsion (B)
- Posterior caudal vertebrae fusion (C)
Comparison of the quality of the product between diploid and triploid turbot: Muscle and nutritional analysis

- Significant **differences in muscle fibre size** between diploid and triploid, however:
  - No significant **differences in the textural parameters values** between ploidies
- The **nutritional analysis** (water holding capacity, total fat, fatty acids, protein, minerals) showed **no significant differences** between ploidies
From the economic point of view turbot is one of the most important aquaculture species in Europe.

Production of turbot in Europe is predicted to triple over the next 3 years.

Triploidy in turbot does affect the quality of the final product.

Triploidy can be an alternative to produce turbot with more than 2 kg and thus, increasing the options of the final manufactured product.

With 6 months more of farming (30 vs 24) turbot would reach 2.5 kg instead of 1.5 kg, meaning a considerable increase (67%) in the final value of the product.

Future studies are needed to know in depth the biology of triploid turbot.
Thank you!