The effect of dietary phosphatidylcholine/phosphatidylinositol ratios on gilthead seabream (Sparus aurata) deformities

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Introduction

One of the major problems afflicting mariculture today is the high incidence (>30%) of skeletal and morphological deformities. This problem drastically affects the market value of the fish harvest. Previous research hypothesized that dietary phosphatidylinositol (PI) was more effective in reducing deformities than the main membrane phospholipid phosphatidylcholine (PC).

The aims of the research were:

To determine, through the use of a soft gelatin micro-encapsulated diet, the effect of dietary PC/PI ratio on the incidence of skeletal deformities, osteocalcin (bone Gla protein, BGP) mRNA expression and the performance of gilthead sea bream larvae, juveniles and fry.

Materials and Methods

• Four microdiets (MDs), differing only in their PC/PI ratios and replacing 75% of the normal Artemia ration (mg DW), were fed to 20–34 days post hatching (dph) larvae (Table 1). The highest PC/PI ratio diet (lowest PI) was considered as the control (Diet A) while a commercial reference treatment (100% Artemia ration) was also tested (Art treatment).

• At 40dph the larvae were graded into small (<1.3 mg larva⁻¹) and large (>2.9 mg larva⁻¹) sizes from each tank and were reared in aquariums (till 67dph) and fry rearing cages (till 141dph).

• Determination of deformities: 67dph juveniles were stained for bone and cartilage using a modified method by Potthoff T. (1984). 141dph fry were manually sorted for phenotypic cranial (jaw) and gill cover deformities. Then, the fry were analyzed using X-ray for skeletal deformities (Plate 1).

• The BGP mRNA levels were tested by RT-PCR from the experimented juveniles in all treatments from five developmental stages (40–83dph).

• All of the Results are expressed as mean ± S.E.M (n=4). Levels within a size group having different letters were significantly (P<0.05) different. Levels between size groups fed the same treatments and having different (*) were significantly (P<0.05) different.

Table 1: The dietary PC/PI ratio in the experimental treatments

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Art</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(g/100 g dry diet)</td>
<td></td>
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<tr>
<td>Phosphatidylinositol</td>
<td>25% Artemia +75% MD</td>
<td>25% Artemia +75% MD</td>
<td>25% Artemia +75% MD</td>
<td>25% Artemia +75% MD</td>
<td>100% Artemia</td>
</tr>
<tr>
<td>Phosphatidylcholine</td>
<td>5.7</td>
<td>4.54</td>
<td>4.42</td>
<td>3.88</td>
<td>4.42</td>
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<tr>
<td>Phosphatidylinositol</td>
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<td>1.95</td>
<td>2.76</td>
<td>3.04</td>
<td>1.78</td>
</tr>
<tr>
<td>PC/PI in total diet</td>
<td>3.07</td>
<td>2.32</td>
<td>1.6</td>
<td>1.28</td>
<td>2.48</td>
</tr>
</tbody>
</table>

Results

1. There was no marked treatment effect on growth rate in 40dph larvae. On the other hand in later juvenile development (67dph), decreasing dietary PC/PI ratio contributed to significantly better growth (Fig 1a) and higher survival (Fig 1b).

2. Decreasing dietary PC/PI ratio significantly reduced cranial deformities (Fig 2a) while induced skeletal deformities (Fig 2b). The skeletal deformity (%) was more marked in faster growing individuals compared to their slower growing cohorts.

3. Sparus BGP mRNA levels correlated well (R² = 0.964) with development in the faster growing fish fed the high PI diet (lowest PC/PI ratio) (Fig. 3, 4).

Conclusions & discussion

• Reducing dietary PC/PI ratio markedly decreased cranial deformity at 67dph. This may have contributed to improved feeding efficiency on pellets in a later stage leading to significantly (P<0.05) better growth and (P<0.05) higher survival.

• The results suggest that PI is involved in the regulation of osteocalcin (BGP) synthesis which reduced cranial deformity while tending to cause over-mineralization and skeleton deformities in faster growing larvae.

• The most effective dietary PC/PI ratio for sea bream larval and fry rearing was 1.28 (PI level of 3.04g 100g⁻¹ diet).

Acknowledgments

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