Amino acid requirements and metabolism in fish larvae and post-larvae

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• Juvenile and adult fish have a higher protein requirement and a lower adaptability of amino acid metabolism than mammals.

• Fish larvae seem to have even less control of their AA metabolism leading to higher catabolic losses of AA, and thereby to higher AA requirements.

• Fish are probably more sensitive to diets poor in protein or with an imbalanced AA profile.
Balanced AA profile

- Fat
- Muscle
- Energy
- Faeces
- Ammonia
Ideal dietary AA profile

Larvae (% IAA)

Diet (% IAA)
Muscle Energy Fat Ammonia Faeces
• Differential absorption of individual AA?
• Selective catabolism of individual AA?

• Differential absorption of individual AA?
$^{13}$C-enriched microalgae

$^{13}$C-enriched Rotifers

$^{13}$C-enriched fish
$^{13}$C-NMR Spectroscopy

- $C_{\beta}$
- $C_{\alpha}$
- $C_{\text{carboxyl}}$
- $\text{NH}_2$
- Aromatic C
- alpha C
- gamma C
- beta C

ppm
$^{13}$C-NMR Spectroscopy

- Ser$_{\text{alpha}}$
- Ala$_{\text{alpha}}$
- Leu$_{\text{beta}}$
- Leu$_{\text{gamma}}$
- Ala$_{\text{beta}}$
- Glu$_{\text{beta}}$
- Methanol
\[
\left( ^{13}\text{C AA}_i / ^{13}\text{C TAA} \right) / \left( \text{AA}_i / \text{TAA} \right)
\]

- **Rotifers**
- **Seabream**

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Rotifers</th>
<th>Seabream</th>
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<tbody>
<tr>
<td>Ile</td>
<td><img src="image" alt="Bar for Ile Rotifers" /></td>
<td><img src="image" alt="Bar for Ile Seabream" /></td>
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<td>Leu</td>
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<tr>
<td>Val</td>
<td><img src="image" alt="Bar for Val Rotifiers" /></td>
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$\left( ^{13}\text{C} \ AA_i /^{13}\text{C} \ TAA \right) / (AA_i / TAA)$

- Rotifers
- Seabream

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<thead>
<tr>
<th>Amino Acid</th>
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**Bioavailability**
There are differences in the bioavailability of individual AA
different absorption efficiencies
and/or
selective catabolism of individual AA
• Selective catabolism of individual AA?

• Differential absorption of individual AA?
First-feeding herring larvae

I. Rønnestad 2000
Senegal sole post-larvae 30 DAH
Herring larvae

Day 0

Lys: Retained 69%, Oxidised 23%, Faeces 8%
Glu: Retained 16%, Oxidised 76%

Day 47

Lys: Retained 63%, Oxidised 22%, Faeces 15%
Glu: Retained 33%, Oxidised 62%, Faeces 5%
Sole post-larvae

32 DAH

% of injected labelled AA

- **Lys**: 11% Retained, 87% Oxidised, 0% Faeces
- **Arg**: 15% Retained, 82% Oxidised, 3% Faeces
- **Glu**: 65% Retained, 33% Oxidised, 2% Faeces
- **Ala**: 41% Retained, 56% Oxidised, 3% Faeces
Conclusions

• Fish larvae and post-larvae use DAA preferentially to IAA for energy production.

• Fish larvae may have a better capacity of regulating AA catabolism than thought before.

• Individual amino acids have different bioavailabilities in fish larvae and post-larvae