Microalgal Omega-3 polyunsaturated fatty acids (PUFAs) effects on cognition, sociability, depressive-like behaviour and brain fatty acid composition in C57BL/6 mice

Clara Seira-Oriachi \textsuperscript{a,b}, Ruairi Robertson \textsuperscript{a,d}, R. Paul Ross \textsuperscript{a,d}, John F. Cryan \textsuperscript{a,c}, Catherine Stanton \textsuperscript{a,d}, Timothy G. Dinan \textsuperscript{a,b}

\textsuperscript{a} APC Microbiome Institute, UCC, Cork \textsuperscript{b} Department of Psychiatry \textsuperscript{c} Department of Anatomy and Neuroscience, University College Cork, Cork, Ireland \textsuperscript{d} Teagasc Food Research Centre, Moorepark, Fermoy, Cork.

Introduction

- Over the last decades, human nutritional intake has undergone major changes characterized by increased omega-6:omega-3 ratio (1:4 1:10; 2011).
- This unbalanced dietary fatty acid intake has caused a major increase in inflammatory-related disorders.

**Essential omega-3 polyunsaturated fatty acids (PUFAs):**

- Most abundant in brain [1].
- Key players in brain development and function, especially during perinatal development and early postnatal period [2].

AIM: To assess the effects of omega-3 PUFAs supplementation or deficiency, from gestation through to adulthood, on cognition, depressive-like behaviour, sociability, anxiety and on brain lipid composition in murine offspring.

Methods

**Diets:**

<table>
<thead>
<tr>
<th></th>
<th>% by weight</th>
<th>Deficient Omega 3</th>
<th>Central</th>
<th>Enriched (Omega 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C18:3 eicosapentaenoic acid (EPA)</td>
<td>0</td>
<td>0.44</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Docosahexaenoic acid (DHA)</td>
<td>0</td>
<td>0.66</td>
<td>0.66</td>
<td></td>
</tr>
<tr>
<td>Eicosapentaenoic acid (EPA)</td>
<td>0</td>
<td>0.35</td>
<td>0.35</td>
<td></td>
</tr>
</tbody>
</table>

**Experimental design:**

<table>
<thead>
<tr>
<th>Pregnancy (16 E3)</th>
<th>Adolescence</th>
<th>Adulthood</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICH</td>
<td>NO</td>
<td>DMB</td>
</tr>
<tr>
<td>FC</td>
<td>FST</td>
<td>FC</td>
</tr>
</tbody>
</table>

Results

**Social behaviour**

<table>
<thead>
<tr>
<th><strong>Cognition</strong></th>
<th><strong>PUFAs brain composition</strong></th>
</tr>
</thead>
</table>

- **Adolescence**
  - Novel Object Recognition (NOR)
  - Depression-like behaviour/HPA axis response to stress

- **Adulthood**
  - Novel Object Recognition (NOR)
  - Depression-like behaviour/HPA axis response to stress

- **Omega 3+** → Enhanced memory compared to control in adulthood
- **Omega 3-** → Memory impairment compared to Omega 3+ group in adolescence and adulthood

- **Omega 3+** → Increased depression-like behaviour in adulthood
- **Omega 3-** → Improved stress response in adolescence

**Acknowledgements & Disclosure**

The authors would like to thank Dr. E. Fosan, Dr. P. Flynn, Dr. C. Ireland and Dr. M. Marley for their technical assistance, and to A. Goda and K. Ray for critical review of the paper. The APC Microbiome institute is a research institute funded by Science Foundation Ireland (SFI), through the Irish Government’s National Development Plan [Grant Number 13/R/227]. TGD and FC are also supported by the Irish Health Research Board, the Dept. of Agriculture, Food & the Marine and Enterprise Ireland. C20:4 is funded through SMART FOOD project.

**References**


**Conclusions**

- Omega-3 PUFAs deficiency caused impairments in cognition, sociability and depression-like behaviour.
- Omega-3 PUFAs supplementation enhanced cognition and stress response.
- The behavioural effects may be related with an increase of Omega-3 PUFAs in the brain.
- Omega-3 PUFAs supplementation/deficiency effects were more pronounced in adulthood than adolescence.
- These findings show the importance of n-3 PUFAs intake on brain development indicating their possible implications in psychiatric disorders.