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Comparing effects of polyunsaturated fatty acids derived from marine and plant sources on endothelial cell inflammation

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Abstract

High consumption of ω-3 long chain polyunsaturated fatty acids (PUFAs) has long-term health benefits. The principal dietary source of these ω-3 PUFAs (eicosapentaenoic acid, EPA and docosapentaenoic acid, DHA) is seafood, particularly oily fish. However current fish stocks are decreasing, indicating a need for alternative sources of bioactive PUFAs. Plant-derived ω-3 PUFAs (alpha-linolenic acid, ALA and stearidonic acid, SDA) may be able to provide land-based sustainable sources, but their functionality has been underexplored.

Anti-inflammatory effects of ALA and SDA were compared to EPA and DHA in cultured EA.hy926 endothelial cells. Cells were treated with PUFAs (10, 25 and 50 μM) for 48 hours prior to stimulation with tumour necrosis factor for 24 hours. PUFAs incorporation was measured by gas chromatography and inflammatory responses were measured by ELISA, RT-PCR, western blot and flow cytometry. Adhesion of THP-1 monocytes to EA.hy926 cells was determined using a static adhesion assay.

All PUFAs were incorporated into EA.hy926 cells in a dose-dependant manner (10 and 50 μM). Pre-treatment with ALA, SDA, EPA and DHA (50 μM) had differential effects on inflammatory responses in EA.hy926 cells depending on PUFA and response examined.

EA.hy926 cells pre-treated with SDA had lower concentrations of soluble ICAM-1 ($p < 0.05$); however EPA and DHA resulted in greater reduction ($p < 0.0001$). EPA and DHA pre-treated EA.hy926 cells had significantly lower concentrations of IL-6 ($p < 0.0001$), IL-8 ($p < 0.0001$) and MCP-1 ($p < 0.05$, $p < 0.01$). ALA pre-treatment did not significantly affect any of the cytokines examined. Lower cell surface expression of ICAM-1 ($p < 0.05$), was seen for EA.hy926 cells pre-treated with SDA again to a lesser extent than EPA and DHA ($p < 0.001$, $p < 0.0001$), with no effect seen after ALA treatment.

EA.hy926 cells pre-treated with ALA had significantly higher relative gene expression of NFKB ($p < 0.05$), as well as a tendency for more phosphorylated NFKBp65 protein ($p < 0.06$). In contrast, EA.hy926 cells pre-treated with DHA had significantly less phosphorylated NFKB ($p < 0.0001$). EA.hy926 cells with DHA treatment had significantly higher relative gene expression of PPARa ($p < 0.05$). SDA and EPA had no effect on expression of either of the genes or proteins examined.

Finally pre-treatment with ALA, SDA and DHA all resulted in reduced adhesion of THP-1 monocytes to EA.hy926, however this effect not observed with EPA.

Marine derived PUFA, particularly DHA, resulted in potent anti-inflammatory effects within this endothelial cell model. Of the two plant derived PUFAs, SDA treatment lead to some anti-inflammatory effects, which were not seen after treatment with ALA.

Conflict of Interest

There is no conflict of interest