Commentary on a trial comparing krill oil versus fish oil

Peter D Nichols1*, Soressa M Kitessa2 and Mahinda Abeywardena2,3

Abstract
Considerable interest exists presently in comparing the performance of krill oil (KO) and fish oil (FO) supplements. Ramprasath et al. (Lipids Health Dis 12:178, 2013) have recently compared use of KO and FO in a trial with healthy individuals to examine which oil is more effective in increasing n-3 PUFA, decreasing the n-6:n-3 ratio and improving the omega-3 index. The authors concluded that KO was more effective than FO for all three criteria. However, careful examination of the fatty acid profiles of the oils used showed that the FO used was not a typical FO; it contained linoleic acid as the dominant fatty acid (32%) and an n-6:n-3 ratio of >1. Due to the fatty acid profile being non-representative of typically commercially marketed FO, the conclusions presented by Ramrasath et al. (Lipids Health Dis 12:178, 2013) are not justified and misleading. Considerable care is needed in ensuring that such comparative trials do not use inappropriate ingredients.

Keywords: Krill oil, Fish oil, Fatty acids, Trial

Background
The benefits of the long-chain (≥C20) n-3 oils (LC n-3 oils) for reduction of the risk of a range of disorders including coronary heart disease, stroke and arthritis is recognised and well documented [1-7]. It is clear that the benefits result from eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3), and optimal intake levels of these bioactive fatty acids for maintenance of health and for prevention and treatment of specific diseases have been developed and adopted by both national and global health agencies. These developments have lead to a steady increase in consumer demand for the LC n-3 oils, mainly in the form of fish oil supplements. The increasing global population has substantial implication for the future sustainability of wild harvest fish stocks to meet this demand. Alternate sources of the LC n-3 oils are being explored and developed. KO is one such oil that has captured increasing consumer interest and market share. Compared to FO which contains predominantly triacylglycerol (TAG), KO contains EPA and DHA in both TAG and phospholipid (PL) form [8]. Interest has existed on whether the phospholipid form of the LC n-3 oils is more bioavailable than the TAG form.

Hence, a recent study by Ramprasath et al. [1] aimed to compare the relative effects of KO versus FO against a placebo (corn oil) on plasma and RBC fatty acid profiles in healthy volunteers following 4 wk of supplementation.

Fish oil – fatty acid profile
Fish oils are the major recognized sources of LC n-3 oils, predominately EPA and DHA, with n-6 fatty acids such as linoleic acid (LA, 18:2n-6) and arachidonic acid (ARA, 20:4n-6) typically only minor components. FO generally show an n-6/n-3 ratio of <1, usually <0.2 (Table 1). The 18/12 FO preparations commercially available are reflective of this since the n-6 fatty acid levels range from 2.9-3.6%.

In contrast, the profile of the FO used by Ramprasath et al. [1] (Table 1) shows linoleic acid (LA, 18:2n-6, 32%) to be clearly the dominant fatty acid followed by 16:0 (17%), EPA (13.5%) and DHA (8.7%). The source of the oil was stated as a TG 18/12 oil. The n-6/n-3 ratio was 1.2. The typical 18/12 TG oils generally contain 18% EPA and 12% DHA, with LA at <2% (Table 1).

It is well known that n-3 and n-6 essential fatty acid series compete with each other for further metabolism. The use of the FO with a high LA level as described by...
Table 1 Major fatty acid composition of krill and fish oil used in Ramprasath et al. [1] and in typical fish oil

| Fatty acid       | Ramprasath et al. [1]   | Typical profile for fish oil |
|------------------|------------------------|-----------------------------|
| 16:0             | 22.1                   | 17.1                        |
| 18:2n-6 LA       | 2.1                    | 32.5                        |
| 18:1n-9          | 13.3                   | 2.6                         |
| 18:0             | 1.4                    | 3.5                         |
| 18:1n-9          | 16.4                   | 13.5                        |
| 20:5n-3 EPA      | 9.5                    | 8.7                         |
| 22:6n-3 DHA      | 0.095                  | 1.2                         |
| EPA + DHA consumed* | 778                   | 664                         |

*Calculated from oil compositions and daily consumption of 3000 mg of oil. Typical fish oil data is the mean of 4 representative 18/12 product brands analysed following transmethylation and GC [9].

Ramprasath et al. [1] has resulted in lower LC n-3 and a markedly increased n-6/n-3 ratio than would be expected with a ‘standard or typical’ FO preparation which generally contain only <2% LA. The authors reported that the use of KO with healthy individuals was more effective in increasing n-3 PUFA, decreasing the n-6/n-3 ratio and improving the omega-3 index. Calculation of the amount of EPA + DHA consumed by the two groups of volunteers in the study by Ramprasath et al. [1] shows that the KO group received 114 mg/day higher amounts of the two n-3 LC-PUFA (778 mg v 664 mg, Table 1) without taking into account any competitive actions imposed by the presence of high level of LA (32%) in the FO treated group. Collectively, these major differences are likely to be responsible for the greater incorporation of n-3 PUFA following consumption of KO compared to the FO group. Unfortunately the trial has been biased by use of an oil which was appears to be a mixture of a FO product (Table 1) diluted or blended with an oil enriched in LA.

Accordingly the trial, which was designed to compare the bio-efficacy of incorporation of n-3 PUFA derived from KO and FO, would need to be repeated using a fully verified standard FO product that conforms to specifications presented above. In a more general context, considerable care is required with both product verification and subsequent trial design to ensure that stated aims can be realistically tested and achieved.

Abbreviations
ARA: Arachidonic acid; DHA: Docosahexaenoic acid; EPA: Eicosapentaenoic acid; FO: Fish oil; GC: Gas chromatography; KO: Krill oil; LA: Linoleic acid; LC: Long-chain (≥C20); LC-PUFA: Long-chain polyunsaturated fatty acids; PUFA: Polyunsaturated fatty acids; RBC: Red blood cells.

Competing interests
PDN, SMK and MA declare no conflict of interest.

Authors’ contributions
PDN analyzed and collated the typical FO data. All authors shared analysis of data and manuscript preparation. All authors read and approved the final manuscript.

Acknowledgements
The authors acknowledge the contribution of the wider CSIRO Food Futures Flagship Omega-3 team. We thank Peter Mansour and Carol Mancuso Nichols for comments on the manuscript.

Author details
1CSIRO Food Futures Flagship, Marine and Atmospheric Research, Hobart, TAS, Australia. 2CSIRO Animal, Foods and Health Sciences, Adelaide, South Australia, Australia. 3CSIRO Preventative Health Flagship Adelaide, Adelaide, South Australia, Australia.

Received: 24 December 2013 Accepted: 26 December 2013
Published: 2 January 2014

References
1. Ramprasath VR, Eyal I, Zchut S, Jones PJH: Enhanced increase of omega-3 index in healthy individuals with response to 4-week n-3 fatty acid supplementation from krill oil versus fish oil. Lipids Health Dis 2013, 12:178.
2. Calder PC, Yaqoob P: Marine omega-3 fatty acids and coronary heart disease. Curr Opin Cardiol 2012, 27:412–419.
3. Roncaglioni MC, Tombesi M, Avanzini F, Barlera S, Cairmi V, Longoni P, Marzona I, Milani V, Silletta MG, Tognoni G, Marchioli R: n-3 fatty acids in patients with multiple cardiovascular risk factors. New Engl J Med 2013, 368:1800–1808.
4. Proudman SM, Cleland LG, James MJ: Dietary omega-3 fats for treatment of inflammatory joint disease: Efficacy and utility. Rheum Dis Clin North Am 2008, 34:469–479.
5. Stall LA, Begg DP, Weisinger RS, Sinclair AJ: The role of omega-3 fatty acids in mood disorders. Curr Opin Investig Drugs 2008, 9:57–64.
6. Parletta N, Milte CM, Meyer BJ: Nutritional modulation of cognitive function and mental health. J Nutr Biochem 2013, 24:725–742.
7. Abejvaradena MY, Patten GS: Role of ω3 long-chain polyunsaturated fatty acids in reducing cardio-metabolic risk factors. Endocr Metab Immune Disord Drug Targets 2011, 11:232–246.
8. Winther B, Hoern N, Bege K, Reubel L: Elucidation of phosphatidylcholine composition of krill oil extracted from Euphausia superba. Lipids 2011, 46:25–36.
9. Godalbaccus BM, Carter CG, Bridge AR, Nichols PD: The “n-3 LC-PUFA sparing effect” of modified dietary n-3 LC-PUFA content and DHA to EPA ratio in Atlantic salmon smolt. Aquaculture 2012, 356–357:135–140.

Cite this article as: Nichols et al.: Commentary on a trial comparing krill oil versus fish oil. Lipids in Health and Disease 2014 13:2.

Submit your next manuscript to BioMed Central and take full advantage of:
• Convenient online submission
• Thorough peer review
• No space constraints or color figure charges
• Immediate publication on acceptance
• Inclusion in PubMed, CAS, Scopus and Google Scholar
• Research which is freely available for redistribution

www.biomedcentral.com/submit