OMEGA 3 HEALTH PRODUCTS; THE HEALTH BENEFICIAL EFFECTS OF CERTAIN OILS MAY BE COMPROMISED BY CONTAMINATING CHEMICAL POLLUTANTS

Mikaela Rehnmark[a], Stefan Rehnmark[b], Bernhard Henkelmann[c], Jarmila Kotalik[c], Silke Bernhöft[c], Marchela Pandelova[c], Karl-Werner Schramm[c,d]

[a] CASCADE high school project, Novum, 14751, Huddinge, Sweden
[b] Karo Bio AB, Novum, 14157 Huddinge, Sweden
[c] Helmholtz Zentrum München**,** German Research Center for Environmental Health (GmbH), Institute of Ecological Chemistry, Ingolstaedter Landstr. 1, D-85764 Neuherberg, Germany
[d] TUM, Weihenstephan Center of Life and Food Science, Department for Biosciences, Weihenstephaner Steig 23, D-85350 Freising, Germany

Introduction

An increasing body of evidence indicates that omega 3 fatty acids are beneficial for the health. Consumption of omega-3 fatty acids, either from eating fatty fish or omega-3 health products, could prevent a wide range of medical problems, including cardiovascular disease, depression, asthma, and rheumatoid arthritis. The three most nutritionally important omega-3 fatty acids are alpha-linolenic acid, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

There are several different omega-3 health products on the market sold in supermarkets and health stores, one claiming to be better than the other, and it is easy for the consumer to be mislead that the more you consume the better it will be for your health. Although the health beneficial effects of omega-3 fatty acids are recognized, depending on the source of the omega-3 oil, these products may contain significant amounts of dioxins, PCBs and pesticides, which may compromise the health beneficial effects of these oils. In order to address this issue, we set out to analyze the concentration of dioxins, PCBs, and organochlorine pesticides in a hand full of omega-3 health products in Sweden.

Materials and Methods

Different brands of omega-3 products from different sources were bought at the local health store and at the supermarket in Sweden - 1 vegetable oil (flaxseed), 5 fish oils (1 containing canola oil) and 1 seal oil. The levels of polychlorinated dibenzo-p-dioxins and -furans (PCDD/F), polychlorinated biphenyls (PCB) and organochlorine pesticides (OCP) were determined in all omega-3 products. The analysis of PCDD/F and PCB were carried out using 2.5 g of sample whereas for OCP analysis 1g per sample was used. In case of the capsule product, the oil was removed from the gelatin cover. To remove interferences, the seven samples were cleaned-up by several sequential liquid chromatography steps [1,2]. PCDD/F, PCB and OCP analysis were performed with a high-resolution mass spectrometer Finnigan MAT 95S (Thermo Electron GmbH, Bremen, Germany) coupled with an Agilent GC 6890 (Agilent Technologies, Palo Alto, CA, USA). The tetra- to octachloro- isomers of PCDD/F, tri- to hepta-isomers of PCB and organochloropesticides (OCP) were identified and quantified in pg/g (fat). The enforcing lab is operating a quality assurance system according to DIN EN ISO/IEC 17025 and is accreditated for the analyses of PCDD/F, PCB and OCP. The applied procedures were validated on the basis of internal reference materials and approved within interlaboratory comparison studies.

Results and Discussion

Table 1 shows the concentrations of PCDD/F and PCB (WHO-TEQ) in pg/g in the different omega-3 oil samples. All fish and vegetable oil samples were found to contain low amounts of the toxic contaminants, while the seal oil sample contained significant amounts of both PCB and PCDD/F congeners.

Table 1.
PCDD/F and PCB concentrations (pg/g (fat)) of vegetable oil (a), fish oil (b-f) and seal oil (g)

sample	PCDD/F pg WHO-TEQ/g	PCB pg WHO-TEQ/g
a	0.003	0.001
b	0.68	0.02

c	0.09	0.15
d	0.57	1.1
e	0.24	0.18
f	0.86	0.17
g	2.3	4.9

As shown in Table 2, the seal oil also contained the highest levels of several OCPs; 1,2,3,4,5,6-Hexachlorocyclohexanes (α-HCH, β-HCH, γ-HCH), DDT-related pesticides (4,4'-DDT, 4,4'-DDD, 4,4'-DDE), Chlordane-related pesticides (trans-Chlordane, cis-Chlordane, oxy-Chlordane), Aldrin, Dieldrin, Pentachlorobenzene and Hexachlorobenzene, were all high, while the levels of Endosulfan-I and Endosulfan-II were almost like in the other samples. Altogether, no detectable values were observed in all samples for δ-HCH, ε-HCH, Heptachlor, trans-Heptachloroepoxide, Aldrin and Methoxychlor except in seal oil (g).

Table 2.
Organochlorine pesticides concentrations (pg/g (fat)) of vegetable oil (a), fish oil (b-f) and seal oil (g)

	a	b	c	d	e	f	g
1,2,3,4,5,6-Hexachlorocyclohexanes:							
α-HCH	24.8	10.4	n.d.	221	n.d.	22.8	36736
β-HCH	n.d.	6.9	n.d.	1255	43.1	26.4	14241
γ-HCH	219	n.d.	n.d.	51.4	n.d.	n.d.	3490
δ-HCH	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	79
ε-HCH	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	92
DDT-related pesticides:							
4,4'-DDT	26.4	n.d.	43	2090	n.d.	n.d.	6503
2,4'-DDT	n.d.	n.d.	n.d.	398	n.d.	n.d.	403
4,4'-DDD	n.d.	69.4	45.1	4893	326	379	9294
2,4'-DDD	n.d.	17.2	9.5	1339	106	82.2	439
4,4'-DDE	9.8	54	89.9	22754	243	229	135580
2,4'-DDE	n.d.	n.d.	n.d.	347	49.6	n.d.	398
Chlordane-related pesticides:							
trans-Chlordane	14.2	n.d.	18.3	546	n.d.	n.d.	9137
cis-Chlordane	n.d.	n.d.	15.5	1022	n.d.	n.d.	2724
oxy-Chlordane	n.d.	n.d.	n.d.	145	n.d.	n.d.	50356
Heptachlor	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	125
cis-Heptachloroepoxide	111	3.2	13.2	470	7.8	n.d.	36617
trans-Heptachloroepoxide	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	277
Aldrin	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	239
Dieldrin	78.5	7.1	53.2	2506	50.7	39	59069
Endrin	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	599
Endosulfan-I	169	246	173	265	30.8	n.d.	552
Endosulfan-II	49.5	243	178	47.2	n.d.	n.d.	180
Methoxychlor	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Mirex	n.d.	n.d.	n.d.	51.5	n.d.	n.d.	642
Pentachlorobenzene	30.1	28.7	13.2	302	21.5	12.1	7094
Hexachlorobenzene	107	129	66.2	1702	59.4	72.9	66174
Pentachloroanisole	153	51.3	20.4	72	n.d.	n.d.	37.1
Octachlorostyrene	n.d.	n.d.	n.d.	42.4	n.d.	n.d.	890

n.d. - not detectable

The vegetable oil and seal oil were the samples with the lowest and highest concentrations, respectively. Unlike most fish oil samples, where the levels of OCP were either not detectedable or very low, the fish oil (d) contained the highest levels of toxic compounds among the fish oils, with markedly elevated levels of DDT-related pesticides.

Negligible PCDD/F, PCB and OCP concentrations were found in the vegetable oil sample and in most of the fish oil samples. The seal oil sample contained high level of PCDD/F concentrations of 2.3 pg WHO-TEQ/g (fat), the highest concentration measured in any of the samples and critical with respect to the limit of 2 pg WHO-TEQ/g (fat) established by the EU. Furthermore the recommended from supplier daily intake of 1-4 capsule each 1g may result maximum total PCDD/F and PCB exposure of about 28 pg TEQ per day. Thus according to the tolerance daily intake of 1 pg TEQ/kg body weight per day could be quite risky for children until 9-10 years and less risky for adults. The seal oil sample also contained high levels of several OCPs, and this in combination with the high level of PCB and PCDD/F makes this product questionable as food supplement. Although the fish oil samples generally showed low levels of contaminants, one of the sample (d) contained relatively high levels of OCPs, especially DDT-related pesticides. This study shows that the levels of contaminating chemical pollutants varies significantly between different omega-3 products, which warrants further studies of these and other toxic pollutants in these health products.

Acknowledgements

The study was financially supported by the CASCADE Project No. 506319

References

1. El-Kady, A., Abdel-Wahhab, M., Henkelmann, B., Belal, M., Morsi, K., Galal, S., Schramm. K.-W. *Chemosphere* 2007; 68: 1660

2. Shen, H., Main, K., Virtanen, H., Damggard, I., Haavisto, A.-M., Kaleva, K., Schmidt, I., Chellakooty, M., Skakkebaek, N., Toppari, J., Schramm, K.-W. *Chemosphere* 2007; 67: 256