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Full Length Research Paper

Determination of mercury and cadmium levels in omega-3 food supplements available on the Ghanaian market

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The numerous reputed health benefits of the omega-3s (eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]), particularly, their cardio-protective effects have led to the manufacture of omega-3 supplements by various pharmaceutical **companies resulting in their flooding of the Ghanaian market. Coldwater fishes which are the primary sources of the omega-3 fatty acids are known to have high levels of mercury and cadmium in them. There is therefore the potential of mercury and cadmium poisoning in the course of people taking the omega-3 food supplements. Mercury and cadmium levels in ten products of omega-3 food supplements have been determined in order to ascertain their safety for human consumption. All the levels of mercury and cadmium determined were within the acceptable limits stipulated by Food and Agriculture Organization and World Health Organization, and therefore do not pose any health threat to consumers.**

Key words: Metals, omega-3, cardio-protective, pharmaceutical.

INTRODUCTION

Omega-3 fatty acids belong to a class of fatty acids that are called essential fatty acids (EFAs). They are so called because the body cannot produce them and thus must be obtained from the diet (Weber et al., 2006). Three major nutritionally important omega-3 fatty acids that are ingested in foods and used by the body are alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) with ALA being the primary omega-3 fatty acid (Weber et al., 1986). EPA and DHA have been receiving a lot of attention because of their cardio-protective and other so called "pleiotropic" effects (Weber et al., 1986).

The primary source of omega-3 has been the oils of cold-water fish, such as tuna, salmon, trout, herring, sardines, bass, swordfish and mackerel, etc., which in turn derive the omega-3s from feeding on the algae, the ultimate biological source (Weber et al., 2006). Studies have revealed that since these coldwater fishes are

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Table 1. Recovery test for metal analysis.

Sample weight	Percentage recovery	
	Mercury	Cadmium
25 ng	88.00	90.00
50 ng	90.00	94.00
100 ng	90.00	92.00
Mean percentage recovery	89.33	92.00

known to have high levels of mercury and cadmium in them, there is the likelihood of mercury and cadmium poisoning in the course of people taking the omega-3s from these sources (Mahaffey, 2004).

There is a strong link between micronutrient uptake by fish and their products, and the impact of contaminations on humans (De Leonardis et al., 2000; Yuzbasi et al., 2003). Mercury and cadmium belong to the class of toxic heavy metals in our environment and have no known biological function in the body (Zhang and Wong, 2007; WHO, 2008).

Humans are most commonly exposed to these metals primarily by eating fish (and fish products) and marine mammals (e.g., whales, seals) that may contain some of these metals in their tissues (International Programme on Chemical Safety [IPCS], 1990; WHO, 2008; Sallsten et al., 1996).

Thus, the benefits of the omega-3 food supplements may be completely reversed if it is found to have high levels of these toxic metals in them (Stillwell and Wassall, 2003; United States Environmental Protection Agency, 2004). Levels of mercury and cadmium in the omega-3 supplements consumed should therefore be of importance and concern. There is lack of data on the levels of mercury and cadmium in omega-3 supplement products imported into Ghana. It is in the light this that this work was done to measure their levels in various omega-3 supplement products available on the Ghanaian market and ensure their safety for human consumption.

MATERIALS AND METHODS

Sampling and sample preparation

A total of 100 samples of omega-3 food supplement soft gels comprising ten different brands were purchased from retail outlets on the Ghanaian Market between November, 2009 and April, 2010. Samples were transported to the laboratory, coded for easy identification and then stored in the fridge until time for analysis.

Digestion procedure for the determination of metals

The omega-3 samples were digested for the total metal determination by an open flask procedure (Akagi and Nishimura, 1991). One soft gel sample was put in a 50 ml volumetric digestion flask. 1 ml distilled water, 2 ml HNO_3:$HClO_4$ (1:1) and 5 ml H_2SO_4 were then added in turn and the mixture was heated within the range of 195 to 205°C for 30 min. The sample solution was then cooled and diluted to 50 ml with double distilled water.

Determination of the metals

Determination of mercury in all the digests was carried out by cold vapor atomic absorption spectrophotometer using an automatic Mercury Analyzer Model HG-5000 (Sanso Seisakusho Co., Ltd, Japan). The procedure is as described by Adimado and Baah (2002).

Determination of cadmium in all the digests was done using SOLAAR (S Series 711239 v1.23) Flame Atomic Absorption Spectrometer.

Recovery of the metals was determined by adding 25, 50 and 100 ng to two different samples of omega-3. The samples were taken through the digestion procedure. The resulting solutions were analyzed for mercury and cadmium concentration using the appropriate methods. Percentage recovery for the spiked solutions was then calculated.

RESULTS AND DISCUSSION

The mean percentage recoveries (Table 1) for mercury and cadmium were 89.33 and 92.00%, respectively signifying the reliability of the method.

The results showing the mean levels of mercury and cadmium in the omega-3 samples are shown in Table 2. The mean daily intakes of the metals are also shown in Table 3. The calculations for the daily metal intakes were based on the recommended daily dosages stated on the products.

Heavy metal content in fish is a good indicator for human exposure to metal bioaccumulation and has been confirmed in many publications (Love et al., 2003; Goyer, 1997; Adimado and Baah, 2002). This means that the consumption of fish products could be a source of human exposure to heavy metals. The main source of the omega-3 oils are the deep sea fishes. The level of heavy metal accumulation in fishes therefore has a direct correlation to the level of heavy metal in the omega-3 product. The mean metal concentrations (µg/g) recorded in this study are comparable to the concentration (µg/g) obtained by Vanaja et al. (2007) and Kotb et al. (1991) who determined the concentrations of trace metals in some brands of fish oil supplements and the levels of some heavy metals in omega-3 fatty acids in popular species of Arabian Gulf fish, respectively (Vanaja et al., 2007; Kotb et al., 1991).

The different levels of the metals in the omega-3 products may be due to the fact that the oils were from different fishes from different sources at perhaps different

Table 2. Average concentration of metals (µg/g) in the omega-3 samples.

Omega-3 samples	Mercury	Cadmium
A	0.017 ± 0.003	0.387 ± 0.062
B	0.093 ± 0.002	0.729 ± 0.014
C	0.021 ± 0.003	0.995 ± 0.047
D	0.273 ± 0.005	1.226 ± 0.110
E	0.123 ± 0.004	0.785 ± 0.103
F	0.658 ± 0.001	0.788 ± 0.014
G	0.018 ± 0.005	0.762 ± 0.030
H	0.027 ± 0.008	0.531 ± 0.025
I	0.428 ± 0.002	0.762 ± 0.035
J	0.029 ± 0.004	0.611 ± 0.063

Table 3. Mean daily intake of metals in the omega-3 samples (µg/g).

Omega-3 sample	Stated daily dosage on product (Capsule)	Mercury	Cadmium
A	2	0.033	0.774
B	1	0.093	0.729
C	1	0.021	0.995
D	3	0.818	3.678
E	6	0.738	4.712
F	1	0.658	0.789
G	3	0.053	2.287
H	1	0.027	0.531
I	1	0.428	0.762
J	1	0.029	0.611

trophic levels (Love et al., 2003), at different factors such as organic matter content, pH, seasonal changes, microbial activities, regional variations and hydrologic conditions as well as the rate of atmospheric deposition (Lindquist, 1991). Different methods of extraction or refining and thermal treatment could also account for the difference in the metal concentrations (Seidler, 1987).

Conclusion

The calculated daily intakes determined for the metals were below the daily intakes recommended by the Joint FAO/WHO expert committee on food supplements and additives showing that the omega-3 food supplements analyzed in this study are not likely to pose any health risk to the public from taking the omega-3 products as far as mercury and cadmium are concerned.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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