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Assessment of Mercury Levels in Omega-3 Food Supplements Available on the Ghanaian Market

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ABSTRACT--- ***As a measure to prevent cardiovascular diseases and enhance in-utero development of the foetus, adequate omega-3 intake has been recommended. This has led to the manufacture of omega-3 supplements by various pharmaceutical companies and these products have flooded the market. Coldwater fishes are the primary sources of the omega-3 food supplements but these fishes are known to have high levels of mercury in them. There is therefore the potential of mercury poisoning in the course of people taking the omega-3 food supplements. Mercury levels in ten products of Omega-3 food supplements have been determined in order to ascertain their safety for human consumption. The mean mercury levels determined for the ten brands were 0.017±0.003 µg/g, 0.093± 0.002 µg/g, 0.021±0.003 µg/g, 0.273±0.005 µg/g, 0.123±0.004 µg/g, 0.0658±0.001 µg/g, 0.018±0.005 µg/g, 0.026±0.008 µg/g, 0.428±0.002 µg/g, 0.428±0.002 µg/g, 0.029±0.004 µg/g. All the levels of mercury 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.***

Keywords--- Mercury, omega-3, cardiovascular, foetus, pharmaceutical.

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1. 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 [1]. 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 Alpha-linolenic acid (ALA) being the primary omega-3 fatty acid. Eicosapentaenoic acid and DHA have been receiving a lot of attention lately because of their cardio-protective and other so called "pleiotropic" effects [2].

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 [1]. These fishes do not actually make the omega-3s themselves, but get them from feeding on the algae, which are the ultimate biological source. Studies have revealed that since these coldwater fishes are known to have high levels of mercury in them, there is the potential of mercury poisoning in the course of people taking the omega-3s from these sources [3]. There is a strong link between micronutrient uptake by fish and their products, and the impact of contaminations on humans [4,5].

Mercury is one of the most toxic heavy metals in our environment [6]. Most of the mercury consumed from seafood sources is in the highly absorbable methylmercury form [7,8]. Some types of fish may contain significantly high levels of methylmercury and other environmental contaminants. The levels of these substances are generally highest in older, larger, predatory fish and marine mammals [7,8].

Humans are most commonly exposed to mercury primarily by eating fish (and fish products) and marine mammals (e.g., whales, seals) that may contain some methylmercury in their tissues or by the release of elemental mercury from the dental amalgam because it may dissolve in saliva and be ingested [7,8,9,10]. Toxic doses of mercury can cause developmental effects in the foetus, as well as on the kidney and the nervous system in children and adults [11,12]. The nervous system is one of the most sensitive targets following an exposure to mercury and may cause cognitive, personality, sensory or motor disturbances. Recent epidemiologic studies have revealed methylmercury exposure has a correlation with coronary heart disorder [7].

Thus, the benefits of the omega-3 food supplements may be completely reversed if it is found to have high levels of mercury [13,14]. For this reason, levels of mercury in omega-3 supplements consumed should be of importance and concern. Data on the levels of omega-3 supplement products imported into Ghana are scarce. The purpose of this study, therefore, is to measure the levels of mercury in various omega-3 supplement products available on the Ghanaian market.

2. MATERIALS AND METHODS

2.1 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 from September to December 2009. Samples were transported to the laboratory, coded and information on dosage, strength, brand name, batch number, manufacturing and expiry dates, and active components were recorded for identification and then stored in the fridge at 4°C until time for analysis.

2.2 Digestion Procedure for the Determination of Mercury

The omega-3 samples were digested for total mercury determination using an open flask procedure [15]. One soft gel sample was put in a 50 mL volumetric digestion flask. 1mL 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 to 200 $\pm$ 5 °C for 30 min. The sample solution was allowed to cool and diluted to 50 mL with double distilled water. A blank solution digests (25, 50 and 100 µL portions of 1 µg/ mL), standard mercury solution were subjected to the same digestion treatment as the sample to yield concentrations of 25, 50 and 100 ng/mL as standard solutions.

2.3 Determination of Mercury

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 elsewhere [16].

3. RESULTS AND DISCUSSION

Two samples were used for the percentage recovery of mercury. The mean percentage recoveries of mercury for samples were 89±0.1 and 87±0.5 respectively (Table 1). These recovery values show that the method used is reproducible.

Table 1. Recovery of samples C and I spiked with mercury

Omega-3 Sample	**Mass (g)**	**Hg added (ng)**	**Hg found (ng/g)**	**Recovered (ng/g)**	**% Recovery**	**Mean % Recovery**
C	1.11	0	21	0	-	89
	1.11	25	43	22	88	
	1.11	50	66	45	90	
I	1.53	0	21	0	-	87
	1.53	25	43	22	88	
	1.53	50	64	43	86	

The detection limit for the various brands ranged from 0.061 – 2.143 µg/g ($p<0.005$). The limit of quantitation for the various brands ranged from 0.183 – 6.429 µg/g ($p<0.005$) (Table 2).

Table 2. Limit of detection of mercury for various samples of omega-3

Omega-3 Sample	L_D (µg/g)	L_Q (µg/g)
A	0.065	0.195
B	0.045	0.135
C	0.084	0.252
D	2.143	6.429
E	0.607	1.821
F	0.065	0.135
G	0.061	0.183
H	0.089	0.267
I	0.084	0.252
J	0.117	0.351

Repeatability studies yielded a relative standard deviation lower than 10% in all cases (Table 3), implying the mercury analyzer was sensitive to the analyte at the operation conditions set.

The mean mercury concentration (µg/g) ranged from 0.017 µg/g for sample A to 0.658 µg/g for sample F (Table 3).

Table 3. Average concentration of mercury (µg/g) in the omega-3 brands

SAMPLE	A	B	C	D	E	F	G	H	I	J
1	0.017	0.096	0.021	0.277	0.112	0.651	0.018	0.029	0.430	0.028
2	0.016	0.097	0.020	0.275	0.133	0.635	0.017	0.027	0.434	0.027
3	0.016	0.092	0.020	0.276	0.123	0.725	0.018	0.027	0.431	0.030
4	0.016	0.092	0.020	0.285	0.128	0.672	0.017	0.023	0.431	0.029
5	0.017	0.091	0.021	0.276	0.119	0.712	0.019	0.027	0.430	0.028
6	0.017	0.093	0.021	0.269	0.121	0.625	0.018	0.024	0.414	0.028
7	0.016	0.091	0.021	0.266	0.124	0.622	0.016	0.028	0.432	0.028
8	0.016	0.094	0.021	0.268	0.119	0.700	0.019	0.029	0.431	0.029
9	0.017	0.091	0.020	0.270	0.121	0.621	0.017	0.027	0.429	0.030
10	0.017	0.093	0.020	0.271	0.128	0.618	0.019	0.025	0.419	0.029
Mean	0.017	0.093	0.021	0.273	0.123	0.658	0.018	0.027	0.428	0.029
SD	0.003	0.002	0.003	0.005	0.004	0.001	0.005	0.008	0.002	0.004

Mercury levels for the various brands ranged from 0.016 to 0.725 µg/g. The mean mercury levels for the various brands ranged from 0.017±0.003 to 0.658±0.001 µg/g (Table 3).

The differences in the concentration of mercury in the omega-3 products may be due to the fact that the oils were from different fishes from different sources at perhaps different trophic levels as found by Love *et al.* [17]. Formulation factors may also be different for each product hence the variations in mercury levels. The low levels of mercury obtained in this study may also be due to the absence of favourable pH, temperature, microbial activities, and organic matter that affect the accumulation of mercury. Seidler [18] found that factors such as cooking, frying, and refining processes could decrease levels of metals in fish oils to as much as 15% depending on the thermal treatment. Hence the low levels of the mercury may be due to inherent low level of mercury in the fish or could be attributed to the extraction and refining methods used. The results obtained corroborate what Bolger and Schwetz indicated in their research findings, that there are many species of fish that are rich sources of omega-3 fatty acids that are low in methylmercury [19,20].

Table 4. Daily and monthly mean consumption of mercury in samples (µg/g).

OMEGA-3 SAMPLE	RECOMMENDED NUMBER OF CAPSULES PER DAY.	MEAN DAILY CONSUMPTION (µg/g)	MEAN MONTHLY CONSUMPTION (µg/g)
A	2	0.033	0.99
B	1	0.093	2.79
C	1	0.021	0.63
D	3	0.818	24.54
E	6	0.738	22.14
F	1	0.658	19.74
G	3	0.053	1.59
H	1	0.027	0.81
I	1	0.428	12.84
J	1	0.029	0.87

RDI / Day of Mercury =16/µg/Day

*The calculations for the mean daily and monthly intake were calculated based on the manufacturer's recommended dose and were compared with the FAO/WHO recommended daily and monthly intake.

The determined daily intakes for mercury which ranged from 0.021 µg/g for sample C to 0.818 µg/g for sample D (Table 4) were below the recommended daily intake of 16 µg/70kg body weight set by the Joint FAO/WHO expert committee on food supplements for mercury [21]. The consumption of the omega-3 products thus poses no health risk as far as level of mercury is concerned. This results confirms the assertion by the United States Food and Drug Administration that fish oil supplements are generally safe [22].

4. CONCLUSION

All the ten products of omega-3 food supplement had some mercury present in them. However, the mercury levels were very low and the calculated daily intake for mercury was far less than the recommended daily intake. Hence all the ten products of omega-3 food supplements studied are safe for use and do not pose any threat of mercury poisoning.

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