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Article

Quantitation of EPA and DHA in Fish Oil Dietary Supplements Sold in the United States

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Abstract: The dietary supplement industry is a growing market with a variety of suppliers, producers, and distributors in terms of size and quality. Because of the little amount of regulation placed on the dietary supplement industry compared to the pharmaceutical industry in the United States, there is less pressure on supplement companies ensure that their labels accurately reflect the actual product's content. There are few studies on the quality of fish oil sold in the U.S., particularly about quantitation of ω -3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The aim of this study was to compare the amount of ω -3 fatty acids found in fish oil capsules and liquids bought from local stores to their label claim. Of the 16 fish oil products tested, 6 were $\pm$ 20% outside of the label claim for EPA and 10 of 15 were $\pm$ 20% outside of the label claim for DHA. One product did not have a label claim for DHA. The large variance in the amount of omega-3s from the product label could mislead consumers to ingesting significantly more or less than expected.

Keywords: Fish oil; EPA; DHA; Label Claim; of ω -3 fatty acid

1. Introduction

Both omega-3 and omega-6 fatty acids are important essential polyunsaturated fatty acids. The Food and Nutrition Board of the U.S. Institute of Medicine has suggested that the adequate intake of omega-3 fatty acids is 1.6 g/day for adult males and 1.1 g/day for adult females, while the suggested intake of omega-6 fatty acids is 17 g/day for adult males and 12 g/day for adult females [1]. These dietary suggestions amount to a ratio of omega-6/omega-3 of around 11. However, current Western diets have omega-6/omega-3 ratios of 15 or higher, which are much higher than the estimated paleolithic diet of 1:1 [2,3]. High omega-6/omega-3 ratios have been associated with obesity, inflammatory diseases, cardiovascular disease, cancer, and other chronic diseases [4,5]. Thus, dietary supplementation with omega-3 fatty acids, such as fish oil supplements, has been recommended to help rectify the omega-6/omega-3 ratio and prevent these chronic diseases [6,7].

With heart disease being a leading cause of death among most groups of people in the United States [8], physicians and researchers are searching for effective methods to prevent or treat heart disease. Researchers in the 1970s discovered that populations that ate a fish-heavy diet, such as the Greenland Inuit and Japanese, had significantly lower rates of cardiovascular disease [9]. Further research has shown that omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), appear to have a beneficial effect on heart health [10]. The FDA has recently approved two prescription medicines that contain either high-purity EPA-based compounds (icosapent ethyl, Vascepa) or both high-purity EPA and DHA-based Lovaza) [11]. However, the cost

of these medications can be more expensive than popular omega-3-based nutraceutical products, such as fish oil capsules [12].

One of the major claims used by fish oil products is that they benefit cardiovascular health and symptoms of osteoarthritis. Researchers have found that taking omega-3 fatty acids can help to reduce high blood pressure [13], reduce high cholesterol [14], and reduce the risk of heart failure in some demographics [15]. In addition to cardiovascular health, some evidence points to the effectiveness of omega-3 fatty acids in reducing pain and inflammation of osteoarthritic joints [16]. The dose of omega-3s varies widely between studies and can be anywhere from 400 mg/day to 5500 mg/day [17].

It is important to note that there is little standardization within the fish oil industry. There are several types of fish oil supplements based on their source including fish, krill, and algae [18], and the quantity of the various compounds varies between species [19]. Common fish used to make fish oil include species from the Engraulidae (anchovy), Scombridae (mackerel), Gadidae (cod), and Salmonidae (Salmon) families [20]. Fish oils can also be sold in varying degrees of refinement, from raw to concentrated [21]. The variation between sources, quality, and refinement of fish oil products may be the reason for some contradictory findings between studies [22].

2. Materials and Methods

Sample Preparation

Fish oil samples from capsules were taken by piercing several capsules and adding the liquid into a vial to form a representative sample. Samples (180 mg) from each fish oil product were carefully measured into a 20 × 150-mm culture tube. Six mL of 0.5 N sodium hydroxide in methanol solution was added to each sample and then each was briefly agitated. The culture tubes were then placed in a 70 °C water bath and agitated 5 times over 20 minutes. The samples were removed from the water bath once the oil droplets were no longer visible. Six mL of 10% (1.3 M) boron trifluoride-methanol solution was added to each sample and briefly agitated. The samples were placed back into the water bath for an additional 20 minutes and then removed. A saturated solution of aqueous sodium chloride (32 mL) was added to each sample. The top oil layer was drawn off with a disposable glass Pasteur pipette and added to a 2-mL vial. These vials were stored in a -20 °C freezer until they were removed briefly for analysis.

GC-MS analysis of fish oil

The fish oil components were identified using GC-MS and quantified by GC-FID analysis as described previously [23]. The instrument was a Shimadzu GCMS-QP2010 Ultra, the scans were performed in the 40-400 m/z range at a rate of 3.0 scan/s, the GC column was a ZB-5ms GC column (60 m length, 0.25 mm diameter, 0.25 µm film thickness). The carrier gas was helium with an inlet pressure of 208.5 kPa, a column flow rate of 2.00 mL/min, and a split ratio of 24.4. The column temperature was initialized at 50.0°C and increased at a rate of 3°C/min until it reached 340°C, holding the final temperature for 5 min. Compounds were identified by comparing their mass spectra with those of our in-house library [24] and using known standards for EPA methyl ester and DHA methyl ester.

GC-FID analysis of fish oil

The GC-FID used to analyze samples was a Shimadzu Nexis GC-2030 with a flame ionization detector equipped with a Shimadzu AOC-20i Plus autosampler. The column was the same as described for GC-MS analysis. The carrier gas was helium with an injection port pressure of 296.3 kPa, a column flow of 3.08 mL/min, and a split ratio of 24.4. The column temperature was set to the same parameters as described for GC-MS analysis but with a final column temperature of 345°C. The detector was set to 350°C and had a sampling rate of 40 ms.

Omega-3 quantitation

A calibration curve was created for the GC-FID using methyl all-(Z)-5,8,11,14,17-eicosapentaenoate (EPA methyl ester) from Supelco and (Z)-4,7,10,13,16,19-docosahexaenoic acid methyl ester (DHA methyl ester) from Sigma-Aldrich. Dilutions of the EPA methyl ester (12500,

29000, 35000, and 75500 ppm) were prepared 12500, 29000, 35000, and 75500 ppm in dichloromethane (DCM). The DHA methyl ester was diluted to 1700, 3600, 7600, and 32000 ppm in DCM.

A portion of each sample was removed using an Eppendorf single-channel pipette and added to a conical glass insert inside a 2-mL GC-MS vial. The dilutions were calculated to have the concentrations of EPA and DHA methyl esters fall within the range of the calibration curve.

3. Results and Discussion

The fatty acid analyses of 16 commercial fish oil supplements are summarized in Table 1. It is obvious from Table 1 that there is much variation in the compositions of the various fish oil supplements. For example, the total saturated fatty acids ranged from 0.4% (sample 14) to 29.1% (sample 13). Importantly, the omega-3 fatty acid concentration was greatest in sample 14 (83.4%) and lowest in samples 2 and 10 (31.6% and 32.4%, respectively). Furthermore, there is wide variation in the omega-6/omega-3 ratios in these fish oil samples, from a low of 0.03 (samples 1 and 14) to a high of 0.40 (sample 4). In order to maximize the health benefits of fish oil supplementation, it is important for consumers to use those oils with the highest concentrations of omega-3 fatty acids as well as the lowest omega-6/omega-3 ratio. There are also some non-fatty acids present in some of the samples. The presence of contaminants in fish oil samples such as fatty aldehydes (e.g., samples 3, 6, and 16) and methyl α -terpinyl ether (sample 1) likely indicates oxidation or degradation of the fish oil [25].

The masses of 5,8,11,14,17-eicosapentaenoic acid (EPA) and 4,7,10,13,16,19-docosahexaenoic acid (DHA) in the fish oil supplements were calculated based on the concentrations of each found in the oils and are summarized in Table 2. The equations used to calculate the masses of EPA and DHA were $(DF \cdot ppm \text{ FA}_{FID}) / [(1 \cdot 10)^6] = (mg \text{ FA}) / [(mg \text{ FO})_{\text{der}}]$ and $(mg \text{ FA}) / [(mg \text{ FO})_{\text{der}}] \cdot [(mg \text{ FO})_{\text{lbl}} / \text{SVG}] = (mg \text{ FA}) / \text{SVG}$, where DF is the dilution factor of the derivatized sample into DCM, FAFID is the detected concentration of the ω -3 fatty acid, FODer is the weight of derivatized fish oil diluted into DCM, FOlbl/SVG is the weight of fish oil per serving listed on the label, and mg FA/SVG is the detected weight of ω -3 fatty acid per serving. From Table 2, there are often large disparities (less than or greater than 20%) between the EPA and DHA levels reported on the labels of the fish oil supplements and the levels determined in this present study. While several showed higher levels of EPA and DHA than their labels stated, some were lower (e.g., samples 2, 10, and 13). This indicates a lack of quality control in processing these fish oil supplements.

Table 1. Fatty acid concentrations (percentages) in commercial fish oil supplements.

Component	RI	Supplement Number															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C20:1 n-9 (gondoic)	2296	21.94	1.90	1.23	1.56	0.61	1.10	1.13	1.34	2.38	0.80	2.57	2.52	1.00	0.47	2.99	0.73
C18:1 n-9 (oleic)	2103	1.97	14.12	10.32	8.50	4.36	11.84	14.07	8.61	1.92	13.01	3.99	7.19	10.79	0.62	13.57	8.21
C22:6 n-3 (docosahexaenoic or DHA)	2359	30.65	1.61	12.72	6.86	20.19	13.07	14.40	14.93	33.07	12.81	26.23	24.97	12.12	53.06	14.07	13.47
C20:5 n-3 (eicosapentaenoic or EPA)	2263	10.91	20.88	18.44	8.89	53.07	17.49	19.73	21.65	41.06	17.31	34.10	34.69	17.97	25.68	19.89	20.74
C22:1 n-9 (erucic)	2499	16.29	1.23	0.74	0.36	0.13	0.36	3.84	0.60	0.38	0.51	4.15	0.97	0.36	0.44	4.09	0.35
C18:3 n-6 (γ -linolenic)	2077	0.40	0.29	2.86	4.60	4.77	0.27	0.42	0.33	0.36	2.02	1.14	0.13	0.27	0.04	0.26	0.37
C18:2 n-6 (linoleic)	2091	0.32	1.16	1.84	15.00	1.12	1.51	2.44	1.47	0.32	3.16	0.66	1.08	1.30	0.29	2.24	1.43
C20:4 n-3 (omega-3 arachidonic)	2276	1.06	0.68	1.03	0.36	2.10	1.10	1.01	1.19	2.27	0.82	2.11	2.06	0.98	1.86	1.29	1.00
C16:0 (palmitic)	1958	0.79	17.90	16.31	7.46	0.40	16.71	10.50	14.57	0.14	16.52	0.73	1.24	17.13	0.09	9.48	15.89
C18:0 (stearic)	2126	0.75	2.28	3.46	3.42	0.70	3.31	3.60	3.35	1.92	3.73	2.16	3.17	3.73	0.16	2.83	3.34

Component	RI	Supplement Number															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C18:1 n-9 (elaidic)	2109	0.7 0	5.3 0	3.1 5	1.0 7	1.2 3	3.2 2	5.1 9	2.8 8	0.7 9	2.8 0	1.49	2.36	3.35	0.18	4.70	3.0 7
C21:0 (behenic)	2522	0.1 2	n.d. .	0.1 7	0.2 2	0.1 0	0.1 5	0.1 7	0.1 7	0.2 0	0.1 7	0.21	0.31	0.15	0.09	0.13	0.1 9
C20:2 n-6 (eicosadienoic)	2295	0.5 9	n.d. .	0.1 9	0.1 4	0.1 9	0.3 0	0.1 8	0.2 5	0.5 9	0.1 7	0.27	0.42	0.17	0.28	0.19	0.2 1
C14:0 (myristic)	1758	0.2 7	1.9 0	6.1 8	0.6 8	n.d. .	6.1 5	0.7 2	5.4 2	0.1 4	5.8 3	0.08	0.11	6.50	0.03	1.13	6.7 9
C16:1 n-7 (palmitoleic)	1901	0.3 8	9.8 8	7.8 9	1.1 5	n.d. .	8.4 9	4.2 9	6.4 9	0.0 5	6.3 2	0.31	0.56	7.78	0.08	5.40	8.5 9
C20:1 n-7 (paullinic)	2300	1.2 7	0.5 6	0.4 1	0.1 5	0.3 0	0.4 3	1.8 7	0.5 0	0.1 4	0.3 5	3.47	1.00	0.38	n.d.	2.33	0.4 7
C24:1 n-9 (nervonic)	2699	0.6 0	n.d. .	0.4 7	0.5 8	n.d. .	0.3 5	0.6 1	0.3 8	0.1 6	0.4 4	0.67	0.65	0.44	0.08	0.58	0.4 1
C18:1 n-6 ((E)-13-octadecanoic)	2114	0.1 1	0.5 4	0.1 6	0.0 5	0.1 4	0.1 2	0.3 9	0.1 1	0.0 4	0.1 2	0.12	0.09	0.13	n.d.	0.55	0.1 6
C20:4 n-6 (arachidonic)	2320	n.d. .	n.d. .	n.d. .	0.3 5	2.4 3	0.7 3	1.9 3	1.1 1	1.8 3	0.7 8	2.05	1.63	0.96	1.53	1.2	0.8 3
C22:5 n-3 (7,10,13,16,19-docosapentaenoic)	2369	n.d. .	n.d. .	n.d. .	0.5 5	1.9 7	0.7 3	0.7 6	1.0 0	2.1 1	0.6 7	1.63	2.00	0.77	2.36	0.71	0.9 2
C19:0 (nonadecylic)	2222	0.1 0	n.d. .	0.1 4	0.0 7	0.1 3	0.0 9	0.1 0	0.1 5	0.2 8	0.1 3	0.17	0.17	0.11	n.d.	0.07	0.1 8
C20:0 (arachidic)	2322	0.2 9	n.d. .	0.3 9	0.2 8	n.d. .	0.2 5	0.3 0	0.3 5	0.9 5	0.3 8	0.90	0.72	0.24	n.d.	0.27	0.3 0
C17:0 (margaric)	2026	n.d. .	0.1 7	0.4 4	0.1 3	0.1 2	0.3 9	0.4 5	0.4 2	n.d. .	0.5 2	0.07	0.13	0.47	n.d.	0.34	0.4 4
C18:3 n-3 (α-linolenic or ALA)	2096	n.d. .	n.d. .	0.3 6	33. 56	0.5 7	0.3 1	0.6 7	0.4 1	n.d. .	0.2 8	0.10	n.d.	0.34	0.07	0.19	0.6 0
C16:2 n-4 (9,12-hexadecadienoic)	1906	n.d. .	0.8 8	1.0 4	0.1 6	n.d. .	1.0 4	0.6 4	1.0 6	n.d. .	1.1 2	0.05	0.09	1.21	n.d.	1.19	1.1 7
C24:0 (lignoceric)	2722	0.0 9	n.d. .	0.1 3	0.1 3	n.d. .	0.0 7	0.0 5	0.0 9	n.d. .	0.1 1	0.07	0.08	0.1	n.d.	0.05	0.1 3
C17:1 n-7 ((Z)-10-heptadecenoic)	2001	n.d. .	0.2 0	0.2 2	0.0 9	0.1 1	0.1 6	0.1 8	0.1 8	n.d. .	0.2 0	n.d.	n.d.	0.16	n.d.	0.20	0.3 0
C15:0 (pentadecanoic)	1962	0.0 8	0.3 5	0.5 4	0.1 0	n.d. .	0.4 2	0.1 4	0.4 4	n.d. .	0.5 9	n.d.	n.d.	0.50	n.d.	0.16	0.5 1
C16:2 n-4 ((E)-hexadecadienal)	1891	n.d. .	n.d. .	1.4 8	0.2 1	0.2 7	1.5 3	0.5 4	1.3 7	n.d. .	1.0 9	n.d.	0.10	0.08	n.d.	0.68	1.7 6
C23:0 (tricosanoic)	2622	n.d. .	n.d. .	0.0 7	0.0 7	n.d. .	0.0 5	0.0 4	0.0 6	0.0 4	0.0 5	0.06	0.05	n.d.	n.d.	0.03	0.1 2
C16:1 n-9 ((Z)-7-hexadecenoic)	1896	n.d. .	0.2 4	0.2 2	0.0 8	0.4 8	0.2 4	n.d. .	0.0 8	n.d. .	0.2 6	n.d.	n.d.	0.22	n.d.	0.16	0.2 7
C21:0 (heneicosylic)	2422	n.d. .	n.d. .	n.d. .	0.0 6	n.d. .	0.0 6	0.0 7	0.0 8	0.1 5	0.0 9	0.07	0.13	n.d.	n.d.	0.06	0.1 1
C22:4 n-6 ((Z)-7,10,13,16-docosatetraenoic)	2452	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	0.3 1	n.d. .	4.1 3	0.1 9	0.47	0.44	0.21	n.d.	0.25	0.2 7
methyl α-terpinyl ether	1219	1.7 3	n.d. .	n.d. .	0.0 8	n.d. .	n.d. .	n.d. .	n.d. .	0.1 2	0.1 5	0.12	n.d.	0.21	n.d.	n.d.	0.4 4
C19:4 n-3 (stearidonate)	2077	n.d. .	8.1 1	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	n.d. .	n.d.	n.d.	1.52	2.59	0.33	3.0 1
C19:1 n-9 ((E)-10-nonadecenoic)	2200	0.1 .	n.d. .	0.1 2	n.d. .	0.2 2	n.d. .	n.d. .	n.d. .	0.2 0	0.0 4	0.05	0.17	n.d.	n.d.	n.d.	n.d. .
C12:0 (lauric)	1523	n.d. .	n.d. .	0.1 0	n.d. .	n.d. .	0.1 .	n.d. .	0.0 8	n.d. .	0.0 7	n.d.	n.d.	0.07	n.d.	n.d.	0.1 6

Component	RI	Supplement Number															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C22:5 n-3 (7,10,13,16,19-docosapentaenoic)	2450	n.d	n.d	n.d	n.d	n.d	n.d	0.6	n.d	0.8	0.4	0.87	0.85	n.d.	n.d.	n.d.	n.d
		.	.	.	.	.	.	.	.	9	9	.	.	.	.	.	.
C20:0 (eicosanoic)	2360	n.d	n.d	0.1	n.d	n.d	n.d	0.1	0.1	n.d	n.d	n.d.	n.d.	n.d.	n.d.	0.19	0.2
		.	.	8	.	.	.	9	5	.	.	.	.	.	.	2	.
C10:0 (capric)	1323	n.d	n.d	n.d	n.d	n.d	n.d	0.1	n.d	n.d	n.d	n.d.	n.d.	0.05	0.03	n.d.	n.d
		.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
C19:1 n-9 ((Z)-10-nonadecenoic)	2193	n.d	n.d	n.d	0.0	0.1	n.d	n.d	n.d	0.0	n.d	n.d.	0.07	n.d.	n.d.	n.d.	n.d
		.	.	.	6	2	.	.	.	7	.	.	.	.	.	.	.
C21:5 n-3 (heneicosapentaenoic)	2359	0.9	0.3	0.8	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		9	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.
C14:0 (12-methyltridecanoic)	1620	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	0.0	n.d	n.d.	0.04	n.d.	n.d.	n.d
		.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.
C12:0 (1,1-dimethoxydecane)	1375	0.0	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C22:2 n-9 (5,13-docosadienoic)	2475	0.1	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C21:4 n-6 (arachidonic)	2244	n.d	n.d	0.9	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	9	.	.	.	.	.	.	.	.	.	.	.	.	.
C8:0 (caprylic)	1124	n.d	n.d	n.d	n.d	n.d	n.d	0.0	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	.	.	.	9	.	.	.	.	.	.	.	.	.
C16:3 n-3 ((Z)-hexadecatrienal)	1886	n.d	n.d	n.d	n.d	0.1	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	.	9	.	.	.	.	.	.	.	.	.	.	.
C20:2 n-6 (ethyl linoleate)	2183	n.d	n.d	n.d	0.0	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
C18:0 (ethyl palmitate)	1992	n.d	0.0	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.
C26:0 (cerotic)	2930	n.d	n.d	n.d	0.0	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.
C16:0 (palmitic)	1961	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	0.1	n.d	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	.	.	.	.	.	.	0	.	.	.	.	.	.
C25:0 (pentacosanoic)	2830	n.d	n.d	n.d	0.0	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d
		.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
C17:2 n-5 (9,12-heptadecadienoic)	1990	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	0.5
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
EPA+DHA		41.	22.	31.	15.	73.	30.	34.	36.	74.	30.	60.3	59.6	30.09	78.74	33.9	34.
		56	49	16	75	26	56	13	58	13	12	3	6	.	.	6	21
Σn-3		43.	31.	33.	50.	78.	32.	37.	39.	79.	32.	65.0	66.0	34.77	83.36	39.8	39.
		61	62	39	22	09	70	17	18	4	38	4	9	.	.	6	74
Σn-6		1.4	1.9	6.0	20.	8.6	2.9	5.6	3.2	7.2	6.4	4.71	3.79	3.04	2.14	4.69	3.2
		2	9	4	21	5	3	7	7	7	4	.	.	.	.	.	7
Σn-6/Σn-3		0.0	0.0	0.1	0.4	0.1	0.0	0.1	0.0	0.0	0.2	0.07	0.06	0.09	0.03	0.12	0.0
		3	6	8	0	1	9	5	8	9	0	.	.	.	.	.	8
Σ saturated fatty acids		2.5	22.	28.	12.	1.4	27.	16.	25.	3.8	28.	4.52	6.11	29.05	0.40	14.7	28.
		7	66	11	73	5	75	53	33	2	29	.	.	.	.	4	38
Σ monounsaturated fatty acids		43.	33.	24.	13.	7.7	26.	31.	21.	6.1	24.	16.8	15.5	24.61	1.87	34.5	22.
		36	97	93	65	0	31	57	17	3	85	2	8	.	.	0	56
Σ polyunsaturated fatty acids		45.	33.	41.	70.	86.	38.	43.	44.	86.	40.	69.6	69.9	39.01	85.50	45.8	46.
		08	95	79	75	87	08	63	77	63	95	8	8	.	.	7	29

n.d. = not detected.

Table 2. Comparisons of the experimentally determined masses of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) with the masses listed on the labels of the supplements.

Supplement Number	mg EPA/Serving (label)	mg EPA/Serving (by GC-FID)	mg DHA/Serving (label)	mg DHA/Serving (by GC-FID)	EPA Matching Label Claim (±20%)	DHA Matching Label Claim (±20%)
1	200	175	600	615	Yes	Yes
2	720	343	N/A*	21	No (↓)	N/A*
3	180	160	120	136	Yes	Yes
4	330	293	225	296	Yes	No (↑)
5	680	835	250	288	No (↑)	Yes
6	130	172	70	161	No (↑)	No (↑)
7	180	161	120	144	Yes	Yes
8	216	257	144	216	Yes	No (↑)
9	800	893	600	822	Yes	No (↑)
10	709	206	443	175	No (↓)	No (↓)
11	700	767	500	677	Yes	No (↑)
12	432	442	288	362	Yes	No (↑)
13	360	109	240	72	No (↓)	No (↓)
14	250	189	500	476	No (↓)	Yes
15	360	376	240	332	Yes	No (↑)
16	800	935	500	752	Yes	No (↑)

*Product label did not provide the mass of DHA per serving.

4. Conclusions

A total of 16 fish oil supplements, obtained commercially, were analyzed by gas chromatographic methods. The fatty acid components showed wide variation between the different supplements as well as notable discrepancies between the contents on the labels and those determined experimentally. Awareness of the fatty acid composition in addition to accurate EPA, DHA, and total omega-3 fatty acid concentrations is important for discriminating consumers to make informed choices in their fish oil supplements.

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