

Supplementary Table 1. 63 Significant statistic metabolites of fish oil (raw/encapsulated). Raw fish oil (Raw FO, n = 3), 2% encapsulated fish oil (EncapFO 2%, n = 3), 4% encapsulated fish oil (EncapFO 4%, n = 3), 6% encapsulated fish oil (EncapFO 6%, n = 3). The statistical significance was using unpaired Tukey's HSD. *(p<0.05), ** (0.001<p<0.005), ***(p<0.001).

NO	Compounds	f-value	p-value	Significant	Tukey's HSD
1	Gluconic acid	2,408.5	3.68E-12	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
2	1,5-Anhydro-D-fructose	2,407.9	3.68E-12	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
3	L-alpha-Glycerylphosphorylcholine	2,364.7	3.96E-12	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
4	(14R,20S)-17,20,21-Trihydroxy-2-methyl-17-oxido-11-oxo-12,16,18-trioxalambda~5~-phosphahenicosan-14-yl 16-methylheptadecanoate	2,055.3	6.93E-12	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
5	4- {[4-(Dimethylamino)phenyl][4-(dimethyliminio)-2,5-cyclohexadien-1-ylidene]methyl}-3-hydroxy-7-sulfo-2-naphthalenesulfonate	1,669.7	1.59E-11	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
6	D-(-)-Erythrose	1,502.9	2.42E-11	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
7	PEG n8	1,421.6	3.02E-11	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw

NO	Compounds	f-value	p-value	Significant	Tukey's HSD
					FO-EncapFO 4%; Raw FO-EncapFO 6%
8	(1R,4aS,7S,7aR)-1-Hydroxy-7-methyl-1,4a,5,6,7,7a-hexahydrocyclopenta[c]pyran-4-carbaldehyde	1,376.8	3.43E-11	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
9	scyllo-Inosamine	1,349.7	3.72E-11	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
10	ascopyrone M	1,273.3	4.69E-11	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
11	PEG n7	906.97	1.82E-10	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
12	PEG n6	896.92	1.90E-10	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
13	[8-Formyl-5-methoxy-2-methyl-2-(4-methyl-2-oxo-3-penten-1-yl)-3,4-dihydro-2H-chromen-7-yl]methyl (9E,12E)-9,12-octadecadienoate	890.3	1.95E-10	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
14	O-{Hydroxy[(2R)-2-(pentadecanoyloxy)-3-	791.54	3.12E-10	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO

NO	Compounds	f-value	p-value	Significant	Tukey's HSD
	(tetradecanoyloxy)propoxy]phosphoryl}- L-serine				2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
15	Acetophenone	637.36	7.40E-10	***	EncapFO 4%-EncapFO 2%; EncapFO 6%- EncapFO 2%; Raw FO- EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
16	(8E)-8-Dotriacontenoic acid	627.14	7.90E-10	***	EncapFO 4%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%- EncapFO 4%; Raw FO- EncapFO 4%; Raw FO- EncapFO 6%
17	PEG n5	563.11	1.21E-09	***	EncapFO 4%-EncapFO 2%; EncapFO 6%- EncapFO 2%; Raw FO- EncapFO 2%; Raw FO- EncapFO 4%; Raw FO- EncapFO 6%
18	Pyrogallol	400.8	4.68E-09	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
19	(1S,4S)-4-Hydroxy-3- oxocyclohexanecarboxylic acid	356.65	7.44E-09	***	EncapFO 4%-EncapFO 2%; EncapFO 6%- EncapFO 2%; Raw FO- EncapFO 2%; Raw FO- EncapFO 4%; Raw FO- EncapFO 6%
20	PEG-4	308.08	1.33E-08	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%- EncapFO 4%; Raw FO- EncapFO 4%; Raw FO- EncapFO 6%

NO	Compounds	f-value	p-value	Significant	Tukey's HSD
21	Ricinoleic Acid	276.97	2.03E-08	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
22	Istamycin C1	164.27	1.59E-07	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
23	2,2'-Methylenebis(4-methyl-6-tert-butylphenol)	123.87	4.81E-07	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; Raw FO-EncapFO 4%
24	Dibenzylamine	109.07	7.91E-07	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%
25	1-myristoyl-2-oleoyl-sn-glycerol	104.09	9.48E-07	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%
26	6alpha-hydroxy-castasterone	85.95	1.99E-06	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
27	N,N-Diisopropylethylamine (DIPEA)	54.693	1.13E-05	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%

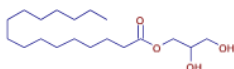
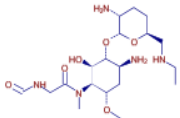
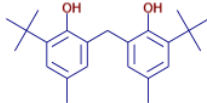
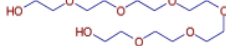
NO	Compounds	f-value	p-value	Significant	Tukey's HSD
28	DG(18:1(11Z)/18:1(9Z)/0:0)	47.435	1.93E-05	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
29	L-a-PALMITIN	38.762	4.11E-05	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
30	(2S)-2,3-Dihydroxypropyl (13Z,16Z)-13,16-docosadienoate	33.337	7.18E-05	***	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%
31	DG(18:2(9Z,12Z)/16:0/0:0)	28.902	0.000121	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%
32	1-Stearoylglycerol	26.271	0.0001708	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
33	D-a-Tocopherol	21.517	0.0003474	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
34	1,3-Dihydroxy-2-propanyl (11Z,14Z)-11,14-icosadienoate	19.962	0.0004516	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
35	3-[(15Z,19Z)-11,12-Dihydroxy-15,19-dotriacontadien-1-yl]-5-methyl-2(5H)-furanone	19.105	0.000526	***	EncapFO 4%-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%
36	C14-Carnitine	18.966	0.0005395	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
37	C18:1-Dihydroceramide	18.243	0.0006169	***	Raw FO-EncapFO 2%; EncapFO 6%-EncapFO

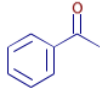
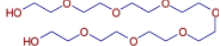
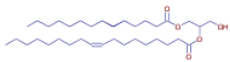
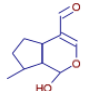
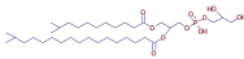
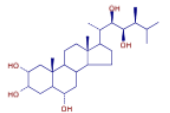
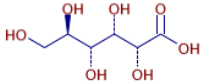
NO	Compounds	f-value	p-value	Significant	Tukey's HSD
					4%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
38	(2S)-3-Hydroxy-2-(octanoyloxy)propyl decanoate	18.179	0.0006243	***	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
39	(1Z)-2-Hydroxy-N-[(2S,3S,4R)-1,3,4-trihydroxy-2-octadecanyl]tridecanimidic acid	16.239	0.0009174	***	Raw FO-EncapFO 2%; EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%
40	DG(14:0/18:3(9Z,12Z,15Z)/0:0)	13.319	0.0017738	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
41	(2Z)-2-(2-Hydroxybenzylidene)octanal	12.674	0.0020848	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
42	4'-Hydroxy-3'-prenylacetophenone	12.031	0.0024653	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
43	(E,E)-alpha-Farnesene	11.64	0.0027399	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
44	(3beta,4alpha,5alpha)-3-Hydroxyergosta-7,24(28)-diene-4-carbaldehyde	11.304	0.0030061	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
45	2-[(5Z)-5-tetradecenyl]cyclobutanone	11.212	0.0030848	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
46	Ethyl (2E,4E,6E,8E,10E,12E,14Z,16E)-2,6,11,15-tetramethyl-17-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2,4,6,8,10,12,14,16-heptadecaenoate	10.788	0.003483	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
47	(2Z)-2-(3-Hydroxybenzylidene)heptanal	10.69	0.0035832	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
48	Galaxolidone	9.6755	0.0048765	**	EncapFO 6%-EncapFO 2%; Raw FO-EncapFO 2%
49	(1Z)-2-Hydroxy-N-[(2S,3S,4R)-1,3,4-trihydroxy-2-octadecanyl]undecanimidic acid	9.0445	0.0059813	**	EncapFO 6%-EncapFO 4%; Raw FO-EncapFO 4%

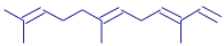
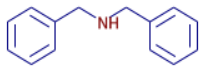
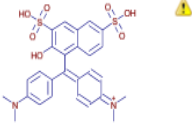
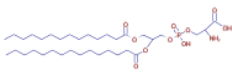
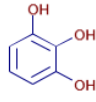
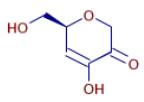
NO	Compounds	f-value	p-value	Significant	Tukey's HSD
50	4-Phenylbutyric acid	8.9359	0.0062018	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%
51	2-(14,15-Epoxyeicosatrienoyl) glycerol	8.0928	0.0083116	**	Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
52	Ethyl palmitoleate	7.7194	0.0095301	**	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
53	Estrane	7.5125	0.010302	*	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
54	(2,4,4-Trimethyl-2-pentanyl)benzene	7.4657	0.010487	*	Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
55	Tretinoin	7.2231	0.011516	*	Raw FO-EncapFO 4%
56	(4E)-1-(4-Hydroxyphenyl)-4-decen-3-one	7.1668	0.011773	*	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
57	4-Isobutylbenzoic acid	6.687	0.014277	*	Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
58	(3beta,9xi,10xi)-3-Hydroxy-24-methylene-9,19-cyclolanostan-28-al	6.5215	0.015293	*	Raw FO-EncapFO 4%
59	Orthosporin	6.5181	0.015315	*	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%
60	6-(2-Hydroxy-16,19-dimethylhexacosyl)-4-methyltetrahydro-2H-pyran-2-one	6.1532	0.017897	*	Raw FO-EncapFO 4%
61	4'-Methoxyacetophenone	5.9783	0.019326	*	Raw FO-EncapFO 2%; Raw FO-EncapFO 4%; Raw FO-EncapFO 6%
62	campest-4-en-3-one	5.9602	0.019482	*	Raw FO-EncapFO 4%
63	N-[(2S)-2-Hydroxypropanoyl]-L-tyrosine	5.0904	0.029243	*	Raw FO-EncapFO 4%

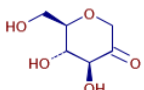
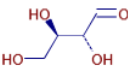
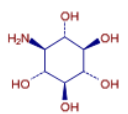
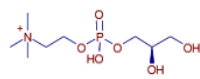
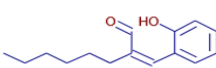
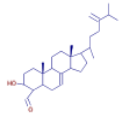
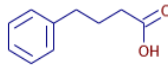
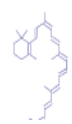
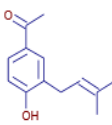
Supplementary Table 2. 35 Valued Importance Performance (VIP) metabolites of fish oil (raw/encapsulated).

Molecular weight, retention time, and formula discovered by HPLC-HRMS (Thermo Scientific Xcalibur 4.5.474.0 software by Thermo Fisher Scientific, Inc. USA) software; VIP compounds analyzed by MetaboAnalyst 6.0 software; and formula, structure, and ionization analyzed by compound discoverer 3.2 software.

No	VIP Compounds	Formula	Molecular Weight	RT (min)	Ionization	Classifications	Structure
1	(1S,4S)-4-Hydroxy-3-oxocyclohexanecarboxylic acid	C7 H10 O4	158.05813	8.86	+	Carboxylic acid derivatives	
2	Ricinoleic Acid	C18 H34 O3	298.25133	17.42	+	Lipids and their derivatives	
3	(2S)-2,3-Dihydroxypropyl (13Z,16Z)-13,16-docosadienoate	C25 H46 O4	410.3395	19.32	+	Lipids and their derivatives	
4	L-α-PALMITIN	C19 H38 O4	330.27694	17.94	+	Lipids and their derivatives	
5	Istamycin C1	C19 H37 N5 O6	431.27354	8.633	+	Formamides (amides derived from formic acid)	
6	2,2'-Methylenebis(4-methyl-6-tert-butylphenol)	C23 H32 O2	340.24053	18.31	-	Phenolic	
7	PEG n7	C14 H30 O8	326.19434	7.339	+	Lipids and their derivatives	
8	PEG n6	C12 H26 O7	282.16827	6.445	+	Lipids and their derivatives	

No	VIP Compounds	Formula	Molecular Weight	RT (min)	Ionization	Classifications	Structure
9	Acetophenone	C8 H8 O	120.05776	9.495	+	Ketone aromatic	
10	PEG n8	C16 H34 O9	370.22078	8.048	+	Lipids and their derivatives	
11	PEG-4	C8 H18 O5	194.11569	3.708	+	Lipids and their derivatives	
12	1-myristoyl-2-oleoyl-sn-glycerol	C35 H66 O5	566.4909	19.79	+	Lipids and their derivatives	
13	(1R,4aS,7S,7aR)-1-Hydroxy-7-methyl-1,4a,5,6,7,7a-hexahydrocyclopenta[c]pyran-4-carbaldehyde	C10 H14 O3	182.09443	9.494	+	Iridoid (a type of monoterpenoid)	
14	(14R,20S)-17,20,21-Trihydroxy-2-methyl-17-oxido-11-oxo-12,16,18-trioxa-17lambda~5~-phosphahenicosan-14-yl 16-methylheptadecanoate	C36 H71 O10 P	694.47539	22.5	+	Lipids and their derivatives	
15	PEG n5	C10 H22 O6	238.14209	5.288	+	Lipids and their derivatives	
16	6α-hydroxy-castasterone	C28 H50 O5	466.36583	20.65	+	Organic compounds	
17	Gluconic acid	C6 H12 O7	196.0579	0.882	-	Carbohydrates and carbohydrate conjugates	

No	VIP Compounds	Formula	Molecular Weight	RT (min)	Ionization	Classifications	Structure
18	(E,E)- α -Farnesene	C ₁₅ H ₂₄	204.18789	19.83	+	Sesquiterpenoids	
19	Dibenzylamine	C ₁₄ H ₁₅ N	197.1206	8.573	+	Aromatic amines	
20	[8-Formyl-5-methoxy-2-methyl-2-(4-methyl-2-oxo-3-penten-1-yl)-3,4-dihydro-2H-chromen-7-yl]methyl (9E,12E)-9,12-octadecadienoate	C ₃₇ H ₅₄ O ₆	594.39148	19.1	+	Lipids and their derivatives	
21	4-{{[4-(Dimethylamino)phenyl][4-(dimethyliminio)-2,5-cyclohexadien-1-ylidene]methyl}-3-hydroxy-7-sulfo-2-naphthalenesulfonate	C ₂₇ H ₂₆ N ₂ O ₇ S ₂	554.11662	19.04	+	Sulfonic acid and their derivatives	
22	1-Stearoylglycerol	C ₂₁ H ₄₂ O ₄	358.3079	18.61	+	Lipids and their derivatives	
23	O-{Hydroxy[(2R)-2-(pentadecanoyloxy)-3-(tetradecanoyloxy)propoxy]phosphoryl}-L-serine	C ₃₅ H ₆₈ N O ₁₀ P	693.45804	18.6	+	Amino acids derivatives	
24	Pyrogallol	C ₆ H ₆ O ₃	126.03184	0.895	+	Phenolic compound	
25	ascopyrone M	C ₆ H ₈ O ₄	144.04235	0.888	+	Glycogen derivatives	

No	VIP Compounds	Formula	Molecular Weight	RT (min)	Ionization	Classifications	Structure
26	1,5-Anhydro-D-fructose	C ₆ H ₁₀ O ₅	162.05257	0.885	-	Carbohydrates and derived	
27	D-(-)-Erythrose	C ₄ H ₈ O ₄	120.0417	0.881	-	Tetrose saccharide	
28	scyllo-Inosamine	C ₆ H ₁₃ N O ₅	179.07955	0.873	+	Amino acids derivatives	
29	L-alpha-Glycerylphosphorylcholine	C ₈ H ₂₀ N O ₆ P	257.103	0.892	+	Lipids and their derivatives	
30	(2Z)-2-(2-Hydroxybenzylidene)octanal	C ₁₅ H ₂₀ O ₂	232.14635	20.16	+	Hydroxybenzylidene derivatives	
31	(3beta,4alpha,5alpha)-3-Hydroxyergosta-7,24(28)-diene-4-carbaldehyde	C ₂₉ H ₄₆ O ₂	426.35021	19.82	+	Sterols derivatives	
32	4-Phenylbutyric acid	C ₁₀ H ₁₂ O ₂	164.08381	20.16	+	Carboxylic acid derivatives	
33	Ethyl (2E,4E,6E,8E,10E,12E,14Z,16E)-2,6,11,15-tetramethyl-17-(2,6,6-trimethyl-1-cyclohexen-1-yl)-2,4,6,8,10,12,14,16-heptadecaenoate	C ₃₂ H ₄₄ O ₂	460.33457	19.46	-	Lipids and their derivatives	
34	4'-Hydroxy-3'-prenylacetophenone	C ₁₃ H ₁₆ O ₂	204.11497	20.16	+	Methyl Ketone derived	

No	VIP Compounds	Formula	Molecular Weight	RT (min)	Ionization	Classifications	Structure
35	DG(18:1(11Z)/18:1(9Z)/0:0)	C39 H72 O5	620.53778	19.66	+	Lipids and their derivatives	