

New fields of application of in food products



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What is so special about fish oils?

- Health benefits
- Decreasing consumption
- Better utilization of fish -raw materials
- Possible applications in foods
 - Our experience
 - New possibilities



Fish oil and health benefits



Omega-3 fatty acids play a crucial role in maintaining optimal mental and physical health.

- EPA is believed to help maintain a healthy heart by improving circulation, lowering homocysteine levels and improving immune function.
- DHA is being heavily studied for its positive effects on the improvement of memory and cognitive function as well as its role in infant brain development.



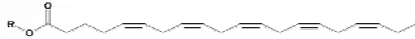
Few review-papers on fish oils (n-3) and health

- **Biological basis for the benefit of nutraceutical supplementation in arthritis**, *Drug Discovery Today*, Volume 9, Issue 4, 15 February 2004, Pages 165-172, Clare L. Curtis, John L. Harwood, Colin M. Dent and Bruce Caterson
- **Prevention of sudden cardiac death by n-3 polyunsaturated fatty acids**, *Pharmacology & Therapeutics*, Volume 98, Issue 3, June 2003, Pages 355-377, Alexander Leaf, Yong-Fu Xiao, Jing X. Kang and George E. Billman
- **Review: the role of omega 3 fatty acids in intestinal inflammation**, *The Journal of Nutritional Biochemistry*, Volume 12, Issue 1, January 2001, Pages 21-32, Jonathan E. Teitelbaum and W. Allan Walker
- **Modulation of human immune and inflammatory responses by dietary fatty acids**, *Nutrition*, Volume 17, Issues 7-8, July-August 2001, Pages 669-673, Darshan S. Kelley
- **Cancer cachexia and its treatment with fish-oil-enriched nutritional supplementation¹**, *Nutrition*, Volume 17, Issue 9, September 2001, Pages 751-753, Matthew D. Barber
- **Longchain n-3 polyunsaturated fatty acids and blood vessel function**, *Cardiovascular Research*, Volume 52, Issue 3, December 2001, Pages 361-371, Mahinda Y. Abeywardena and Richard J. Head
- **N-3 polyunsaturated fatty acids, inflammation and immunity: pouring oil on troubled waters or another fishy tale?**, *Nutrition Research*, Volume 21, Issues 1-2, January-February 2001, Pages 309-341, P. C. Calder
- **Marine oils: the health benefits of n-3 fatty acids**, *Nutrition*, Volume 16, Issues 7-8, July-August 2000, Pages 680-684, Ricardo Linau and Alfonso Valenzuela
- **Effects of altering dietary fatty acid composition on prostaglandin synthesis and fertility**, *Prostaglandins, Leukotrienes and Essential Fatty Acids*, Volume 61, Issue 5, November 1999, Pages 275-287
- **Health effects of n-3 polyunsaturated fatty acids in seafoods: World Review of Nutrition of Dietetics**, Volume 66 S. Karger AG, Basel, Switzerland, 1991.
- **Omega-3 fatty acids in health and disease and growth and development**, *Am J Clin Nutr*, Volume 54, 1991, Pages 438-463, A. P. Simopoulos
- **The metabolic role of n-3 polyunsaturated fatty acids: Relationship to human disease**, *Comparative Biochemistry and Physiology Part A: Physiology*, Volume 98, Issues 3-4, 1991, Pages 581-585, Frank J. Kelly
- **Omega-3 fatty acids in health and disease**: edited by Robert S. Lees and Marcus Karel, Marcel Dekker, 1990.
- **DHA Home page**: www.panix.com/~dha/



Famous omega-3 fatty acids

EPA (Eicosapentaenoic acid - 20:5n3)



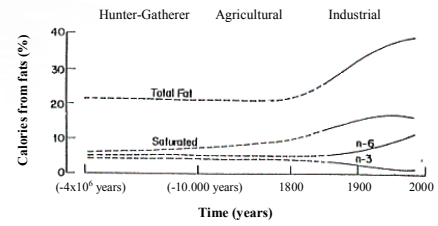
DHA (Docosahexaenoic acid - 22:6n3)



α -Linolenic acid (18:3n3)



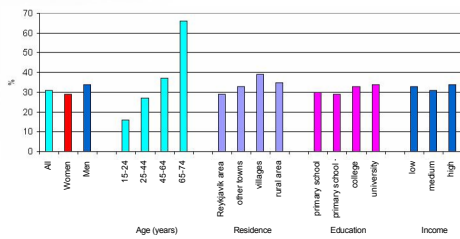
Dietary fatty acids and possible changes subsequent to industrial food processing



Source: Simopoulos, A. P. *Am J Clin Nutr* 1991, 438-63.



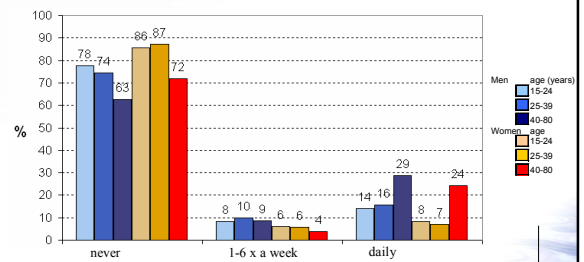
Fish consumption 3 times a week or more



Ref: The Diet of Icelanders. The Icelandic Nutrition Council 2002.



Cod liver oil consumption in Iceland frequency



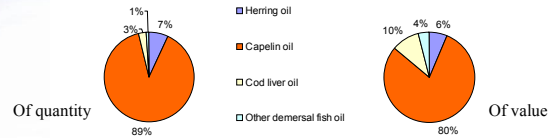
Ref: The Diet of Icelanders. The Icelandic Nutrition Council 2002.



Fish oil products as suppliments



Fish oil export - 2002



0.1-0.2% of the capelin oil is used for human consumption



Capelin – highest in fisheries quantity (> 40%)

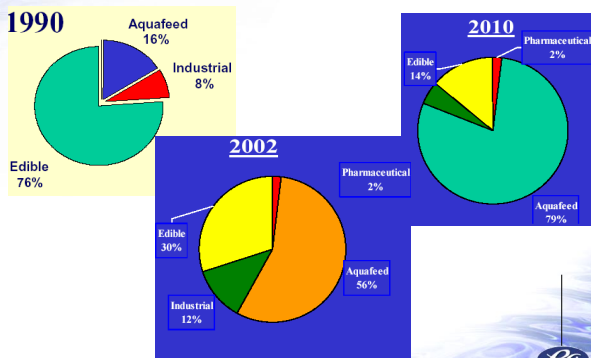
• Mainly utilized as feed ingredient

Capelin oil is 2-3% of the total value



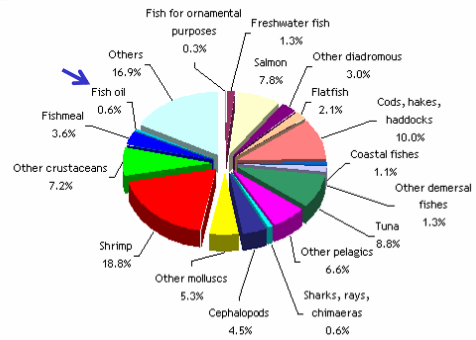
Source: Statistics Iceland (External Trade).

Summary of fish oil use for the period 1990-2010



Source: Barlow, S. <http://www.ifo.org.uk/Supplies.pdf>.

World exports of fishery commodities in 2001, in value






Ref.: FAO, Fishery Information, Data and Statistics Unit. <http://www.globefish.org/index2.htm>

Fish oils

- Fish oils are healthy for you
- Lacking in diet
- Better utilization of resources
- What can we do about it?

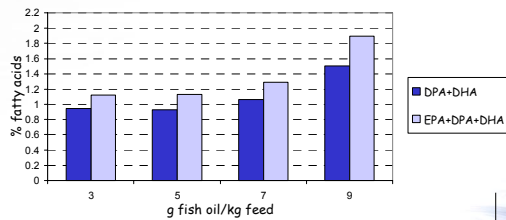


Fish oils in other foods

- Direct addition 
- Microencapsulation 
- By animal feeding 



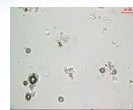
Influence of cod liver oil on fatty acid composition of pork-subcutaneous fat



Source: Jonsdottir et al. *J Muscle Foods*, 2003, 14, 51-65.



Stability of microencapsulated n-3 cod liver oil



Spray-drying micro-encapsulated oil

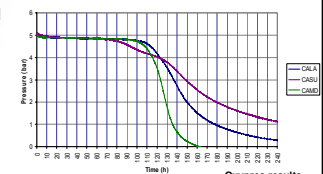


Table 1. Key aroma compounds identified by SPME, GC/IO and GC/MS in fresh microencapsulated fish oil

Possible compound	rt (min) ^a	RI ^a	ID mean ^b	Odor description	Odor intensity ^c		
					CALA-0	CAMD-0	CASU-0
1-butanol			1, 2, MS				
pentanal	2.7	237	1, 2, MS	caramel, vanilla	3.5	2.5	2.5
3-hydroxy-2-butanone	3.4	274	1, 2, MS	heavy, milk-like	3.0	3.0	2.0
hexanal	6.1	369	1, 2, MS	grass	2.0	2.0	
cis-4-heptenal	10.7	600	1, 2, MS	rancid, potato-like	4.5	4.3	4.0
heptanal	11.0	507	2, MS	rancid	2.8	3.3	4.0
1-octen-3-ol	14.0	579	1, 2	mushroom	3.0	3.0	2.8
2,4-heptadienal	14.8	595	MS			+	+
2,6-nonadienal	20.6	755	1, 2	cucumber	4.0	4.0	4.0
2,4-decadienal	25.0	930	1, 2	rancid	3.5	4.0	3.0

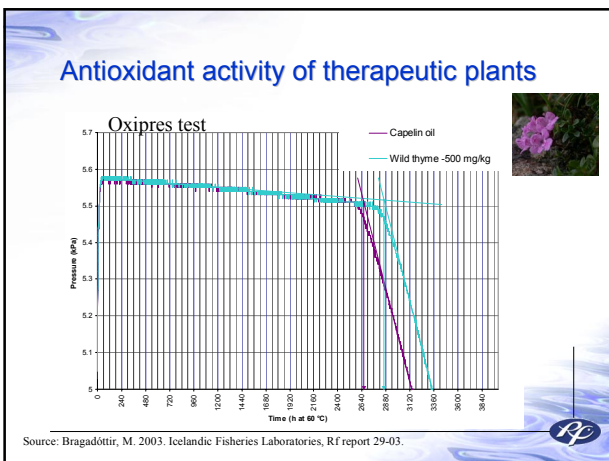
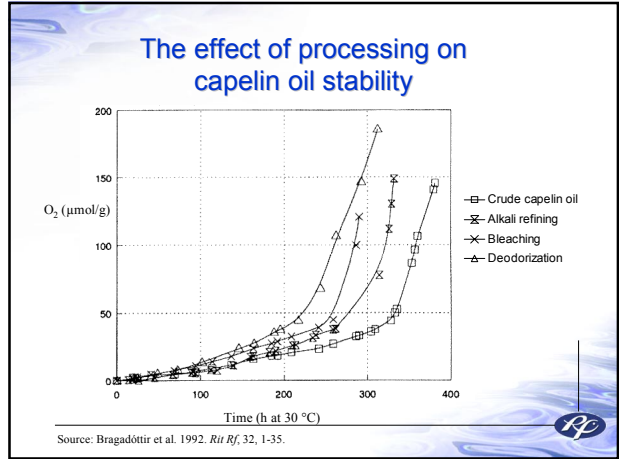
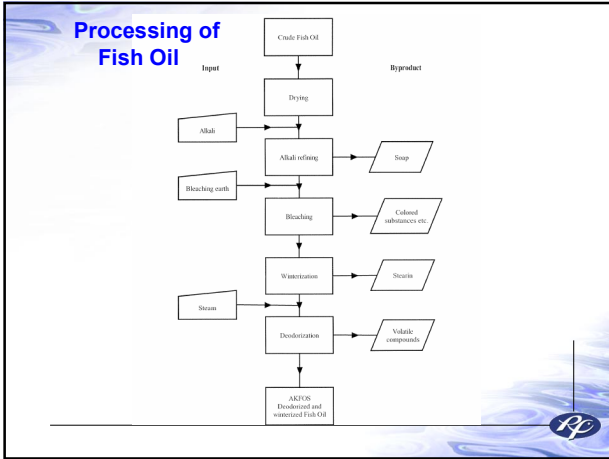
^aCalculated ethyl ester retention index on DB-5ms capillary column



^bIdentification means: MS, mass spectra; 1, authentic standards; 2, odor identification; 3, odor identification and RI references

^cOdor intensity calculated as average of at least two samples; intensity scale from 0 (not present) to 5 (very strong)


Source: Arnarson et al. 2003. Proceedings of the 1st Trans Atlantic Fisheries Technology Conference.









Menu Item	Serving Size	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Cholesterol (mg)	Sodium (mg)	Carbohydrate (g)	Dietary Fiber (g)	Sugars (g)	Protein (g)	Vitamin A	Vitamin C	Calcium	Iron	Fat g/100 mL
												% Daily Value				
Newman's Own® Cobb Dressing (59 mL)	2.0 fl oz	120	80	9	1.5	10	440	9	0	5	1	*	*	4	*	15
Newman's Own® Creamy Caesar Dressing (59 mL)	2.0 fl oz	190	170	18	3.5	20	500	4	0	2	2	*	*	6	*	31
Newman's Own® Low Fat Balsamic Vinaigrette (44 mL)	1.5 fl oz	40	25	3	0	0	730	4	0	3	0	*	*	4	*	7
Newman's Own® Ranch Dressing (59 mL)	2.0 fl oz	290	270	30	4.5	20	530	4	0	3	1	*	*	4	*	51




Fatty acid composition of Capelin oil and some vegetable oils

	Capelin oil	Corn oil	Olive oil	Palm oil	Rapeseed	Safflower	Soya oil	Sunflower	Walnut oil	38:70 COSSVO CO tips	
12:0	0.1	0.1	0.1	0.1						0.0	
14:0	8.1	0.1	0.1	1.0		0.1	0.4	0.1		1.3	
16:0	12.2	11.3	10.1	41.5	4.2	6.2	10.7	6.2	6.5	5.4	
17:0			0.1						0.1	0.0	
18:0	0.6	2.1	3.0	4.6	1.5	4.3	3.8	4.3	2.4	1.1	
20:0	0.5	0.4	0.3	0.6	0.3	0.4	0.3	0.1	0.1	0.2	
22:0	0.2	0.1		0.3	0.8	0.5	0.8			0.0	
24:0	0.2	0.4		0.3	0.1	0.3				0.1	
<i>Total saturated</i>	<i>20.9</i>	<i>14.4</i>	<i>14.2</i>	<i>47.7</i>	<i>6.6</i>	<i>12.0</i>	<i>15.9</i>	<i>12.0</i>	<i>9.1</i>	<i>8.1</i>	
16:1n7	10.9	0.2	0.7	0.2	0.1	0.1	0.1			1.9	
18:1n6		29.4	71.9	37.1	57.6	11.4	20.8	20.2	16.2	25.2	
18:1n9	14.5									2.2	
20:1n6		0.3	0.3		1.2	0.2	0.2	0.1		0.1	
20:1n9	13.8									2.1	
20:1n11										0.0	
22:1n6		0.3	0.3	1.0	0.2	0.2	0.1	0.1	0.1	0.1	
22:1n9					0.2	0.2	0.1	0.1		0.0	
22:1n11, n13	21.2									3.2	
<i>Total monounsaturated</i>	<i>60.4</i>	<i>30.2</i>	<i>73.2</i>	<i>38.1</i>	<i>59.4</i>	<i>12.1</i>	<i>21.3</i>	<i>20.6</i>	<i>16.3</i>	<i>34.7</i>	
18:2n6	1.1	50.4	7.5	10.1	19.7	73.9	51.5	63.2	58.4	2.8	
18:3n3		0.9	0.7	0.3	9.6	0.1	7.3	0.1	11.5	0.2	
20:3n6										0.0	
18:4n3	3									0.5	
20:4n6										0.0	
22:4n6										0.0	
22:5n3		7.4								1.1	
22:5n6		0.5								0.1	
22:6n3		4.2								0.6	
<i>Total poly-n6</i>	<i>1.1</i>	<i>50.4</i>	<i>7.5</i>	<i>10.1</i>	<i>19.7</i>	<i>73.9</i>	<i>51.5</i>	<i>63.2</i>	<i>58.4</i>	<i>2.8</i>	
<i>Total poly-n3</i>	<i>15.1</i>	<i>0.9</i>	<i>0.7</i>	<i>0.3</i>	<i>9.6</i>	<i>0.1</i>	<i>7.3</i>	<i>0.1</i>	<i>11.5</i>	<i>2.5</i>	
n-6/n-3 ratio	0.09	56.0	10.7	33.7	2.05	739	7.05	632	5.08	1.35	
										Portion of 30 g: 0.75 1.69	



Conclusions

- The technology is almost there
- Several solutions
- Appeal to consumers




Thank you for listening

