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Algae: *our original omega-3 source*

PUFACHain

The overall goal of PUFACHain is to develop a robust scientific and technological basis for the industrial development of high-value products from algae. The main targeted application is the use of high purified omega 3 fatty acids (DHA/EPA) for nutrition and pharmaceutical applications. A consortium with 6 companies and 3 research institutes will integrate state of the art science and technologies. The PUFACHain project runs from 2014 to 2017 and is funded by the European Commission's Seventh Framework Program.

www.pufachain.eu



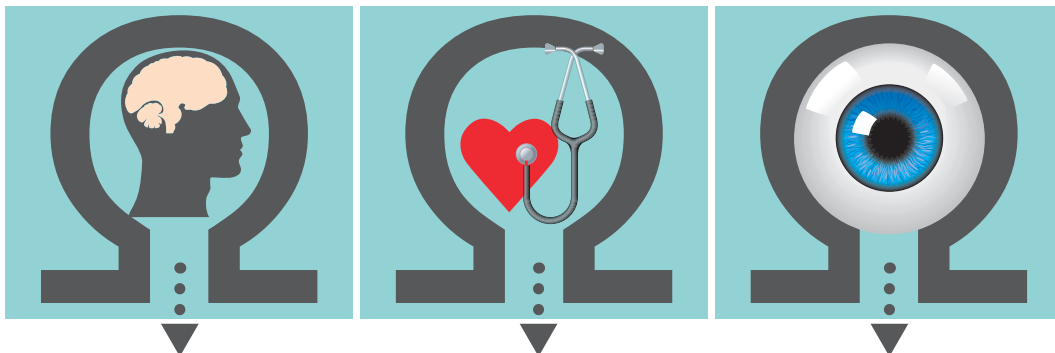
Omega-3 fatty acids for human health

Polyunsaturated (omega-3) fatty acids protect against heart diseases, are beneficial for brain and eyes and fit into a healthy diet. The best known are the fish fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) and the vegetable fatty acid alpha-linolenic acid (ALA).

The European Food Safety Authority (EFSA) has approved health claims on omega-3 fatty acids. DHA/EPA for maintenance of normal cardiac function and normal (fasting) blood concentrations of triglycerides. DHA for maintenance of normal vision and normal brain function. And ALA for contribution to brain development.

EFSA approved health claims	DHA/EPA	DHA	ALA
maintenance of normal cardiac function	X		
maintenance of normal (fasting) blood concentrations of triglycerides	X		
maintenance of normal vision		X	
maintenance of normal brain function		X	
contribution to brain development			X

www.efsa.europa.eu



"Polyunsaturated (omega-3) fatty acids protect against heart diseases, are beneficial for brain and eyes and fit into a healthy diet."

Sources of omega-3 fatty acids

ALA: Plants

ALA is a vegetable fatty acid, which is found in (wal)nut, linseed oil and other vegetable oils. The human body can also make EPA and DHA itself from alpha-linolenic acid (ALA). However this provides only a small amount of EPA and DHA.



Flax plants produce ALA in linseed



High EPA/DHA levels can be found in anchovy

EPA/DHA : Fish and algae

EPA and DHA are found in fish and shellfish. High levels can be found in fatty fish, such as anchovy, mackerel, herring and salmon. However fish cannot make their own DHA and EPA, but obtain them from algae.

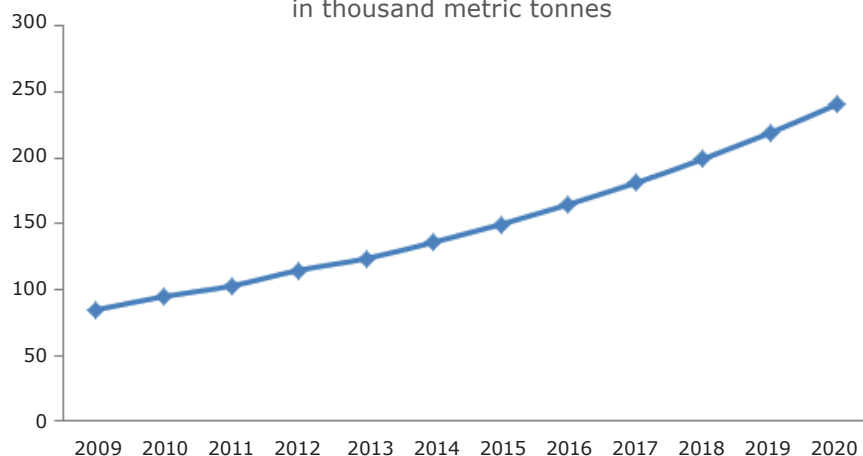
EPA/DHA consumer market

EPA, DHA and ALA can also be extracted directly from fish, algal or plant oils.

The global EPA/DHA consumer market has been growing fast and is expected to keep on growing in the future. The positive clinical research coupled with regulatory recognition, increasing health awareness and the improvement in standard of living on several continents are driving factors.

EPA/DHA market volume

in thousand metric tonnes



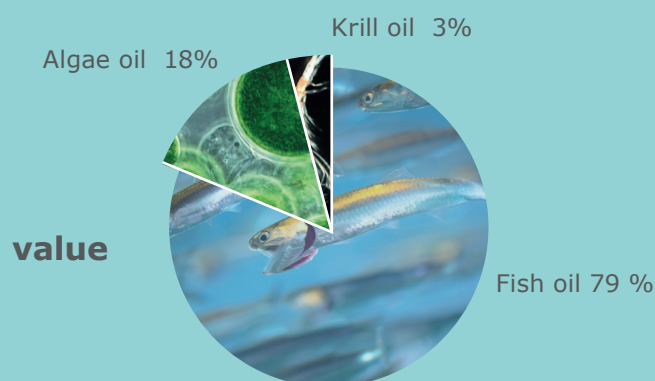
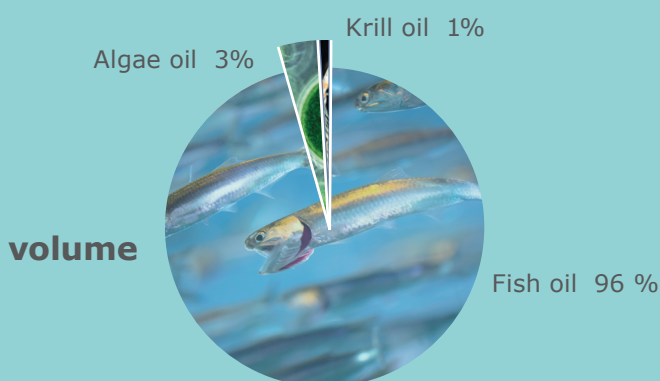
Global EPA/DHA consumer market development in thousand metric tons
(www.reportlinker.com; www.en.siriopharm.com and Ismael, 2013)



Most of the EPA/DHA oil is used for dietary supplements, followed by pet foods, food and beverage, infant formula, pharmaceuticals and clinical nutrition. In terms of value the image changes: the share of pharmaceuticals, infant formula and clinical nutrition is larger then.

The largest part of the EPA/DHA oil market volume and value is from fish and only a small part from algae. Algae oils have a relatively larger share in market value than in market volume. De EPA/DHA consumer market leader sells algae based DHA (mainly for infant formulas) and EPA/DHA products. These algae are grown on sugar (heterotrophic) in closed fermentation vessels without exposure to sunlight (in contrast to phototrophic algae production). Because of the depleting anchovy supply, algae are expected to be the most promising source of raw material in the near future. Why should we catch fish to produce fish oil, if the oil is already in the algae that fish eat?

EPH/DHA source: market volume and value

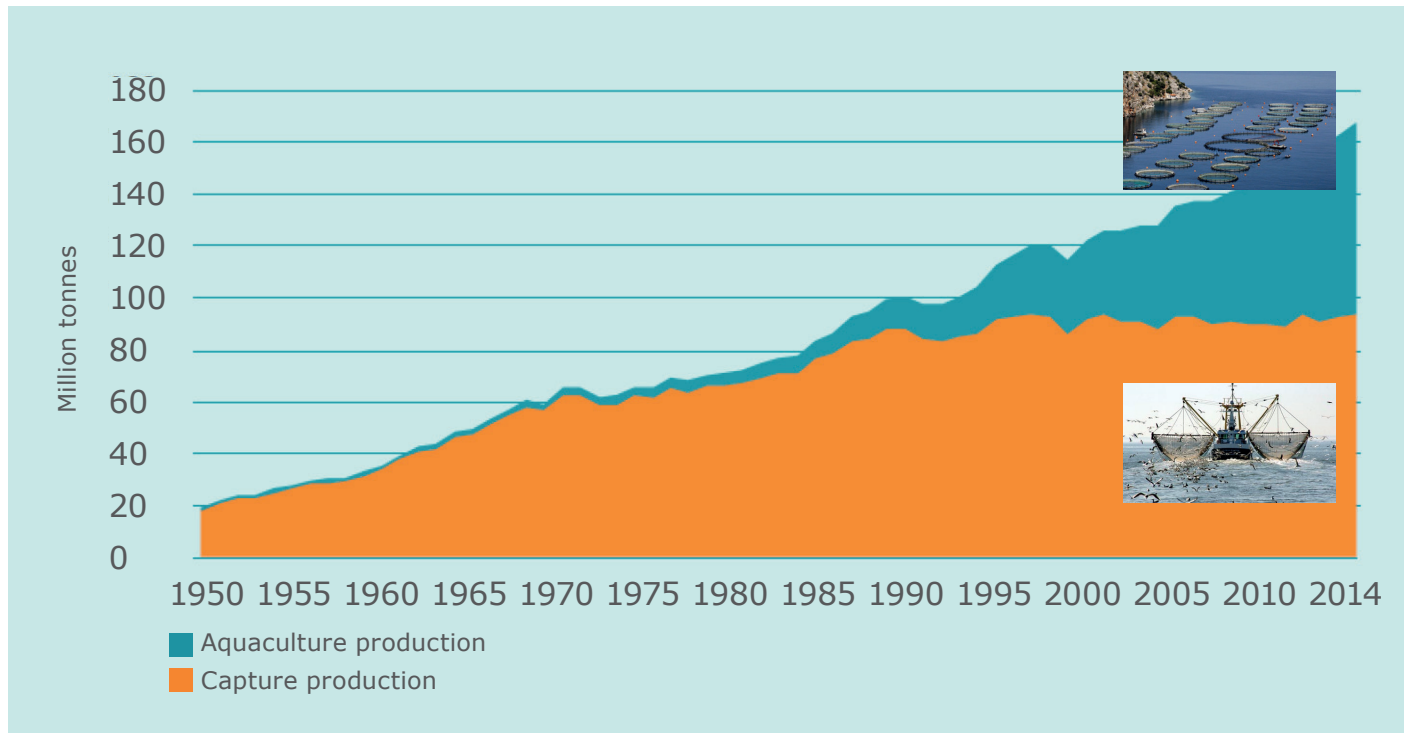


EPA/DHA market volume and value by source (www.en.siriopharm.com and Ismael, 2013)

Strong global fish production growth

Global fish production has grown steadily in the last five decades. Because the capture production is limited, the growth comes mainly from aquaculture production. Almost half of the fish we consume is farmed rather than wild caught, and this proportion can be expected to increase steadily in the future. (www.fao.org)

World capture fisheries and aquaculture production



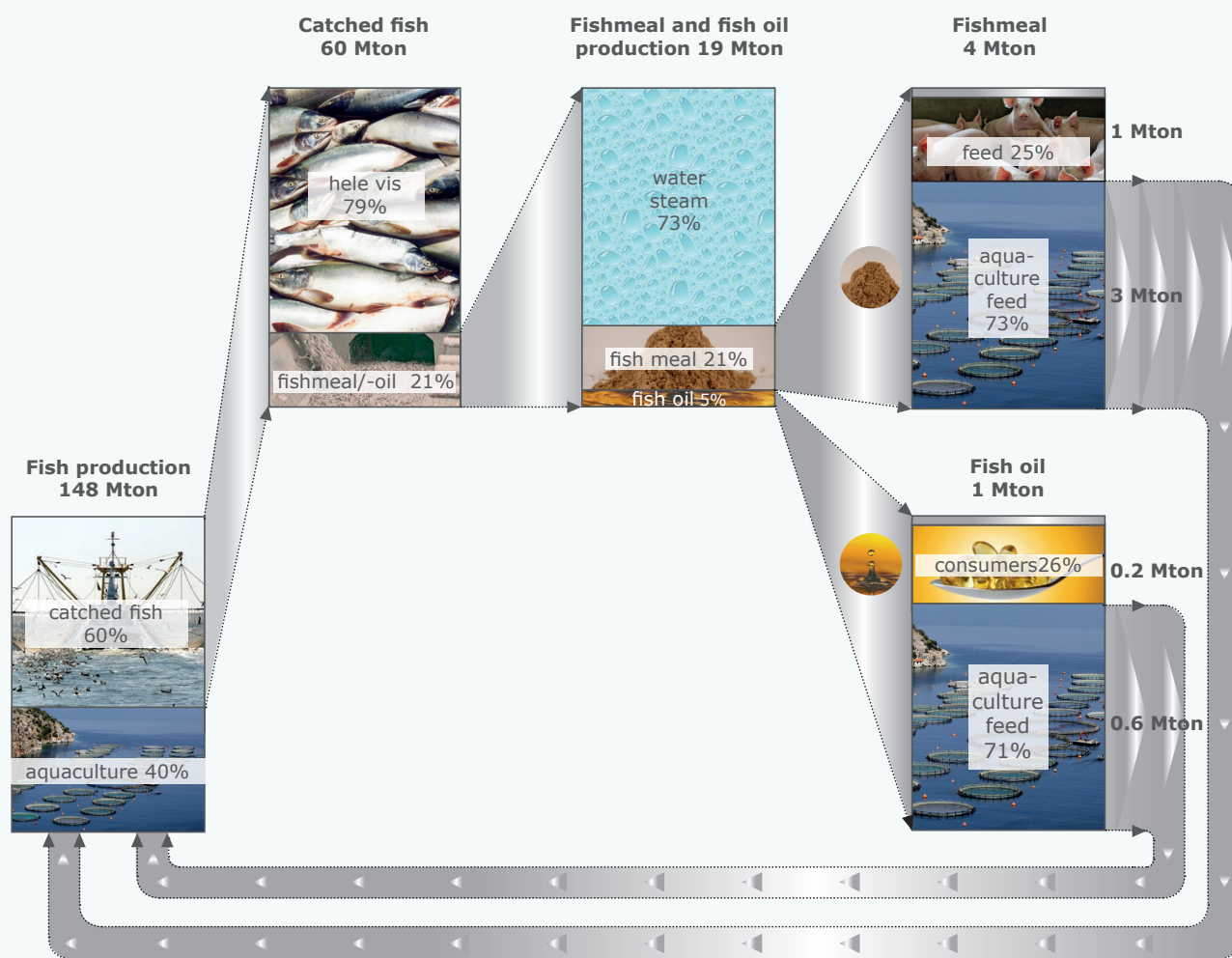
World capture fisheries and aquaculture production in million ton (www.fao.org)

The increasing aquaculture production makes the aquaculture feed market grow steadily too. Main ingredient in the global aqua feed is soybean followed by fish meal. In the cultivation of carnivorous fish species they try to use as much as possible vegetable materials in feed, but plants do not contain the necessary EPA / DHA omega-3 fatty acids. Therefore the feed, for example for farmed salmon, exists for a large part of fish meal and oil.

A large part of the fish catch is used for fish oil and fishmeal production

In 2010 about 20% of the fish capture as whole fish and by-products were used to produce 0.9 and 4.2 million ton fish oil and fishmeal respectively. The fishmeal and fish oil production varies year to year and dips significantly during the El Niño phenomenon every few years. Fish meal is mostly used (73% in 2010) as high protein feed ingredient in diets for farmed fish. Fish meal contains 68% to 72% crude protein and 6% to 12% fish oil. Pure fish oil is mainly used in feeds for farmed fish (71% in 2010) too and there is an expanding market for fish oil for human nutritional supplements and functional foods today. (IFFO, 2008; www.iffonet.net and Shepherd & Jackson, 2012)

Fishmeal and fish oil production and use in million tonnes (2010)



(sources: www.fao.org, IFFO, 2008; www.iffonet.net and Shepherd & Jackson, 2012)



Opportunities for EPA/DHA from algae oil

The need to find new sources of EPA and DHA because of fear of overfishing, depleting fish supply and concerns about contaminations is an opportunity for algae based PUFAs.

According to the Rabobank report "Algae: A Brave New Industry" aquaculture feed is expected to be one of the first areas in which algae products become competitive with existing products. In particular the salmon industry is looking for sustainable alternative sources. One of the market key players is recently able to provide (approved) feed formulations with different EPA/DHA ratios from algae.

At the moment the largest part of the EPA/DHA consumer market volume and value is from fish and only a small part from algae, but algae oils have a relatively larger share in market value than in market volume. No or less fishy taste and smell and desirable labels like "vegetarian," "kosher" or "organic" distinguish algae from fish oil based EPA/DHA. The EPA/DHA consumer market leader sells algae based DHA (mainly for infant formulas) and EPA/DHA products. These algae are grown on sugar (heterotrophic) in closed fermentation vessels without exposure to sunlight (in contrast to phototrophic algae production).



heterotrophic (Ismael, 2013) and phototrophic (A4F) algae production methods

For the time being algae EPA/DHA producers have to deal with higher prices than the fish based EPA/DHA competitors, a strong price competition and a high price sensitivity among final consumers. New market players have to deal with powerful food and pharmaceutical companies. Only five companies represent about 75% EPA/DHA market share. In addition PUFA's from phototrophic algae have to compete with the lower costing heterotrophic algae.

Colofon

This brochure has been compiled by Joanneke Spruijt from Wageningen University & Research within the PUFACHain project, which has received funding from the European Commission's Seventh Framework Programme (FP7-KBBE-2013-7-single-stage).

PUFACHain partners

