biovis' DIAGNOSTICS

Fatty acids and their importance for human health

An overview of nutritional fundamentals of fatty acids and the diagnostic possibilities for biovis diagnostics

Fatty acids and their importance for human health

In all industrial nations, we see deficits in the consumption of **omega-3 fatty acids**. This leads to an imbalance with regards to omega-6 fatty acids. In the following we would like to explain what effects this can have on people.

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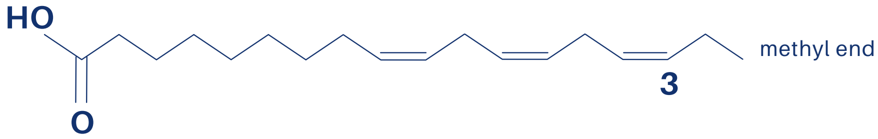
Omega-3 fatty acids are plant-based fatty acids that can be found concentrated in the seeds and leaves of plants. We find this in high concentrations in linseed oil (approx. 55 - 60%), chia oil (approx. 60%), cameline oil (approx. 40%), hemp oil (approx. 17%), walnut oil (approx. 13%), rapeseed oil (approx. 9%), and in soybean oil (approx. 8%).

All of these plant oils contain alpha-linolenic acid (ALA), a fatty acid chain with 18 carbon atoms (C atoms) in the above-given concentrations. This fatty acid has 3 unsaturated double connections between the ninth and fifteenth carbon atoms. The name omega-3 means that only 3 further saturated C atoms follow until the methyl end of the fatty acid chain. In short, this is written as 18 : 3 ω3. This means: a chain of 18 C-atoms with 3 double connections. The last double connection is in position omega-3.

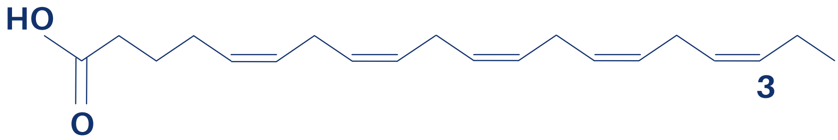
Algae and microalgae moreover contain long-chain, highly unsaturated fatty acids, as for example EPA (eicosapentaenoic acid, 20 : 5 ω3) and DHA (docosahexaenoic acid, 22 : 6 ω3). These form a nutritional basis for fish, and are necessary to optimize membrane function even in low temperatures.

Fig. 1: The most important Omega-3 fatty acids

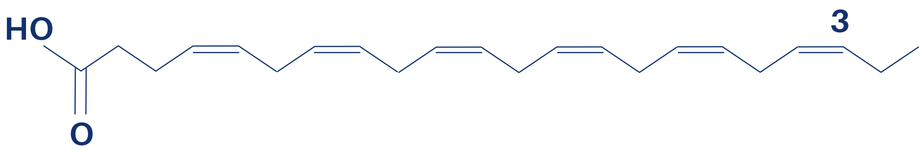
Omega-3 fatty acids



Alpha-linolenic acid (ALA, C 18 : 3, Omega-3)



Eicosapentaenoic acid (EPA, C 20 : 5, Omega-3)



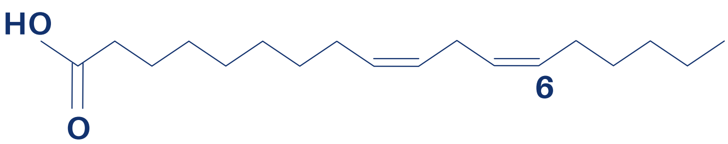
Docosahexaenoic (DHA, C 22 : 6, Omega-3)

What are omega-6 fatty acids?

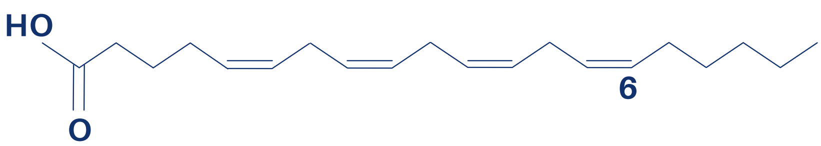
Like omega-3 fatty acids, omega-6 fatty acids are also unsaturated fatty acids. The difference between the two types of fatty acids lies in the position of the first double connection. While in the omega-3 fatty acids, viewed from the methyl end out, the first double connection is found on the third. C-atom (ω3), the first double connection of the omega-6 fatty acid lies on the sixth C-atom (ω6). The most important representatives of the omega-6 fatty acids are linoleic acid (18 : 2 ω6) and arachidonic acid (20 : 4 ω6). Linoleic acid has mainly a plant-based origin, while arachidonic acid is largely from animal origins.

Fig. 2: The most important omega-6 fatty acids

Omega-6 fatty acids



Linoleic acid (LA, C 18 : 2, Omega-6)



Arachidonic acid (AA, C 20 : 4, Omega-6)

Is it possible to increase the EPA / DHA levels with the intake of plant-based omega-3 fatty acids (ALA)??

The general opinion is that only a minimal change (conversion) is possible in the human body. The figures for the EPA conversion rate range from 1% to 5%. The DHA conversion rate amounts to only approx. 0.5%. It is important to note that the omega-6 fatty acids compete with the omega-3 fatty acids for the same enzyme (Fig. 3, page 7). This means that the higher the level of omega-6 fatty acids in comparison to the omega-3 fatty acids, the higher the chance that EPA and DHA will be synthesized from ALA. This means that a balanced ratio of omega-3 and omega-6 fatty acids is important.

In terms of enzymes, there are **desaturases** and **elongases**, which are responsible for the creation of double connections and for the lengthening of the fatty acid chains. The conversion of ALA to EPA and DHA functions very well in newborns. In case of adults, however, a lower intake of omega-6 fatty acids must be the goal to help out the enzyme systems.

In an investigation of 36 subjects, after 6 weekly administrations with 13 ml linseed oil daily (7 g ALA), the ratio of EPA to AA was increased by almost 30%. The AA / EPA index fell from 16: 1 to 12: 1. The proportional EPA portion increased highly significantly from 0.7% to 1.0% EPA. In this investigation, no further interventions affecting the dietary behavior of the subjects was undertaken. Other investigations achieved similar results.

Omega-3 and omega-6 are opponents in metabolism

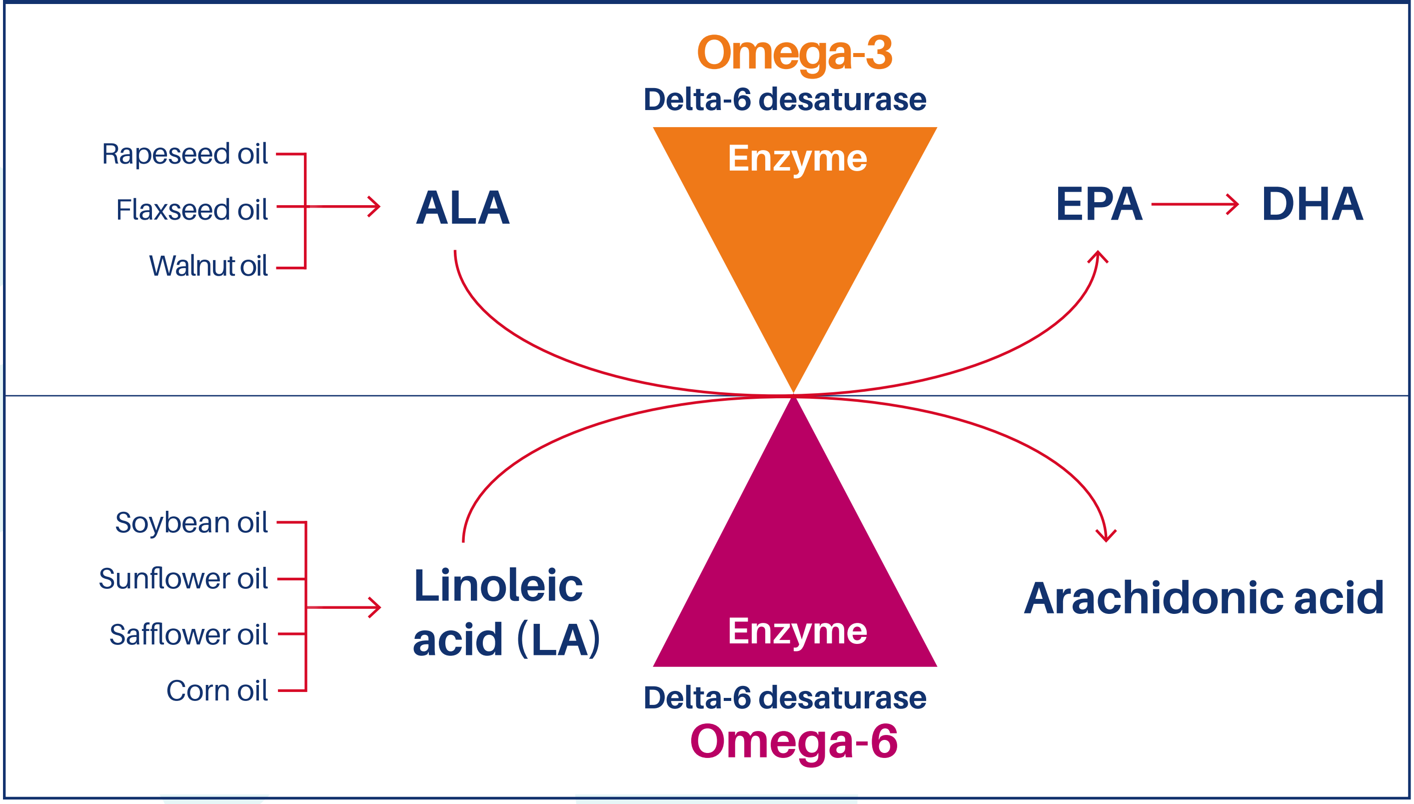


Fig. 3 *Omega-3 and omega-6 fatty acids - Opponents in metabolism*

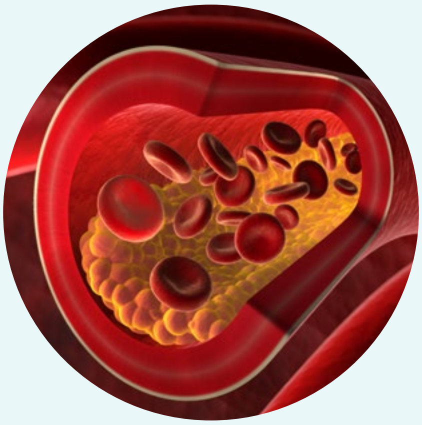
The importance of omega-3 fatty acids for your health

Very simply put, further metabolic processes create **anti-inflammatory** tissue hormones from EPA and DHA, and **pro-inflammatory** tissue hormones (prostaglandins) from arachidonic acid.

Fatty acids are essential for our bodies. We can synthesize most fatty acids, but with two important exceptions: The omega-6 fatty acid linoleic acid and the omega-3 fatty acid alpha-linolenic acid. In addition, a conversion of omega-6 into omega-3 fatty acids in the human organism is not possible. For this reason, our body is dependent on an exogenous supply (through diet), this is why these two fatty acids are designated as essential. Earlier, before the chemical classification, these were categorized in the same group as Vitamin F. After exact chemical classification, nothing has changed in the fact that these are just as important as vitamins.

Cardiovascular diseases

Today, we can safely say that a high concentration of EPA and DHA contribute to the reduction of fatal cardiovascular diseases. Omega-3 fatty acids appear to have a positive effect in stroke prophylaxis (minus 30%).



Pregnancy and breastfeeding

During pregnancy and breastfeeding, large amounts of omega-3 fatty acids are necessary to ensure the healthy development of the baby. Child brain development is dependent on a sufficient intake of omega-3 fatty acids. The mother's EPA- and DHA-storage undertakes this task. At the same time, this empties out the mother's omega-3 fatty acid stocks. A sufficient supply also seems to prevent postpartum depression. Premature births occur less frequently with a sufficient supply. A sufficient supply of omega-3 fatty acids during breastfeeding has a positive effect on the complex brain development of the child.

Eyes

Omega-3 fatty acids are essential for the structure and function of the brain and eyes. This applies in particular to DHA. The risk of macular degeneration likewise appears to correlate with low EPA- and DHA-levels.

Brain

Sufficiently high levels of omega-3 fatty acids have a clear effect in stroke prophylaxis (minus 30%). Cognitive development in dementia and Alzheimer's likewise appear to be positively influenced with a sufficient supply of omega-3 fatty acids. In depression and bipolar disorder, EPA substitution seems in particular to offer success. In schizophrenia, likewise, low omega-3 fatty acid levels are measured. In 3 of 4 studies, positive effects were seen when omega-3 deficits were compensated for. Attention deficit/hyperactivity disorder is in many cases characterized by a deficit of long-chain omega-3 fatty acids. A substitution for 3 - 6 months shows a long-term improvement of symptoms that is comparable to the effects of Ritalin administration..

Malignancies

In the prophylaxis of prostate carcinoma, patients with high EPA- and DHA-levels seem to become ill less often. The risk of illness with colon carcinoma and with breast carcinoma likewise appears increased with a deficit of EPA and DHA.

Autoimmune diseases

In inflammatory illnesses with autoimmune components, anti-inflammatory/pro-inflammatory immune modulators play a decisive role. Here, the relationship of the eicosanoid output products arachidonic acid and eicosapentaenoic acid are of decisive importance. The "eicosanoid balance" appears to have a decisive role in the emergence and propagation of illnesses such as rheumatoid Arthritis, Colitis ulcerosa, Crohn's disease, bronchial asthma, Neurodermatitis, or primary sclerosing cholangitis. Further intervention studies are still necessary to clarify the situation in this case. However, experience at our own practice suggest that compensation in case of disrupted "eicosanoid balance" (EPA/AA ratio) bring positive results.

Metabolic syndrome and Type 2 diabetes

With metabolic syndrome (diabetes mellitus Type 2, insulin resistance, hyperlipidemia, hypertension, central obesity, and nutritive-toxic hepatosis), a differentiated consideration of lipid metabolism is necessary. However, a differentiated provision of omega fatty acids becomes sensible only after the supply of saturated fats and carbohydrates with a high glycemic index is reduced, combined with exercise. Again and again, we find a disrupted balance of omega-3 and omega-6 fatty acids. Here, a reduction of saturated fats and a reduction of linoleic acid appear to have a positive impact on the function of the insulin receptors.

Differences in the fatty acid diagnostics at biovis diagnostics

Fatty acid status of the erythrocyte membranes	Analysis of the 10 most important fatty acids in cell membranes	Distribution of the most important fatty acids exclu-sively in the cell membranes for a therapeutic measure that is as exact as possible	Fatty acid intake over a time frame of approx. 3 months
Fatty acid status in whole blood	Analysis of 15 fatty acids, sums of fatty acid groups and fatty acid quotients	Fatty acid distribution in the cell membranes combined with the intake of fatty acids through diet	Lower impact of nutritional factors than in the serum
Fatty acid blood spot	Analysis of the 12 most important fatty acids, sums of the fatty acid groups and fatty acid quotients	Fatty acid distribution in the cell membranes combined with the intake of fatty acids through diet	Minimally-invasive Lower impact of nutritional factors than in the serum
Fatty acid blood spot expanded	Analysis of 21 fatty acids and trans fatty acids, sums of the fatty acid groups and fatty acid quotients	Expansion of the blood spot with all demonstrable fatty acids as well as in trans fatty acids	Minimally-invasive Lower impact of nutritional factors than in the serum
Fatty acid status in the serum	Analysis of 13 fatty acids, sums of the fatty acid groups and fatty acid quotients	Short-term intake of fatty acids through diet	Keep to prior diet! Follow-up after 2-3 weeks possible

Typical fatty acid chromatogram (fatty acid status in whole blood)

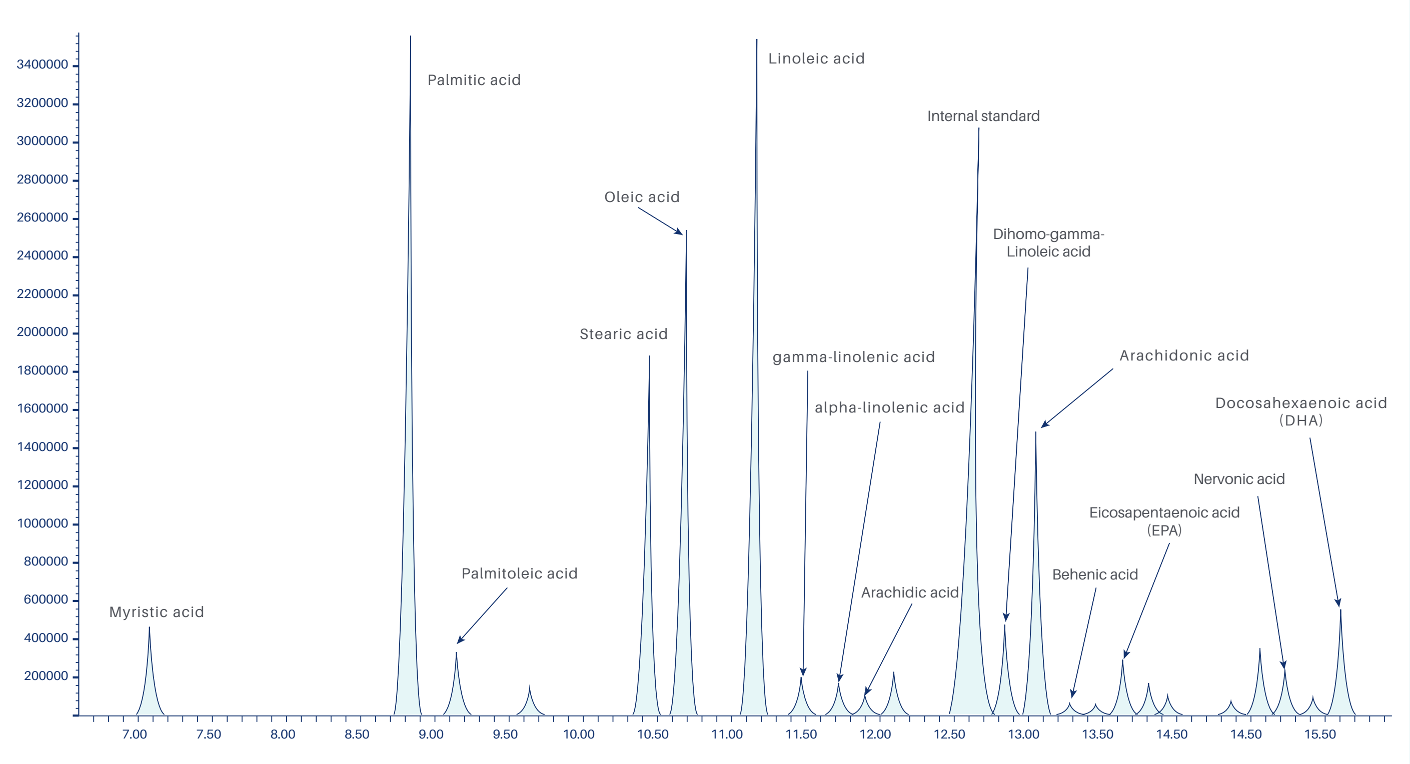


***Fig. 4**: Example chromatogram of fatty acid analysis using gas chromatography with mass spectrometry coupling (GC/MS)*

The most important omega-3 and omega-6 fatty acids in mg/100 g food

Food with fatty acids	AA (n-6)	EPA (n-3)	DHA (n-3)	ALA (n-3)	LA (n-6)	Omega-6 / Omega-3 ratio
Herring, salted	23	1770	586	54	132	0,06
Halibut, smoked	38	128	338	23	16	0,11
Tuna fish	287	1620	2440	250	273	0,13
Mackerel, salted	171	645	1150	251	171	0,17
Linseed oil				52800	14300	0,27
Shrimp, cooked	80	243	187	9	73	0,35
Salmon	65	949	1520	338	999	0,38
Mussel	53	18	59	114	98	0,49
Fruit-linseed				8700	6050	0,7
Hard cheese	30			332	540	1,72
Rapeseed oil				8580	15000	1,75
Mountain cheese (goat)				191	356	1,86
Cow milk	3			23	42	1,96
Beef	43	17		263	115	2,32
Butter	114		10	423	1220	3,08
Pork	226	33		357	1160	3,55
Walnut				1020	42	4,12
Walnut oil				12200	52400	4,3
Cocoa butter				296	1990	6,72
Soybean oil				7700	52900	6,87
Wheat germ oil				7800	55700	7,14
Chicken soup	775	34	420	164	3710	7,26
Chicken egg - (White and yolk)	56		75	80	13300	8,94
Olive oil				855	8320	9,73
Lamb chop	139	32		195	2280	10,66
Lard	1700			1010	9350	10,94
Avocado				111	1510	13,6
Palm oil				500	9600	19,2
Peanuts				528	13800	26,14
Wild boar meat	37	15			624	44,07
Corn oil				960	55500	57,81
Pumpkin seed oil				480	49200	102,5
Cashew nut				81	8620	106,42
Hazelnut				58	6370	109,83
Almond oil				191	22500	117,8
Grape seed oil				480	65900	137,29
Safflower oil				470	75100	159,79
Almond, sweet				44	11500	261,36
Sunflower oil				178	50200	282,02
Brazil nut		14		62	29100	382,89

AA = arachidonic acid **EPA** = eicosapentaenoic acid **DHA** = docosahexaenoic acid **ALA** = alpha-linolenic acid **LA** = linoleic acid

Source: BLS 3.02, Optidiet plus 6.0

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