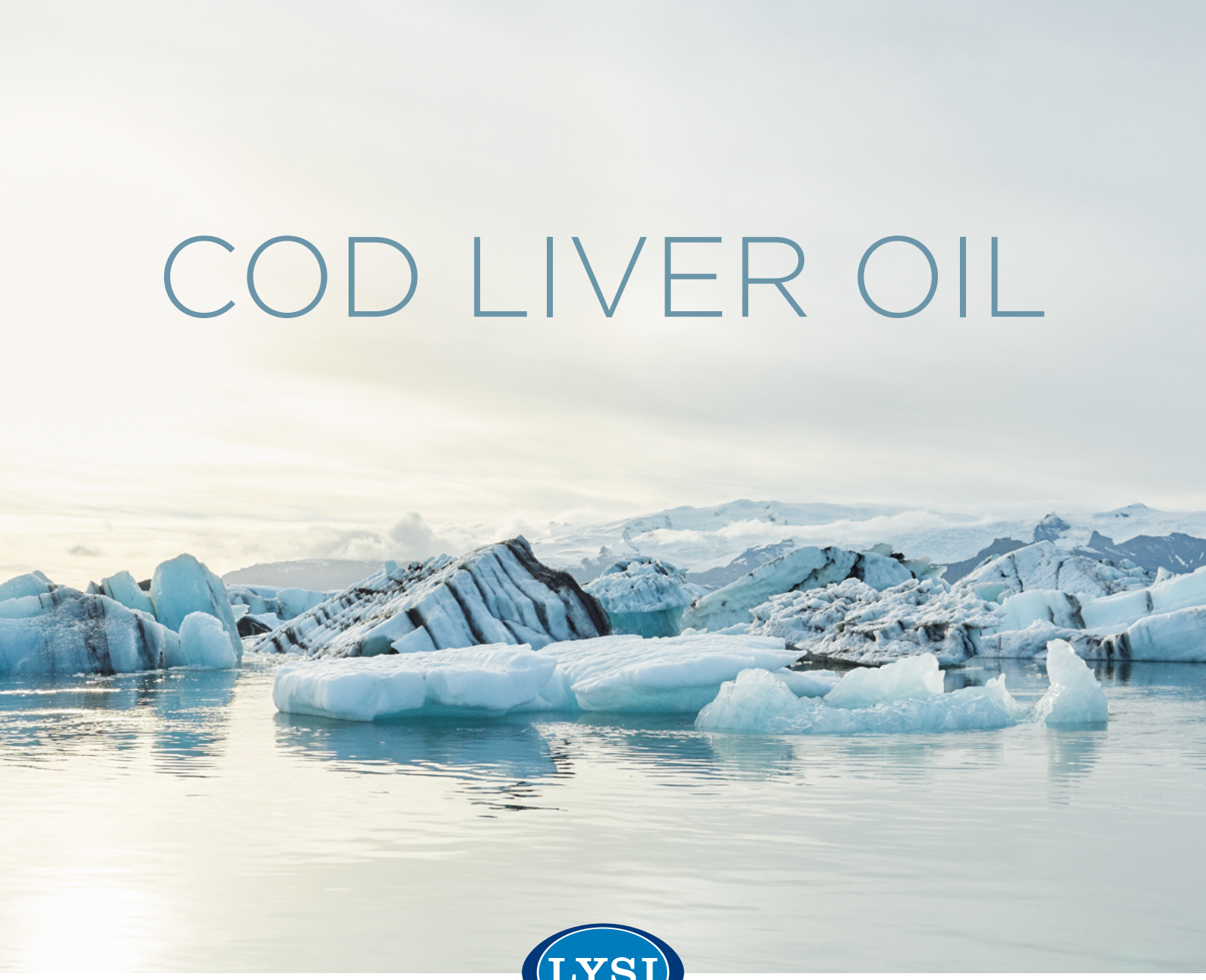
COD LIVER OIL



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Most types of cod liver oils from LYSI are categorised as food supplements. However, the company also offers fish oils to customers as APIs (active pharmaceutical ingredients). Pharmaceutical companies use APIs as the key ingredients in the manufacturing of medicines. LYSI API oils and relevant documents fulfil all requirements made by national regulatory bodies for the registration of medicines.

Cod liver oil is, like other fish oils, a complex mixture of triacylglycerols (also called triglycerides) and trace components. What sets it apart from most other fish oils is the fatty acid profile and the high level of vitamins A and D_3.

The oil is extracted by physical means from fresh livers of cod *(Gadus morhua)* and related Gadidae species that are caught around Iceland. The livers come from fish stocks that are strictly controlled by Icelandic authorities and are therefore fully sustainable. Moreover, the fish stocks are certified by the Marine Stewardship Council (MSC).

LYSI collects the livers from fish processors around the country and extracts the crude oil in its own rendering plant in **Þorlákshöfn.** The crude oil is subsequently fully refined in LYSI's state-of-the-art refinery in **Reykjavík,** Iceland.

LYSI is a major producer of cod liver oil, supplying approximately one third of the world's total production of cod liver oil as a food supplement.

The Refining Process

Crude cod liver oil is not suited for direct consumption and must be refined before use. The refining process removes unwanted components such as free fatty acids, pigments, contaminants and various other substances that can impart fishy flavour or off-flavour to the oil.

The refining process of cod liver oil is comprised of 5 or 6 steps, as outlined below. Distillation (short-path) is not always called for. During the standardisation process, the vitamin levels are adjusted as needed.

- **Crude Oil**
- **Neutralisation**
- **Bleaching**
- **Winterisation**
- **Distillation**
- **Deodorisation**
- **Standardisation**
- **Product**

It is imperative that the products we consume are clean and that they meet the most stringent international demands issued by health authorities.

This is secured through elaborate and comprehensive production processes in the LYSI refinery. The equipment used for refining is custom-made, built on the extensive knowledge of fish oil refining obtained over the last 85 years. The key processes have been validated and approved.

The company is **FSSC 22000** and **GMP** certified. FSSC 22000 is a food safety scheme that is fully recognised by the Global Food Safety Initiative (GFSI) and GMP is a pharmaceutical standard.

Technical Aspects

The composition of cod liver oil is defined in the European Pharmacopoeia and the USP.

Cod liver oil from LYSI meets both pharmacopoeias. However, the content of the vitamins can be adjusted in accordance with the needs of the individual customer, often to levels that are outside the limits of the pharmacopoeias.

Some LYSI cod liver oil products are blends of liver oil and fish body oil from the Gadidae family or other oils. This is always clearly defined in the product specifications.

Every batch of cod liver oil produced at LYSI is analysed per specification. The batch is released by QC only when it meets the specification. A certificate of analysis is issued for every batch.

Our standard specification for cod liver oil is shown in the table on the opposite page.

Properties of Cod Liver Oil

Cod liver oil has been used throughout the centuries for various purposes, as lamp oil (the Icelandic name for cod liver oil is **lýsi,** derived from the verb **lýsa,** or to **illuminate**), as an ingredient in ointments and as a food supplement.

Cod liver oil is a rich source of the vitamins A and D_3. In fact, other good dietary sources of vitamin D_3 are scarce. The oil was initially used as a raw material for the production of these vitamins, but the importance of the omega-3 fatty acids was eventually discovered and this fact altered the status of the oil. It is now widely used as an important source of the omega-3 fatty acids EPA and DHA, in addition to the vitamins. These fatty acids are often considered essential due to their low conversion efficiency from alpha-linolenic acid.

Cod liver oil may be taken orally as a liquid or in capsule form.

Parameters	**Specification**
Vitamin A (Qg/g)	min. 1000
Vitamin D3 (Qg/g)	min. 100
EPA (area %)	min. 8,0
EPA (mg/g as FFA	min. 70,0
EPA (mg/g as TG)	min. 70,0
DHA, (area %)	min. 10,0
DHA (mg/g ad FFA)	min. 90
DHA, (mg/g as TG)	min. 90
Total Omega-3 fatty acids (area %)	min. 22,0
Total Omega-3 fatty acids (mg/g ad FFA)	min. 200
Total Omega-3 fatty acids (mg/g as TG)	min. 210
Free fatty acids (%)	max. 0,25
Acid value (mg KOH/g)	max. 0,50
Peroxide value (meq. O_2/kg)	max. 5,9
Anisidine value	max. 20,0
Iodine value (g I/100 g)	150–180
Unsaponifiable matter (%)	max. 1,5
Refractive Index at 20°C	1.477–1.484
Cold test; remains clear at 0°C (hours)	min. 3
Density at 20°C (g/ml)	0.917–0.930

EPA and DHA have been extensively studied for the last three decades and their different effects on the body have been described. Initial studies on the physiological effects of long-chain omega-3 fatty acids focused on the relationship between EPA and DHA and cardiovascular disease. The findings showed that both the acids reduced the risk of cardiovascular disease (Casula, et al., 2013) (de Oliviera Otto, et al., 2013) (Zock, et al., 2016).

A deficiency of omega-3 fatty acids has been implicated as a risk factor in mental disorders such as depression, schizophrenia and ADHD (McNamara, 2016) (Parletta, et al., 2016) (Königs & Kiliaan, 2016).

Reports dating from the 18th century show that people used cod liver oil to reduce symptoms of arthritis. This appears to have been demonstrated by more recent research. Omega-3 polyunsaturated fatty acids have been shown to contain anti-inflammatory properties. These acids play a role in arthritis and possibly other conditions associated with inflammation (Yates, et al., 2014) (Calder, 2015) (Khatib, et al., 2016).

A number of recommended intakes of EPA and DHA have been published. Health claims authorised by the EU give daily intakes from 250 mg to 3 g EPA+DHA, depending on the claim. For example, the beneficial effect to normal heart function is obtained with 250 mg of EPA and DHA, but the beneficial effect to maintenance of normal blood pressure is obtained with 3 g of EPA and DHA. In comparison LYSI cod liver oil normally contains 175 mg EPA+DHA/g.

Product Groups

Cod liver oil from LYSI falls into two groups, pure cod liver oil and cod liver oil blends.

Pure cod liver oil

Fully refined cod liver oil is produced to fulfil LYSI's many different specifications. The specifications can be generic or determined in collaboration with customers in terms of individual requirements.

Other ingredients can be added, such as antioxidants and flavourings. Mixed tocopherols are used as antioxidants.

All ingredients/additives must be non-GMO, non-irradiated and preferably, Halal-certified.

Cod liver oil blends

LYSI offers a similar range of blended cod liver oil products. Again, the specifications can be generic or determined with customers. Cod liver oil blends must contain at least 51% of cod liver oil.

The oil used in the cod liver oil blend is usually extracted from whole fish of the Gadidae family, most commonly blue whiting (Micromesistius poutassou) . The analytical parameters usually correspond to the monograph for cod liver oil from the European pharmacopoeia.

LYSI also offers special cod liver oil blends where the level of EPA and DHA has been increased by adding omega-3 fish oil or tuna oil.

The cod liver oil blends can contain added ingredients, similar to the pure cod liver oil.

The products are packed into steel drums. IBC's, tankcontainers or flexicontainers, all acording to customers requirements.

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LYSI hf.
Fiskislod 5–9
101 Reykjavik
Iceland

Tel +354 525 8100
lysi@lysi.com
www.lysi.com