

From raw to refined: The purification of omega-3 oils

With the growing awareness of the health benefits of omega-3 unsaturated fatty acids, demand for supplements, fortified foods and enriched beverages is rising.

Numerous studies have shown how important omega-3 fatty acids are for our minds and bodies. For a long time, fatty fish and seafood were said to be the most important sources; now, a huge array of dietary supplements is available on the market and many foodstuffs and beverages are enriched with essential fatty acids.

Fish is still a popular source of oil, but it's a challenging material to process: it oxidises quickly and can become contaminated during cultivation or transport. However, most food operators are extremely well informed about the hurdles that have to be overcome when using oils containing polyunsaturated fatty acids such as omega-3 and omega-6. The ketones and aldehydes that are formed as the oil breaks down produce a dark colour and, sometimes, a strong "fishy" smell and taste. But it's not just sensory properties that make a good omega-3 oil, purity is also crucial.

Nutriswiss, a small refinery that specialises in purifying and modifying high-quality edible oils, has been processing fish oil for many years. Keeping a close eye on market developments, this Swiss company is well aware of the plant-based trend and now processes just as much algal oil as fish oil. In addition, vegetable sources such as nuts, seeds and crops (including rapeseed, chia and linseed) have become increasingly popular, as have marine microalgae.

Health benefits

Long-chain omega-3 fatty acids play an important role in brain growth and development, blood pressure regulation, kidney function, blood clotting and numerous inflammatory and immunological reactions. In terms of cognitive well-being in particular, the ingestion of omega-3 fatty acids improves learning, mood, memory and blood flow in the brain. Omega-3 treatments are advantageous and well-tolerated. In



Mild refining preserves the valuable polyunsaturated fatty acids in a variety of raw material sources.

fact, omega-3 is important for our mental health throughout life: brain cells with high levels of omega-3 in their membranes are thought to be better at communicating with other cells, an important process for brain function.

Sensitive and valuable with a high risk of oxidation

The chemical structures of omega-3 (DHA or docosahexaenoic acid) and omega-6 (ARA or arachidonic acid) fatty acids contain several double bonds, which is why they react with ambient air very quickly. The result is the formation of undesirable oxidation products, including hydroperoxides and secondary degradation products such as ketones and aldehydes.

The higher the proportion of unsaturated fatty acids in a raw oil, the more carefully it needs to be handled. On one hand, both the crude and refined oils must be protected and kept within a controlled atmosphere; on the other, it means that harsh refining environments need to be avoided. For sources with extremely high omega-3 contents, such as tuna oil, which contains 25% DHA, the oxidation potential is correspondingly high. It is too unstable to be refined like rapeseed or soy oil is, for example. At the same time, though, any contaminants that are harmful to health must be refined out to comply with food safety standards. Once the extracted oils are micro-encapsulated or powdered, the valuable fatty acids are completely isolated, which makes further decomposition reactions less likely.

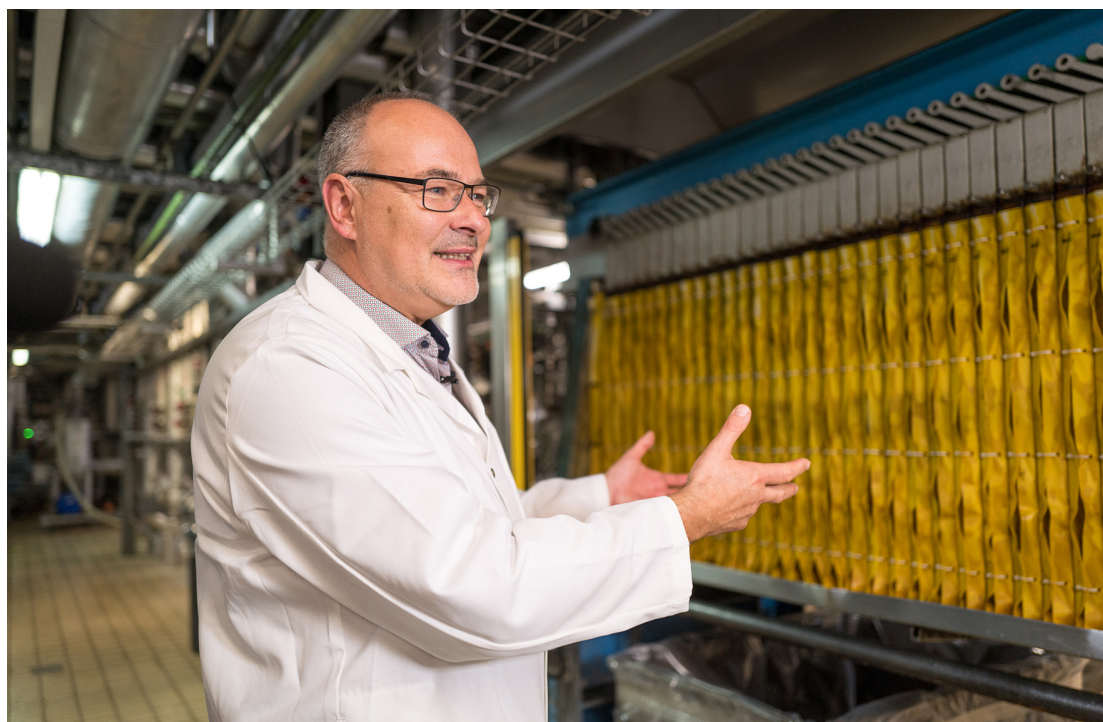
Contaminants

Oxidation products are not the only compounds that have to be removed from crude oil by refining. Owing to their apolar structure, lipids are especially susceptible to environmental contaminants. Oils from

plants often accumulate the insecticides, fungicides and herbicides used in traditional cultivation. In addition, mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH) — originating from exhaust gases or emissions from industrial facilities, among other sources — may have been transferred to the raw oil during processing and packaging.

Marine animals are particularly at risk: other than cultivated (fermented) algae, which grow in tanks in a closed system, they can potentially accumulate pesticides that might be present in the ocean. Of all the common omega-3 sources, algae have the lowest contamination levels and a high-fat content (up to 50%). DHA oil is more bioavailable for the human organism than, for example, linolenic acid, which is found in rapeseed or linseed oil. Plus, the linolenic acid that is contained in seed oils can also be adversely affected by climatic conditions. In addition, environmental contaminants, mycotoxins and certain plant toxins may become incorporated. All omega-3 oils require customised treatments and a higher degree of care than ordinary oils to preserve their essential fatty acids, micronutrients and vitamins.

The challenge is implementing a gentle purification process that preserves valuable polyunsaturated fatty acids. And, even when refining oils in a dedicated facility, manufacturers must strike a balance between using a process that's both gentle and thorough. Beyond the labile nature of crude oils, the unrefined raw materials often demonstrate levels of pre-existing contamination or the presence of harmful substances that must be reduced by purification processes to be suitable for use in foodstuffs. In other instances, unwanted by-products such as plasticisers, trans fatty acids and/or MCPD fatty acid esters have been known to form during purification as a result of harsh process conditions. For this reason, many manufacturers set their own guideline



Frank Möllering (Head of R&D) in front of the company's filtration plant - one of the first steps in a purely physical but effective process.



Omega-3s derived from algae oil have become increasingly popular.

values — in addition to the legal limits that they must comply with — especially for products intended for small children and adolescents.

Choosing a gentle process

Physical or alkaline-based refining processes that work well for other vegetable oils operate at temperatures of 180–250 °C. As this would be an excessive thermal load for omega-3 oils, Nutriswiss has established a system to both maximise the yield and minimise the level of contaminants. At the centre of this technique is a mild, multi-step refining technology — a particularly gentle physical separation process that is already well-established in the fish oil industry.

For its wide range of edible oils, however, the Nutriswiss plant has been custom designed and equipped with additional process technology. With the help of a finely controlled vacuum (with a pressure of less than 0.01 mbar) and short residence times, the thermal load on the product is significantly reduced, which minimises the formation of process contaminants. At the same time, free fatty acids, plasticisers and pesticides are removed to an extent that cannot be achieved with conventional technology. MOSH/MOAH levels can also be significantly reduced.

Subsequently, the sensory quality can be further

optimised by adding various absorbents — such as activated carbon — before the deodorisation stage. The final refining steps are only done directly before delivery to keep the storage times short and to prevent oxidation. In the end, even volatile fish oils arrive with a completely neutral taste and odour while looking just like rapeseed oil with a light-yellow colouring.

Welcome to the neutral zone

Even though taste and quality are more closely linked to omega-3 oils than some other products, Nutriswiss insists on the very best conditions, right from the start. No matter whether the extract is derived from fish or algae or plants, the result is sensorial neutrality. To facilitate this, carefully controlled and selected raw material sourcing is essential. As such, longstanding collaborations with suppliers and independent inspectors, coupled with the company's own sealed food-grade containers, which protect the raw materials from contact with foreign materials and ambient oxygen, ensure the best possible outcome.

In addition, before production starts, each process is tested in the laboratory, so that all procedures and methods can be adapted to suit individual applications. To ensure that the key data and sensory profile information meet the requirements for pharmaceutical or special nutrition products, the refining steps are carefully planned and monitored.

For instance, the composition of a baby food formulation, including the optimum ratio of omega-3 and omega-6, can be developed according to specific customer requirements. Test batches can be run with only a few kilos and, afterwards, scaled up — from quantities of just 500 kg to several metric tons. This might be particularly interesting when developing novel foods and other specialities. Companies that want to minimise contamination risks from the outset can rely on Nutriswiss' own, cost-effective raw material sourcing offer.

www.nutriswiss.ch/en/home



To preserve the integrity of the oils being processed, the raffinate is cooled as quickly as possible.