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Keeping omega-3 oils safe, pure and taste-neutral

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With the growing awareness of the health benefits of omega-3 unsaturated fatty acids, demand for supplements, fortified foods and enriched beverages is rising. High-quality vegetable and microalgae-derived oils are particularly popular, but consumers are still sceptical about omega-3 products containing fish oil. Straight away, "fishy" smelling and tasting capsules come to mind. Yet, there are methods and processes available that refineries can use to supply high-purity oils that are absolutely neutral in terms of sensory properties.

Although the number of people who still abide by the old dietary recommendation of eating fish at least once a week is declining, there is increasing evidence to illustrate just how important omega-3 fatty acids are for our minds and bodies. For a long time, fatty fish and seafood such as mussels were said to be the most important sources; now, however, a huge array of dietary supplements are available on the market, and a growing number of 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, like any crude oil of plant or animal origin, can become contaminated during cultivation or transport. Additionally, fish oil poses the greatest challenge in terms of neutralising its fishy odour and taste. 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 at the same time, this Swiss company is well aware of the plant-based trend and now processes just as much algal oil as fish oil.

Growing demand for health and wellness

To ensure a sufficient supply of essential fatty acids, alternatives to fish oil are in demand. In recent years, vegetable sources such as nuts, seeds and oils (such as rapeseed) have become increasingly popular; chia and linseed are frequently used as toppings in healthy bowls or shakes, for example. Compared with marine sources, they mainly contain the omega-3 fatty acid, ALA (alpha-linolenic acid), which must be converted by human metabolism to DHA (docosahexaenoic acid) and EPA (eicosapentaenoic acid). As this is only partially possible and an inefficient process, the required intake is much higher.

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. A recent study showed that omega-3s can protect the brain from the damage caused by inhaled particulate matter.[1] As a component of cell membranes, the unsaturated fatty acids in breast milk, especially DHA, are important for healthy eye and brain development, particularly during the first two years of life. And as the body of scientific proof expands, so too do the regulatory requirements: DHA must now be present at a concentration of 20–50 mg per 100 kcal in any infant formula that's to be sold in the EU.[2]

High risk of oxidation

Once the extracted oils are microencapsulated or powdered, the valuable fatty acids are completely isolated, which makes further decomposition reactions less likely. Most food operators understand that when handling oils containing polyunsaturated fatty acids, an oxidation reaction takes place when they come into contact with oxygen in the ambient air, which induces decomposition. The consequences clearly manifest themselves as off notes, an unappealing taste and a dark colour (mainly because of the formation of ketones and aldehydes that are responsible for that all-too-familiar fishy smell). But, it's not just sensory properties that make a good omega-3 oil, purity is also crucial.

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. The chemical structures of omega-3 fatty acids contain several double bonds, which is why they react very quickly. 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 in the same way that 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.

Microalgae

Many companies have now realised that microalgae can serve as a sustainable alternative raw material: they are relatively easy to cultivate and reproduce quickly (Fig. 1). For instance, the food industry considers them to be a productive marine source of omega-3. As they comprise up to 50 % fat, refining the raw oil is very efficient and, almost as importantly, they contain EPA and even more DHA than tuna oil. Fish does, too, but they get it from consuming algae — so why not start directly at the source? In addition, algae cultures are more environmentally friendly and protect fish stocks. Although the microalgae market is still in the discovery phase, growers and refiners such as Nutriswiss are already ahead of the curve and are driving further research and product development with algae oil.

Sensory properties correlate with quality

Optimising the sensory properties of omega-3 oils means more than just consumer acceptance; unpleasant off notes and a bad odour are symptoms of a decaying product. At Nutriswiss, a comprehen-

Fig.1: In the food and nutraceuticals industry, and beyond, microalgae are the new all-rounders. (Photo©: 123rf/Akhararat Wathanasing)

sive “key figure” profile is initially compiled for each oil in the factory’s own analytical laboratory. This determines how much “damage” has already occurred. Key factors such as the anisidine value, which measures the secondary degradation products of lipid-compound oxidation — such as aldehydes — provide information about the history of the raw material. After the refining process, the analyses are repeated: the removal of secondary oxidation products makes it possible to reduce the anisidine value in fish oil to less than 10 and, in some cases, less than 5, which corresponds to premium quality. Figures such as these are responsible for the company’s excellent reputation worldwide, especially as a supplier of high-purity oils and specialities for a wide range of sectors, including food, infant formula and pharmaceuticals.

Contaminants

Oxidation products are not the only compounds that have to be removed from a 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 are at risk of accumulating pesticides that might be present in the ocean.

As with almost all sensitive natural raw materials, the challenge is implementing a gentle purification process that preserves the valuable polyunsaturated fatty acids. To remove certain contaminants, high temperatures are normally required, which actually promotes the formation of other contaminants (trans fatty acids and chlorine-fatty acid esters such as 3-MCPD, for example). For 3-MCPD, in particular, more stringent regulations are due to come into effect in the EU for infant foods in January 2021. And, tighter restrictions are also being considered for other residues and applications.

Choosing a gentle process

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 short path distillation (SPD), a particularly gentle physical separation process that is already well-established in the fish oil industry (Fig.2). Equipped with additional process technology, it is the procedure of choice for difficult-to-process raw materials, those that are heavily contaminated or when an extremely pure end product is required (baby food, for example). 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.

Fig. 2: The strength of short path distillation is that it is gentle on unsaturated fatty acids and yet provides effective purification. (Photo©: Nutriswiss)

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 as far as possible. In the end, even volatile fish oils arrive with a completely neutral taste and odour, and look 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 end 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 and method 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. Afterwards, scale-up – from small quantities of around 500 kg batches of several tons – can be done, which can be particularly interesting when developing novel foods and other specialities. In fact, the process is so successful that when a member of the research team baked a Gugelhupf (yeast based) cake with fish oil instead of baking fat for his children, they didn't notice any difference.

Among others, Nutriswiss processes the following omega-3 crude oils:
Fish oil, Algae oil, Rapeseed oil/canola oil, Linseed oil, Hemp oil, Walnut oil, Chia oil, Perilla oil

The refined or modified oil can then be delivered in:
Bags-in-Boxes, Containers, Cartons and cups, Bottles, Barrels

The omega-3 oils can be used in the following applications:
Infant formula (powdered or spray-dried), any fortified foodstuff such as dairy products or soft drinks, Pharmaceuticals (encapsulated)

References

[1]Cheng Chen et al. (2020): Erythrocyte omega-3 index, ambient fine particles exposure and brain aging, Neurology Vol. 95 (8). https://n.neurology.org/content/95/8/e995. Accessed 9 October 2020
[2]Delegated Regulation (EU) 2016/127 of the Commission of 25 September 2015. https://eur-lex.europa.eu/eli/reg_del/2016/127/oj/deu. Accessed 14 October 2020

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