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Extraction of fish oil using green extraction methods: a short review

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Abstract

This article describes green extraction methods: Supercritical fluid extraction using CO₂ (SCF-CO₂), ultrasound-assisted extraction (UAE), microwave-assisted extraction (MAE) and enzymatic hydrolysis, their process, the main disadvantages and advantages in the use in fish oil extraction from fish or fisheries processing waste briefly compared to traditional methods. Green extraction methods allows to improve oil extraction yied, optimize and innovate in pretreatment and extraction procedures. Based on reviewed scientific papers the most promising green extraction method is extraction of oil using supercritical CO₂, other methods described are still being developed.

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1. Introduction

Green extraction is based on findings and the development of the extraction process that reduces energy consumption, allows the use of alternative solvents, renewable natural substances, and provides secure high-quality extract/product, thus fulfilling the circular bioeconomy principles [1–7]. To develop and deliver a green extraction laboratory or offer green extraction on an industrial scale three main solutions have been identified as an approach for optimal raw material consumption, solvents and energy: (1) the existing process optimization and improvement, (2)

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the use of non-specific facilities, (3) innovations in processes and procedures, including the discovery of alternative solvents [8].

Fish oil is the primary natural long-chain (LC) Omega-3 fatty acid source containing two human health beneficial fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) [9]. It is scientifically proven that EPA and DHA have a positive impact on human health, they reduce the chance of heart and vascular disease, cancer, diabetes, decrease the risk of depression, as well as affect the immune system, and ensure the proper neural development. Since the beginning of biochemical and biomedical research more than 31,000 reviewed scientific articles have been published about Omega-3 fatty acids [10].

Fish oil accounts for about 2 % of world consumption of fats and oils. Traditionally, the fish oil is obtained as a by-product of the fish meal industry. But currently smaller fish with a relatively high fat content – anchovies, sardines, herring, eels are in the centre of attention as a raw material in the fish oil industry. Already historically fish oil has played a significant role in the human diet, and currently, the demand for fish oil is still growing thanks to its curative properties [9]. Fish oil is mainly used in food and pharmaceutical industry, agriculture and aquaculture as a feed additive. Around the world from 25–30 million tons of healthy fish and fish cuttings approximately 1.1 million tons of fish oil are produced [9]. While only 5 % of it is used to extract the Omega-3 fatty acids, the remaining is used in the aquaculture industry [11]. Although in some regions of Europe and the rest of the world, fisheries sector still has a great place for growth and resource optimization [34], analysis of the current situation shows that fish oil production is relatively static and the future projections show that the available fish oil sources will not be able to provide the increasing demand [9]. Therefore, the last decade has emphasized the research of a new source or species in different parts of the world, the environmental impact reduction of the extraction methods and the integration of green extraction methods in an industrial scale. This article is intended to summarize the information available on the green fish oil extraction methods, to give a brief introduction of method and define main advantages and drawbacks, and parameters influencing extraction.

2. Green extraction methods for fish oil extraction

In fish oil extraction from whole fish or fisheries waste both traditional – hydraulic pressing, heat extraction, solvent extraction, and relatively new, innovative and environmentally friendly methods – supercritical fluid extraction, enzyme extraction, microwave-assisted extraction, and ultrasound assisted extraction can be used [12, 13]. The main disadvantage of traditional methods from the quality of the product is that the high temperatures degrade heat-sensitive and labile natural compounds, and toxic solvents are used, which remains are present in the final product. Also, traditional methods often have a greater impact on the environment because the extraction process requires a significant amount of heat, there is a risk of organic solvents leaking into the environment [13]. In the last 20 years, the green extraction methods are recognized as a promising alternative to the organic solvents and oil extraction grease. Mostly it is the supercritical fluid extraction using CO₂, but also other green methods keep up with the SCF-CO₂ regarding extraction yield, product quality, the content of Omega-3 Fatty acids EPA and DHA [14]. Although the green extraction methods can ensure the same quality or product, the green methods like traditional ones also have their drawbacks (Table 1).

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