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RESEARCH

Ohmic Heating as a By-Product Valorization Platform to Extract Oil from Carp (*Cyprinus carpio*) Viscera

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Abstract

This study proposed a new application for ohmic heating (OH), i.e., extracting oil from carp viscera, a seafood processing by-product. The effects of temperature (75 ℃, 85 ℃, 95 ℃) and electric field strength (EFS) (7, 9, 22 V/cm) on the system performance and the physicochemical characteristics of the extracted oil were studied and compared with conventional heating (CH). Besides, environmental impacts were assessed based on green extraction principles. Results showed that heating rate values were higher for OH than CH (4.5–51.1 ℃/min vs. 1.0 ℃/min). Also, the specific energy consumption (SEC) of OH was lower than that of CH by 94.46%. Furthermore, replacing CH with OH reduced the extraction time from 72 to 30 min. Compared with CH, OH improved the color values and decreased the peroxide, free fatty acids (FFA), and thiobarbituric acid (TBA) values by 13.63%, 44.25%, and 93.15%, respectively. An EFS of 22 V/cm and a temperature of 95 ℃ resulted in the highest system performance (0.97), productivity (1.03 L/h), and oil yield (26.66%). Moreover, increasing temperature and EFS improved productivity. Similarly, temperature and EFS affected the viscosity and density of extracted oils. Gas chromatography–mass spectrometry (GC-MS) identified fourteen major fatty acids in the extracted oil samples. These include dodecanoic acid, n-hexadecanoic acid, and oleic acid. The approach proposed in this study valorized the carp viscera, yielded a value-added product, and improved process greenness by 50.08–69.07%. Such an approach can contribute to achieving sustainable development goals (SDGs), considering reduced energy consumption, enhanced process greenness, and increased resource efficiency through waste valorization.

Keywords Ohmic heating · Carp viscera · Electric field strength · Oil extraction · Valorization · Emerging technologies

Introduction

The production of aquaculture is about 120 Mt worldwide. Forty percent of this is utilized for manufacturing and human consumption (Delgado et al., 2003). At the same time, 60% can be considered waste, such as heads, skin, fins, gills, scales, and viscera (Halim et al., 2016). Carp (*Cyprinus carpio*) is a common fish in various regions, and its main processing by-products, viscera, is a part of the abovementioned group of waste (Al-Hilphy et al., 2021; Huang et al., 2020). This waste leads to environmental pollution problems while it can be converted into value-added products such as gelatin, bioactive peptides, protein, and fish oil (FO) (Ghaly, 2013).

Among these, FO is a vital part of the human healthy diet due to the presence of valuable components such as eicosatetraenoic acid (EPA) and docosahexaenoic acid (DHA). Health benefits of FO include preventing heart disease, depression, and brain diseases (Pradeepkiran, 2019). Also, FO is the primary source of long-chain polyunsaturated fatty acids (LC-PUFAs) that enter human consumption to play various essential roles associated with general health and well-being. Fish oil comprises triglycerides, phospholipids, wax esters, and glycerol ethers (Saleh et al., 2022). Consuming fats rich in omega-3 fatty acids regularly and in adequate amounts provides a wide range of health benefits, such as inhibiting inflammation, cardiovascular disease, diabetes, arthritis, and ulcerative

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