LWT - Food Science and Technology 129 (2020) 109541

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Infrared-assisted oil extraction for valorization of carp viscera: Effects of process parameters, mathematical modeling, and process optimization

Asaad Rehman Al-Hilphy[a], Sabah Malik Al-Shatty[a], Atheer Abdul Amir Al-Mtury[a], Mohsen Gavahian[b,*]

[a] Department of Food Science, College of Agriculture, University of Basrah, Iraq
[b] Department of Food Science, National Pingtung University of Science and Technology, Pingtung, 912, Taiwan, ROC

ARTICLE INFO

Keywords:
Infrared heating
Fish viscera oil
Process optimization
Waste valorization
Emerging food processing technologies
Data modeling

ABSTRACT

This study proposed a new infrared-based oil extraction technique and investigated the applicability of this method for the recovery of oil from the viscera of common carp (*Cyprinus carpio* var. *communis)* at pilot-scales. An optimization attempt was performed to understand the effects of independent process parameters of this novel valorization approach, i.e., input power (130–250 W), temperature (50–70 °C), and the radiation distance (1–30 cm), on oil yield (OY), viscosity, thiobarbituric acid (TBA), free fatty acid (FFA), and peroxide value (PV) using the response surface methodology. The optimal extraction conditions were found to be the input power of 168.3 W, the temperature of 70 °C, and a distance of 6.08 cm. OY, viscosity, TBA, FFA, and PV at these processing conditions are expected to be 23.73%, 3.04 Pa.s, 1.55 mg malonaldehyde/kg oil, 0.675%, and 2.83 meq/kg oil, respectively. Besides, statistical results showed reduced cubic and quadratic models were well-fitted on the experimental data to predict PV and OY, respectively. The proposed valorization technique has a good potential for industrial adaptation considering the simplicity of the technology, ease of process control, and the possibility of enhancing the fish oil quality and quantity.

1. Introduction

Fish oils are considered valuable products as they contain large amounts of unsaturated fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). It was reported that people who consume fish oil regularly, i.e., the recommended daily dosage of 0.5 g EPA and DHA, are characterized by low cholesterol in their blood serum (Skulas-Ray et al., 2019). Such effects can reduce the risk of cardiovascular disease (Parletta et al., 2019). This can be considered as one of the reasons for the growing trends of fish farming and processing around the world.

It was reported that the total production of edible fishes was about 80 million tons in 2016 (Eurostat, 2018). At the same time, the development of the fish processing industry is generating increasing amounts of waste, such as viscera, that may constitute more than fifty percent of fish used in industrial processing (Eurostat, 2018). Such amounts of waste can be considered an environmental concern and an additional expense such as waste handling and treatment costs. Recently, waste valorization to produce value-added products from the food processing by-products, such as fish waste, has attracted the attention of the researchers around the world this can reduce the environmental issues and bring more profits for the industry (Gavahian, Chu, et al., 2019; Gavahian, Munekata, et al., 2019). For example, a recent study highlighted that fish wastes can be a used a good source to obtain valuable edible oils (Galanakis, 2019).

Solvent extraction is probably the most common extraction method that has been used for fish oil extraction. However, this method suffers from several drawbacks, such as introducing toxic chemicals (e.g. hexane) in the product which is associated with safety and environmental concerns (Bonilla-Mendez & Hoyos-Concha, 2018). To address issues associated with the conventional oil extraction methods, researchers proposed several innovative extraction techniques including supercritical fluids extraction, biological approaches, and infrared-assisted extraction (Bruno, Ekorong, Karkal, Cathrine, & Kudre, 2019; Ye, Xue, & Shi, 2019). Among these emerging technologies, the latter seems to have good potential for industrial application due to a relatively lower capital cost compared to other methods such as supercritical fluids extraction (Adeoti & Hawboldt, 2014).

Infrared is a part of the electromagnetic spectrum with wavelength ranges from 0.75 to 1000 μm (Aboud, Altemimi, Al-HiIphy, Yi-Chen, &

* Corresponding author. Department of Food Science, National Pingtung University of Science and Technology, Pingtung, 912, Taiwan, ROC.
E-mail address: mohsengavahian@yahoo.com (M. Gavahian).

https://doi.org/10.1016/j.lwt.2020.109541
Received 24 December 2019; Received in revised form 6 April 2020; Accepted 3 May 2020
Available online 11 May 2020
0023-6438/