Received: 16 May 2019 | Revised: 4 November 2019 | Accepted: 22 November 2019

DOI: 10.1111/jfpp.14343

ORIGINAL ARTICLE

Journal of Food Processing and Preservation | Institute of Food Science + Technology ifst | WILEY

Supercritical fractionation of antioxidants from algerian *Opuntia ficus-indica* (L.) Mill. seeds

Souad Khaled[1] | Farid Dahmoune[1,2] | Khodir Madani[3] | José Santiago Urieta[4] | Ana Maria Mainar[4]

[1]Laboratoire de Biomathématiques, Biophysique, Biochimie, et Scientométrie (L3BS), Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, Bejaia, Algérie

[2]Département des Sciences Biologiques, Faculté des Sciences de la Nature et de la Vie et des Sciences de la Terre, Université de Bouira, Bouira, Algérie

[3]Centre de Recherche en Technologies Agro-Alimentaires, Université de Bejaia, Algérie

[4]GATHERS Group, I3A (Aragón Institute of Engineering Research), Universidad de Zaragoza, Zaragoza, Spain

Correspondence
Farid Dahmoune, Laboratoire de Biomathématiques, Biophysique, Biochimie, et Scientométrie (L3BS), Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, Bejaia 06000, Algérie
Email: farid.dahmoune@yahoo.fr

Funding information
Ministry of Higher Education and Scientific Research

Abstract

The recovery of active ingredients from vegetable wastes is a very attractive research field for the development of a sustainable economy. In order to revalue the waste from the extraction of oil of *Opuntia ficus-indica* seeds, in this study cakes resulting from the pressing were macerated in ethanol and then a Supercritical Antisolvent Fractionation (SAF) technique was used for the recovery and enrichment of the antioxidants present in the ethanolic extract. Catechin, epicatechin, and ferulic acid, as characteristic antioxidant components, were identified and quantified by HPLC in the fractions obtained through SAF. A series of 11 SAF experiments was programed by Response Surface Methodology (RSM) to optimize the recovery of the original extract and the yield in antioxidants. Optimal SAF conditions were: 15 MPa pressure, 30 g min^{-1} CO_2 flow rate, and 13.6 MPa, 10 g min^{-1} CO_2 flow rate for extract mass recovery (77.96%), and epicatechin yield (3.81%), respectively.

Practical applications

Due to the worldwide diffusion of *Opuntia ficus-indica* (L.) Mill. seeds, its valorization for the recovery of bioactive compounds with potential diversified applications (food, cosmetic, pharmaceutical, and material sectors) can represent an important source of additional income for the producers allowing, at the same time, the production at reduced costs of bioactive-based products. Industrial large scale implementation of such recovery strategies requires the development of a cost-effective process. Emerging technologies based on Supercritical Antisolvent assistance has been increasingly investigated for this purpose. This work demonstrated the possibility of exploiting the SAF technique to obtain extracts remarkably enriched in valuable antioxidants from industrial wastes resulting from the obtaining of seed oils. The operation time is short and the activity of the antioxidants contained in the starting material preserved. This laboratory- model could advantageously be scaled to a acomercial plant within the framework of Green Chemistry.

1 | INTRODUCTION

Opuntia ficus-indica (L.) Mill (OFI, common names: Prickly pear cactus, nopal) is a species of cactus that belongs to the *Cactaceae* family, order *Centrospermae*, and genus *Opuntia* (El Kossori, Villaume, Boustani, Sauvaire, & Méjean, 1998; Kuti, 2004). This plant, which originally came from Mexico, had been domesticated in other countries and proliferates today on dry and stony lands of the five

