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Inclusion complexes of *Melia azedarach* L. seed oil/β-cyclodextrin polymer: preparation and characterization

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Abstract
The objective of the present study is the encapsulation of *Melia azedarach* L. seed oil by the β-cyclodextrin–epichlorohydrin polymer to protect it against external environmental factors and also to increase its solubility. The encapsulation of this oil was carried out by the lyophilization method. The chemical composition of the extracted oil revealed that the main components identified were: linoleic (62.38%), oleic (26.95%), palmitic (05.80%) and stearic (02.37%) acids. Characterization of the β-cyclodextrin–epichlorohydrin polymer determined by different analytical techniques: nuclear magnetic resonance spectroscopy (^{1}H NMR), Fourier transform infrared spectroscopy (FT-IR), scanning electron microscopy (SEM) showed that the β-cyclodextrin–epichlorohydrin polymer adopts inclusion complex formation with β-cyclodextrin, a high molecular weight and higher solubility. The encapsulation of the oil with this polymer was also characterized and showed that the capsules obtained had an average size of 232.133 ± 3.52 nm with a polydispersity index of 0.226 ± 0.010.

Keywords *Melia azedarach* L. seed oil · β-cyclodextrin–epichlorohydrin polymer · Encapsulation · Freeze-drying method · Characterization

Introduction

Melia azedarach Linn. (*Meliaceae*), known as "Persian lilac" is a large tree native to Asia. It is found in China, India, South and Central America (Aoudia et al. 2012; Ben Ghnaya et al. 2013). Previous literature revealed that *Melia azedarach* (*M. azedarach*) has been successfully introduced as ornamental species because of its high tolerance to extreme environments and great potential to compete for nutrition resource as well as its high growth rate and prolific seed production (M'rabet et al. 2017). Subsequently, it was adapted in the Middle East and North Africa (Alaoui Ismaili et al. 2016). *M. azedarach* is known for its anticancer, antimalarial, analgesic, anti-inflammatory, anti-helminthic, antilithic, diuretic, astringent and stomachic properties (Faheem Khan et al. 2018). These therapeutic virtues are due to its richness in chemical compounds such as triterpenoids, limonoids, fatty acids and phenolic compounds (Kumazawa et al. 2013). Previous literature revealed that *M. azedarach* seed oil is composed of four important fatty acids: palmitic acid, stearic acid, oleic acid and linoleic acid (Bachheti et al. 2012). It is reported that this seed oil possesses several medicinal properties such as: anti-ulcer, anticancer, anti-diabetic, anti-inflammatory, antifungal, insecticidal, antibacterial and antioxidant (Maciel et al. 2006; Viqar Khan et al. 2011; Erdogan Orthan et al. 2012). However, its use has been limited due to its strongly bitter taste and strong odor (Devi and Maji 2011). Also, this oil is known for its thermosensitivity and may be subject to change when it is exposed to light for long periods of time or at temperature approaching 50 °C. To remedy this problem of oil instability, the encapsulation method is an effective means to protect seeds' oil against environmental damage and ensure its shelf life (Devi and Maji 2010). Cyclodextrins have been widely used for the encapsulation of essential oils (Cabral Marques. 2010). They can create a protective barrier around the oil to protect it from environmental damage. Cyclodextrins (cyclic oligosaccharide)

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