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Effect of the addition of Chachafruto flour on the stability of oil-in-water emulsions and the physicochemical properties of spray-drying microcapsules

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ABSTRACT

This study aimed to assess the suitability of Chachafruto flour (CHF) as a stabilizing agent for an oil-in-water emulsion and its impact on the physicochemical properties of the emulsion after spray drying. Emulsions with varying CHF concentrations (2 %, 3 %, and 4 %) were prepared and compared to a control. The results from the creaming index and particle size (emulsion) analyses indicated that the highest emulsion stability was achieved with 4 %CHF, attributed to its protein content (20.5 %). The encapsulates exhibited spherical and rough surface morphologies but without holes on the surface. Low moisture content (MC < 5 %) and water activity ($a_w < 0.2$) were associated with powder stability. The encapsulates added with CHF showed good reconstitution properties. FTIR confirmed the absence of chemical interactions during the encapsulation process, contributing to the stability. Furthermore, the addition of CHF improved the thermal stability of the encapsulates. This study represents the first investigation on the emulsifying potential of Chachafruto flour.

1. Introduction

The encapsulation of oil and lipophilic compounds has been used to extend the shelf life of the core ingredients. In the food and pharmaceutical industry, encapsulation is achieved through the implementation of chemical (coacervation, molecular inclusion, and co-crystallization) or physical methods (spray-drying, extrusion, freeze-drying, vacuum drying, spray-cooling or chilling, and fluidized bed coating) (Sonawane, Bhanvase, Sivakumar, & Potdar, 2020). Among these methods, spray drying is considered one of the most suitable techniques for encapsulation purposes. The encapsulation of lipophilic compounds by spray drying comprises a two-stage process (Esparza, Ngo, & Boluk, 2020). In the first stage, a stable oil-in-water (O/W) emulsion is prepared with suitable viscosity characteristics for the drying equipment (Umaña, Wawrzyniak, Rosselló, Llavata, & Simal, 2021). Meanwhile, in the drying stage, the O/W emulsion is fed through an atomizer and is put in contact with either a co-current or counter-current hot gas flow responsible for the dehydration of the sample until it becomes a powder (dry emulsion) (Daza et al., 2016). However, different drawbacks can negatively impact the stability of the emulsions before and during the drying stage, such as coalescence, creaming, sedimentation, flocculation, oiling off, and Ostwald ripening (Esparza et al., 2020; Yan et al., 2020). Therefore, emulsion stabilization is an essential step in producing dry emulsions.

Emulsifiers are ingredients that can be adsorbed to droplet surfaces and reduce the interfacial tension, thereby facilitating droplet breakup and favoring emulsion stability (Yan et al., 2020). At the industrial level, synthetic emulsifiers such as glycerin fatty acid esters, polysorbates, sorbitol anhydride fatty acid esters, sucrose fatty acid esters, and soybean ester phospholipids and others are commonly used (Nagtode et al., 2023; Soni et al., 2023). However, using these additives in different foods or processed products can negatively impact the overall quality of the products, such as food taste. More recently, the adverse impact of these additives on consumer health has been proven (Gao et al., 2016; Partridge et al., 2019). In this context, the search for new natural, renewable, clean-label, and environmentally friendly sources of emulsifiers has become a challenge for researchers (Burgos-Díaz et al., 2018; Francisco, de Oliveira Júnior, Marin, Alvim, & Hubinger, 2020; Umaña, Turchiuli, Rosselló, & Simal, 2021). The emulsifying properties of plant proteins, including soybeans, peas (Francisco et al., 2020; Ribeiro, Morell, Nicoletti, Quiles, & Hernando, 2021), and cereals (Rosenberg, Rosenberg, & Zhang, 2018) have been widely studied as have shown good emulsifying properties mainly due to their surface activity and fast interfacial adsorption kinetics. However, using these crops for non-food

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