Chapter 1

Introduction

1.1. Background

In recent years, the importance of natural food additives has been accumulating an increased amount of interest both from consumers and food manufacturers. The public will generally select food products that contain little to no additives, but may settle with foods added with natural additives over their synthetic analogues when non-additive products are absent (Carocho et al., 2014). This is affirmed by several studies that have found consumer's higher awareness towards health in correlation to tendency to choose food additives from natural sources when compared to their artificial counterparts (Bearth et al., 2014; Mitterer-Daltoé, 2021). Thus, the development of naturally obtained food additives may be considered to be one of the current primary focus in global food research.

Pandanus conoideus Lamk. is an endemic *Pandanus* plant to Papua Islands which spreads in Maluku, Papua, West Papua, as well as Papua New Guinea (Murtiningrum et al., 2012). The fruit of *Pandanus Conoideus Lamk* is locally known as *buah merah*, which literally means red fruit. Red fruit extract or oil is commonly used by the local inhabitants as traditional medicine, food, and natural colourants (Sirait et al., 2021). These wide applications of red fruit derivatives are primarily due to its high abundance of nutrients, namely α-carotene, β-carotene, tocopherol, unsaturated fatty acids (oleic and linoleic acids), vitamin C, protein, decanoic, calcium, and fiber (Inayatilah et al., 2022; Kio et al., 2018). Among those nutrients, the high concentration of carotene of the fruit has been recorded as one of the potential sustainable sources of natural food colourant.

The extraction of a food colourant isolated from an oil-based source, however, may lead to a substantial drawback of low solubility in water, which inhibits its usage and bioavailability for food application (Katherine et al., 2018). This principle is affirmed by findings from several studies which stated carotenes to have an extremely low solubility in water (Chen et al., 2017; Ishimoto et al., 2019;

Moreira et al., 2019). This major limitation of carotenoids may be attributed to its high inherent hydrophobicity nature (De Paz et al., 2014; Polyakov et al., 2009). Hence, a treatment to improve the solubility of red fruit oil-based food colourants is necessary.

Various methods to improve the functionality and physical properties of food bioactive compounds have been invented and advanced over the last decades. One such technique is encapsulation, which is defined as a process to entrap or surround an active food component with an inert coating material (Abd El Kader & Abu Hashish, 2020; Timilsena et al., 2020). Food encapsulation consists of numerous methods with a large dependency on heating processes, namely spray drying, freeze drying, extrusion, fluid bed coating, and co-crystallization (Nedovic et al., 2011). Among these applications, co-crystallization may be contemplated as one of the most advantageous techniques due to its functional simplicity and substantial benefits. In food discipline, co-crystallization is defined as a process to incorporate a secondary active compound into a sucrose crystal matrix by the principle of rapid crystallization of the sugar supersaturated solution in the presence of heat (Bhandari et al., 1998). Co-crystallization offers simple and cost-effective physical properties improvements of the active ingredient, which include solubility, stability, wettability, anti-caking, antiseparation, flowability, and homogeneity (Chezanoglou & Goula, 2021). A study by Karangutkar & Ananthanarayan (2019), for instance, has revealed the application of co-crystallization to increase the storage stability of betacyanin pigments due to combination of low water activity and high sucrose concentration, which inhibits the growth of microorganisms. Another study example by Katherine et al. (2018) has also shown the implementation of dextrose co-crystallization to increase the solubility of curcumin (natural food colourant) up to 25 mg per mL of water when compared to its pure extract. Formulation of co-crystallized red fruit oil (RFO) in conjunction with sucrose, emulsifiers, and stabilizers has been investigated by our previous studies, which had analyzed several important parameters of co-crystallized RFO, such as total carotenoid content (TCC), solubility, storage stability, and color. The post-dissolution stability of the powder with emulsifier and stabilizers, however, has not been thoroughly studied.

Post-dissolution system of co-crystallized red fruit oil powder in water will create an emulsion, as water (polar) and oil (non-polar) will both be present. Emulsion may be defined as a mixture of two or more immiscible liquids consisting of dispersed and continuous phases. Emulsions in general are thermodynamically unstable due to unfavorable contact between oil and water molecules, which will cause the two phases to become separated via aggregation or fusion of droplets (Akbari & Nour, 2018). There are several emulsion instabilities, but creaming may be regarded as the most common issue to occur in an oil-in-water emulsion, as such in milk and other dairy products (Silva & Chandrapala, 2021; Tarannum & Pooja, 2021). Creaming is the migration of droplets to the surface of an emulsion due to the buoyancy of the emulsion droplets as a result of density differences of the dispersed and continuous phase (Wilde, 2019). Creaming may be analyzed with Creaming Index, a simple and widely used assay to evaluate the occurrence of creaming via visual observation of oil separation on the top of an emulsion (Maphosa & Jideani, 2018).

Stability of carotenoids, as the primary source of color, is essential to be measured in the co-crystallized red fruit oil emulsion system to predict its potential as a food colorant. Carotenoids are well-investigated to degrade overtime due to its high susceptibility to numerous environmental degradations, such as light, thermal, oxygen, and acid (Boon et al., 2010). The carotenoid content retention of co-crystallized red fruit oil emulsion system during storage is therefore also important to be analyzed to determine its applicability in foodstuffs. Thus, the objective of this study is to assess the post-dissolution stability of co-crystallized red fruit oil added with emulsifier and stabilizers in relation to Creaming Index and Total Carotenoid Content (TCC).

1.2. Objective

This research aims to:

a. Investigate potential methodologies to assess the post-dissolution stability of co-crystallized red fruit oil samples.

b. Assess the post-dissolution creaming stability of co-crystallized red fruit oil samples added with stabilizers using the creaming index method.

c. Analyze the post-dissolution carotenoid content stability of co-crystallized red fruit oil samples added with stabilizers using spectrophotometric method.

1.3. Hypothesis

a. H_O: There are no significant differences on the creaming index between co-crystallized RFO samples in water after 3 days of storage.

   H_1: There are significant differences on the creaming index between co-crystallized RFO samples in water after 3 days of storage.

b. H_O: There are no significant differences of carotenoid content of dissolved co-crystallized RFO samples after 3 days of storage.

   H_1: There are significant differences of carotenoid content of dissolved co-crystallized RFO samples after 3 days of storage.