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Microencapsulation of Kabocha Pumpkin Carotenoids

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***Abstract*—Kabocha pumpkin (*Curcubita maxima* [Duchesne ex Lamb.]) is a potential source of carotenoids. However, the usage of carotenoids is limited due to their instability and also their susceptible degradation against harmful conditions such as base and acidic conditions, oxidation, and illumination. In this study, kabocha carotenoids were incorporated into microencapsulation containing chitosan, sodium alginate and sodium tripolyphosphate. The objective of this study is to determine the formulation of coating agents, carotenoid stability in acidic conditions for mimicking the microencapsulation process, and to characterize the microencapsulated carotenoids including the determination of the efficiency of carotenoid incorporation into microencapsulates. A mixture of sodium alginate, chitosan and sodium tripolyphosphate (0.19 g : 1.92 g : 0.24 g, w/w/w) was the best of coating agents according to the physical characteristics and also its moisture content. Microcapsules obtained with and without addition of carotenoids were determined to be a microparticle size by SEM analysis. The products of microencapsulated carotenoids have the water content of around 5.4% to 7.1%.The highest efficiency of microencapsulation obtained was 91% at the carotenoid concentration of 117.98 μg · g^{-1} (0.5 %, w/v), although the efficiency was decreased with increasing carotenoids added to the microcapsules probably due to over loading of carotenoids used. The pattern of this efficiency was in line with L* and °hue values, whereas not only a*, b*, and chroma values, but total carotenoids, and total provitamin A also increased.**

***Index Terms*—Carotenoids, emulsion, kabocha (*Curcubita maxima* [Duchesne ex Lamb.]), microencapsulation, pumpkin.**

I. Introduction

Carotenoids have several functional benefits for human body. Carotenoids have roles in epithelisation process, influencing cell progression of the fibroblast, antioxidant, in protecting agent of UV radiation and decreasing the skin cancer risk. In addition, some types of carotenoids have a role as provitamin A [1]. However carotenoids are susceptibly degraded by harmful conditions, i.e. light radiation, high temperature, and the presence of acid or oxygen. These conditions may degrade their quality on disappearance of color, rancidity and decrease in bioactivity and food functional roles [2].

Some protecting techniques have been explored to protect pigments from the degradation. Encapsulation is a common way that protects bioactive molecules by entrapping them into other substances and also that changes the size of particles into nano- or microparticles. Microencapsulation is encapsulation which produces micro particles (1 μm to 1000 μm) [3]. Microencapsulation has been applied in some kind of food products and usually uses spray-drying (high temperature) as a drying method while microencapsulation conducted by freeze dryer is still rare. The Freeze drying method produces the best quality for final product and does not change the bioactive composition in food because it uses low temperature. Suitable coating agents are needed in the encapsulation process, because the coating agents give protecting barrier to the bioactive compounds. Chitosan and sodium alginate are two kinds of coating agents that have been used for microencapsulation in pharmacy. These two agents give a good synergy in forming transparent, flexible, and strong film, and have high tensile strength [4], [5]. Preparation of microcapsule via emulsification with biopolymer combined with freeze drying technology is known to produce microspheres, having a particle size ranging between 20 μm and 5 000 μm [5].

Kabocha pumpkin (*Cucurbita maxima*) Duchesne is a potential carotenoids source. Kabocha has higher carotenoids content (285.91 mg·100 g^{-1}) than local pumpkins (26.62 mg·100 g^{-1}) [6]. In present study, the microencapsulation process of carotenoids from kabocha was conducted by freeze dryer. The best proportion of chitosan-sodium alginate-sodium tripolyphosphate (STPP) as coating agents of microencapsulated carotenoids would be chosen. The addition of different carotenoid concentrations was evaluated to determine microcapsules characteristics, such as color properties and encapsulation efficiency. The final product of microencapsulated kabocha carotenoids can be utilized as natural carotenoid powder with high stability.

II. Materials and Methods

A. Materials and Reagents

Kabocha and sunflower oil (Golden Bridge, Malaysia) were purchased from Lai-Lai Fruit Market (Malang, Indonesia). Chitosan and Sodium Tripolyphosphate (STPP) (Changzhou Kamadi Trading Co., Ltd, Changzhou, China), sodium alginate (Qingdao Hyzlin Biology Development, China), tween 80 (Sigma Aldrich, St. Louis, United States), demineralized water with resistivity 100×104 Ω cm, N_2 gas (UHP grade, PT Samator, Surabaya, Indonesia) were used directly. Glacial

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