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Encapsulation, Properties, and Thermal Study of Red Biocolorant from Selected Plants Obtained Through Physical Extraction

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***Abstract*—The human perception on food is closely associated with its color. Since the standard manufacturing procedure often causes partial even total degradation of natural pigments, resulting in color fading, the addition of colorants becomes necessary. Natural colorant, produced from plants or animals, has health promoting effects, better safety, and need not any specific toxicity evaluation. However, the extraction method will be crucial in determining the properties of this biocolorant. In the present study, red biocolorant was prepared from selected local plants i.e., red spinach, red cabbage, beetroot, and dragon fruit, through physical extraction in order to avoid the using of organic solvents. Then, we applied the encapsulation technique and evaluated its coloring and antioxidant properties, as well as its stability against thermal treatment. The results showed that the encapsulated biocolorant of red spinach and beetroot exhibited red hue at pH range 2-11, whereas those of red cabbage and dragon fruit indicated color alteration at different pH. The prominent red hue intensity was found at pH 4 for encapsulated beetroot extract, which endured up to 10 days at aqueous buffered solution when stored in the dark at 20^0C. In addition, it underwent merely low degradation (~30%) during incubation at 60^0C for 30 minutes. The antioxidant activity of encapsulated biocolorant of beetroot was comparable to that of red cabbage, being higher than the others.**

***Index Terms*—Biocolorant, coloring properties, encapsulation, red, thermal stability.**

I. Introduction

It is widely known that color is one of the prime factors in food choice, besides its physical appearance and odor. The appetite stimulators are red and yellow, while the most potential suppressor is blue [1]. Food industries have extensively used both synthetic and natural colorants in order to embellish their products, either giving new color or just improving the color after processing treatment that might cause fading. Although the properties of synthetic colorants are unrivaled, the health-aware consumers and regulatory authorities have unavoidably led the worldwide movement towards more natural colors in food [2]. The Royal Society of Chemistry recently published that over than ninety percent of European new products released during 2011 – 2016 have applied natural colors [3].

According to our latest market survey at several supermarkets in East Java, Indonesia, the use of non-synthetic colorant was dominant in baby food and (100%) and dairy products (60%), while its utilization on other categories was less than 20%, even none for instant meals. Our finding was in line with the common concept of human perception. The yellow beta-carotene (23%) and red carmine (21%) were predominantly employed beside the other natural sources such as annatto, curcumin, caramels, chlorophylls, and anthocyanins [4]. In fact, there is the 'carmine problem' which is related to its nauseating animal origin, aluminium content, microbiological issues, as well as its ability for inducing severe allergic reactions led to several public scandals [5]. Consequently, there is an urgent need for potential substitutes, coming from pigments or plant origin.

Some plants have been mentioned as the possible alternative for production of red biocolorant, i.e. dye sorghum (*Sorghum bicolor*), fruit of *Optunia stricta*, beetroot (*Beta vulgaris* L.), dragon fruit (*Hylocereus polyrhizus*), roselle (*Hibiscus sabdariffa*), and other plants of the Amaranthaceae [6]–[11]. Moreover, the subsequent concern is addressed to the preference of extraction and concentration method that should be able to compromise the instability of natural pigments, inexpensive, food-grade process, and environmental friendly. To the best of our knowledge, there is only a limited number of study in the production of red biocolorant which relied on solvent-free extraction and nonthermal processing.

In the present work, we encapsulated the red biocolorant, physically extracted from red spinach, red cabbage, beetroot, and dragon fruit, and then evaluate its properties and thermal stability. The encapsulation procedure is followed by lyophilization to give concentrated red biocolorant in powder form. Reconstitution of red biocolorant in buffered solution was intended to verify the influence of pH on its coloring properties and thermal stability. The antioxidant assay was carried out to examine the potency of these red biocolorants as functional food ingredients.

II. Materials and Methods

A. Materials

The red spinach (RS), red cabbage (RC), beetroot (BR), and

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