PRELIMINARY STUDIES ON PHYSIOCHEMICAL CHARACTERIZATION OF ENCAPSULATED COCOA POWDER

Muhammad Bilal Muslim*, Armizan Che Men
Cocoa Innovation and Technology Centre, Malaysian Cocoa Board, Lot PT 12621, Nilai Industrial Park, 71800 Nilai, Negeri Sembilan[a]
**Corresponding author: bilal@koko.gov.my*

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ABSTRACT – *Microencapsulation is a versatile technique that can be used to encase a variety of substances, including flavors, colors, nutrients, and pharmaceuticals. It is a valuable tool for the food industry, as it helps to protect flavors and control their release. The use of microencapsulation in cocoa powder is now gaining the attention of the food industry. Most of the industry today are demanding the improving of quality of cocoa powder in terms of physical properties. Hence, this study will provide the information of physical properties of normal cocoa powder, high fat cocoa powder and encapsulated cocoa powder in terms of bulk density and hygroscopicity characterization. Three type of cocoa powder will be used for this study which are normal cocoa powder, high fat cocoa powder and encapsulated cocoa powder. The encapsulated cocoa powder shows more promising result on water resistant behaviour which have high bulk density and lower hygroscopicity values. The utilization of microencapsulation technology can increase the quality of cocoa powder in terms of characterization.*

Key words: Cocoa Powder, Microencapsulation, Physiochemical, Bulk Density, Hygroscopicity

INTRODUCTION

Cocoa (*Theobroma cacao L.)* is a crop that contributes the most to Malaysia's agricultural economy, after oil palm and rubber. Cocoa plantations are concentrated in Sarawak and Sabah, with 5,000 hectares and 5,500 hectares, respectively. Peninsular Malaysia has 4,500 hectares of cocoa plantations. (Majid & Rining, 2019). The demand for cocoa and cocoa-based products is high, and it is expected to continue to grow in the coming years (Bermudez, Voora, Larrea, & Luna, 2022). Malaysia's export of cocoa-based products, such as cocoa powder, cocoa butter, and chocolates, has also increased in recent years. These products are popular and in high demand in many countries due to their unique flavor and aroma.

Cocoa powder is one of the product that widely consumed by consumers for variety purpose. Cocoa powder is a key ingredient in many cocoa-based products, such as ice cream, drink, and cake fillings. It is made by pressing cocoa liquor, which is a thick, dark liquid made from roasted cocoa beans. The pressing process removes some of the fat from the cocoa liquor, leaving behind a solid mass called cocoa cake. The cocoa cake is then ground into a powder, which is cocoa powder (Caligiani, Marseglia, & Palla, 2016). The fat that is removed from the cocoa liquor is called cocoa butter, and it is reused as an ingredient in chocolate and other cocoa-derived products. Cocoa powder comes in two main varieties: natural and Dutch-processed (Miller, *et al*., 2008). Basically, natural cocoa powder will be made by pressing cocoa liquor and then grinding the solids into a powder. It will have a light brown color and a slightly acidic flavor. Dutch-processed cocoa powder is made by treating cocoa liquor with an alkaline solution, which changes the pH and gives the powder a darker brown color. Both natural and Dutch-processed cocoa powders are good sources of antioxidants, which have been shown to have some health advantages, such as lowered the risk of heart disease and stroke (Hackman, *et al*., 2008). They are also good sources of dietary fiber and iron.

The demand for cocoa powder in industry is expected to increase in the next 5 years. Most of the industry today is demanding the improving quality of cocoa powder in terms of moisture absorption. The utilization of microencapsulation technology can increase the quality of cocoa powder in terms of characterization (Zain, Osorio, & Herrera, 2017). However, there is lack of literature that focused on the effect of microencapsulation on cocoa powder and what is the performance in terms of characterization.

Microencapsulation is a promising technology for the efficient delivery of natural compounds into food products. (Mahdavi, Jafari, Ghorbani, & Assadpoor, 2014). This technique involves trapping volatile compounds in a solid material, which helps to prevent them from evaporating, breaking down, or developing off-flavors while being stored. Microencapsulation with the addition of coating materials can be done with various techniques, including spray-drying (Kolanowski, Ziolkowski, Weißbrodt, Kunz, & Laufenberg, 2006). Various materials are used as coating agents such as maltodextrin, Arabic gum, disaccharides, starches, chitosan-cellulose. However, there are lack of information that cover the physiochemical properties of normal and encapsulated cocoa powder. Limited information has been provided from previous study about cocoa powder encapsulation such as the literature that has been conducted by Zain *et al*., (2017). However, the researchers only investigated how microencapsulation by spray drying affected the preservation of cocoa aroma compounds and not cover the behavior of the normal and encapsulated cocoa powder. This means that previous research has not looked at how microencapsulation affects the physiochemical properties of cocoa powder, such as its bulk density and hygroscopicity. .Hence, that gap of information that covered on the behavior and characterization of normal and microencapsulation cocoa powder will be provided in this research.

MATERIALS AND METHODS

Materials

Three samples which are normal cocoa powder (NC), high fat cocoa powder (HFC) and encapsulated cocoa powder (EC) were purchased from the local and international market. All these samples will be tested for the comparison study of physical properties of these three different types of cocoa powders. All these three cocoa powders were kept in dry and cold places.

Figure 1 Three different cocoa powder (a) Normal cocoa powder (b) High fat cocoa powder (c) Encapsulated cocoa powder

Bulk tapped density

Bulk tapped density was determined according to Regiane, Soraia, Diego, & Eric, (2013) with some modification. Approximately 5 g of each cocoa powder will be placed in a 25 mL of graduated cylinder. The cylinder was repeatedly lifted and tapped on a hard surface, lifted and dropped the cylinder under its own weight until the powder did not present a difference in the occupied volume. The bulk density of cocoa powder was calculated by dividing the mass of the cocoa powder by the final volume that it occupied(M_f) with the volume of cocoa powder (V) in the cylinder. All experiments will be performed in three replicates. Bulk density is express as mg of powder per mL (mg/mL). The following equation from Amidon, Meyer, & Mudie, (2017) for the bulk density will be used as shown below:

$$Bulk\ density\ of\ cocoa\ powder\ = \frac{M_f}{V} \qquad (1)$$

Hygroscopicity

Hygroscopicity is a measure of how much moisture a powder will absorb from the air. It is calculated by measuring the amount of moisture that a powder absorbs after being exposed to humid environment with relative humidity of 81%. (Etzbach, Meinert, Faber, Klein, & A., 2020). For the determination of the hygroscopicity, 1 g of powder will be weighed in an aluminium dish and placed in a humidity chamber at 25 °C. The weight gain will be determined in triplicate after 1, 3, 7, and 24 hours and the moisture absorption will be calculated with the following equation:

$$Moisture\ Absorbtion(\%) = \frac{Final\ Weight}{Initial\ Weight} \times 100 \quad (2)$$

RESULTS AND DISCUSSIONS

Physiochemical Properties

Bulk Density Analysis

Tapped bulk density is an essential consideration for packaging and commercialization powders. A dry product with a high mass per unit volume can be stored in a smaller container than a similar product with a low mass per unit volume. (Fernandes, Borges, Botrel, & Cassiano, 2014). Hence, the small storage size is important for cocoa powder because it allows for better storage. The results from previous bulk analysis were recorded and tabulated as shown in Table 1.

Table 1: The bulk density of different cocoa powder

Sample	Bulk Density (g/cm3)
Normal Cocoa Powder	0.3846
High Fat Cocoa Powder	0.4545
Encapsulated Cocoa Powder	0.6250

From Table 1, the encapsulated cocoa powder provides the highest value of bulk density which is 0.6250 g/cm3 compared to another three samples. Meanwhile, the normal cocoa powder has the lowest bulk density which is 0.3846 g/cm3 respectively. This behavior can be impute to the bigger particle size of the normal cocoa powder in comparison to others, which can make a better ordering of the particles, thus occupying more space (Ziegler & Hogg, 2008).

Hygroscopicity Analysis

Hygroscopicity is the ability of powders to take on water in a humid environment. The water absorption rate is a key factor in microencapsulation because water may influence the lipid oxidation process and the loss of flavoring compounds. The hygroscopicity studies were run in terms of moisture absorption. The moisture was calculated and tabulated as shown in Table 2.

Table 2: The amount of moisture absorption after several hours (g H_2O/g powder)

Sample	**Time (hours)**			
	1	3	7	24
Normal Cocoa Powder	4.73	7.07	7.4	7.59
High Fat Cocoa Powder	1.69	2.79	3.33	3.72
Encapsulated Cocoa Powder	0.92	1.76	2.17	2.35

From Table 2, the values were obtained between 0.92 g H_2O/g powder and 7.59 g H_2O/g powder for all samples. However, the encapsulated cocoa powder shows the lowest increasing trend of moisture absorption compared to another three samples. Meanwhile, the normal cocoa powder shows the higher amount of moisture absorption. This is due to the hydrophobic nature of the wall material itself, which does not absorb water. The lowest hygroscopicity values were found in high concentrations of wall material. Basically, the encapsulated cocoa powder is coated with wall material in order to protect the core material from the outside exposure (Choundury, Meghwal, & Das, 2021). This demonstrates the efficiency of the wall material as the carrier agents in dealing with materials with low hygroscopicity values.

CONCLUSIONS

The encapsulating cocoa powder shows better characterization of anti-moist cocoa powder compared to another cocoa powder. Encapsulated cocoa powder provide higher bulk density and the lowest increasing trend for hygroscopicty analysis. The study's findings suggest that encapsulated cocoa powder has superior physiochemical properties to regular cocoa powder, making it a promising product for the food industry in the future.

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