Comparison of Material Handling and Process Preparation Methods for Cocoa Pod Husk Powder

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ABSTRACT
Cocoa produces a huge by-product during its processing, such as cocoa pod husk (CPH). It requires a proper material handling method to process cocoa pod husk due to its perishability, so it can be used as a food ingredient. This research purpose is to get the best way to produce high-quality cocoa pod husk flour. The CPH raw material was obtained from a local cocoa farmer in Kalibawang, Kulonprogo. Fresh CPH was transported from the field using two treatments: an ice-cool box and a dark bag (polypropylene), afterward it was stored in the ambient room (25±2℃), showcase (5±1℃), and freezer (-5±1℃), then visually observed the appearance during the storage for its quality parameter. Subsequently, the pretreatment to produce CPH powder was boiling and steaming. CPH without pretreatment was used as a control. CPH was dried until the moisture content reached 8-10 %wb. Dried CPH was ground and sieved to obtain a CPH less than 177 µ CPH powder. The evaluation of CPH powder consists of proximate (protein, moisture, lipid, ash, and fiber), color (L, a, b), browning index, and whiteness index. Cocoa pods transported in a cold box equipped with ice gel resulted in a fresher endocarp. Meanwhile, the CPH transported in a dark bag resulted in browning in the endocarp. Moreover, CPH stored in the freezer resulted in a minimum of physical and mold deterioration. The yield of CPH powder obtained was around 7.3 -9.2%. The boiling process produces the best results on CPH powder characteristics, shown by the lowest ash level highest crude fiber content, and highest lightness (L) value. However, CPH powder produced with the different treatments has no significant effect ($p<0.05$)on BI and WI.

***Keywords:** cocoa pod husk, functional food, powder*

1. INTRODUCTION

Cocoa processing has several by-products, the huge one is cocoa pod husk (CPH). CPH represents 70-75% of the total weight of the fruit. It was commonly used as feed and fertilizer by local farmers. However, the utilization of CPH has not been optimized. CPH is just disposed of in the field carelessly. This situation can lead to the growth of fungal diseases, such as *Phytophthora palmivora and P. megakarya* fungi, which cause black pod disease [1]. In addition, CPH waste can clog the water drainage system which has the potential to flood. Thus, it can be a potential problem for farmers, society, and the environment.

CPH contains some nutrients that have benefits for health. It can be an alternative resource for antioxidants, polyphenols, and dietary fiber. Some reports claimed that it could help reduce oxidative stress and obesity. Several studies report that dietary fiber can help prevent and relieve intestinal disorders and minimizes coronary heart disease and diabetes. In addition, CPH, as a source of hydrolase enzymes, has high mineral content (K, P, Ca, Mg) and pectin. The high pectin content allows it to be used as a substitute for emulsifiers.

CPH processing into food ingredients is still limited. Several studies have tried to apply CPH as a raw material for food products. High fiber bread was produced using CPH powder as one ingredient containing high fiber. CPH powder had a significant effect on bread volume and hardness attributes so that the texture of the bread becomes more rigid and denser. Moreover, CPH flour as a source of dietary fiber was tested to become one of the ingredients for frankfurters [2]. CPH could be a new ingredient to improve a meat

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product's parameters, functional characteristics, and stability. The objective of this research was is to get the best way to produce high-quality cocoa pod husk flour.

2. MATERIAL AND METHOD

2.1. Material

CPH was obtained from local farmers in Banjaroya, Kalibawang, Kulonprogo, Special Region of Yogyakarta, Indonesia. The analysis reagent used for testing were aquadest, phenolphthalein indicator, $HgSO_4$, K_2SO_4, H_2S0_4, H_3BO_3, HCl, BCG/MM indicator, C_2H_5OH, NaOH, and C_6H_{14}, The equipment for producing CPH powder was a gas stove, pan, stirrer, analytical balance, measuring cup, filter, and IKA C-MAG HS7 hotplate, Oven Memmert UN55, porcelain cups, electric stoves, analytical balances, desiccators, aluminum foil, test tubes, pipettes, propipettes.

2.2. Material Handling

Fresh CPH is transported from farmers using two treatments, an ice-cool box and a dark bag made of polypropylene equipped with ice gel. During the test, samples were kept at ambient (25±2℃), showcase (5±1℃), and freezer (-5±1℃). Physical changes that occur during CPH storage were observed the appearance during the storage for its quality parameter.

2.3. Cocoa Pod Husk Powder

The production of CPH powder refers to the [2] method with slight modifications. CPH powder is processed by removing the black spots on the cocoa husk from its pulp. CPH was cut as broad as 1 cm and then divided into three pretreatments: without treatment steaming, and boiling. Boiling and steaming were done for 30 minutes and then dried until the moisture content reached 8-10 %wb. The dried CPH then was ground using a grinder and passed through a stainless-steel sieve with a size of 80 mesh.

2.4. Proximate Analysis

Proximate analysis was carried out to determine the water, ash, fat, protein, and fiber content using the standard AOAC method [3]. Measurement of water and ash content using the gravimetric method, fat content using the Soxhlet extraction (SOX), protein content using Kjeldahl, and crude fiber content using acid-base extraction. Calculation of water content and ash content using 5 g of sample.

2.5. Colour Analysis

Colorimetric analysis was performed using a Chromameter CR-400 (Konica Minolta, Japan). The measurement method refers to the CIE system using coordinates L, a, and b [6]. L* is lightness; a* is red between 0 to 60, green is from 0 to -60, b* describes yellow from 0 to 60, and blue is from 0 to -60. The browning index (BI) and whiteness index (WI) were calculated using eq 1 and eq 2 [2][7]. BI was used as an indicator of the effect of heat treatments on CPH flour. WI is one of the main attributes of the last flour user for both household and industry and is often used to express flour quality.

$$BI = \frac{[100(\times-0.31)]}{0.172} \quad (1)$$

$$WI = 100-\sqrt{((100-L)^2+(a)^2+(b)^2)} \quad (2)$$

2.6. Statistical analysis

The SPSS 19.0 program was used to analyze variance (ANOVA). The results were expressed and plotted as the mean value ± standard deviation (SD). ANOVA tests were performed for all experiments at a 95% confidence interval. The Tukey multiple range tests were used to determine significance.

3. RESULT AND DISCUSSION

3.1 Effect of material handling method

CPH transported for 2 hours from the field in a cold box with ice gel resulted in fresher endocarp when they arrived at the laboratory. Meanwhile, the cocoa pods that were brought in dark bags had browned in the endocarp. CPH needs to handle immediately after cocoa beans were taken, the browning reaction on the endocarp will occur more quickly.

CPH storage was carried out with three treatments, namely ambient room (25±2℃), showcase (5±1℃), and freezer (-5±1℃). The storage of CPH in the ambient room (25±2℃) has been drastically damaged. Thin mold began to appear on the endocarp at about 10% with a bit of browning on the mesocarp and endocarp for some CPH on the second day. On the third day, the browning began to spread and the mold became a bit thick about 50%. On the fourth day, the mold in the mesocarp was thick, browned thoroughly, and the CPH became wrinkled. On the fifth day, the mold had covered all parts of the cocoa pod, the mesocarp and the endocarp became very thin due to wrinkles, and the CPH was almost rotten. At this stage, the cocoa pods are feasible to be discarded. After 2 weeks, the mold disappeared and the CPH got dry, wilted, and wrinkled. As for storage in the showcase (5±1℃) and freezer (-5±1℃), the growth of mold is slower. CPH stored in the showcase (5±1℃) began to appear as mold on the seventh day. Then the mold began to cover the entire cocoa husk and brown mucus appears on the fourteenth day. Cocoa pods stored in the freezer (-5±1°C) are protected from mold. CPH stored in the freezer (-5±1°C) is covered with ice crystals which can inhibit the growth of mold. However, browning still occurs in some cocoa pods. The yield of CPH flour obtained was 7,2, 7.3, and 9.2% for steamed, boiled, and without treatment, respectively.

3.2 Proximate analysis

Table 1 shows the variation of CPH powder's physicochemical characteristics in boiled, steamed, and without treatment. Different preparation methods significantly affected ($p<0.05$) the crude fibre, ash, and moisture content. Meanwhile, protein and fat content were not affected ($p<0.05$) by each treatment.

The highest crude fibre content was obtained for boiled treatment at 37.74% and the lowest for without treatment at 34%. The steamed treatment produced the highest ash content (14.20%), while the boiled had the lowest level (10.38%). The boiled treatment obtained the highest moisture content at 10.11%, whereas the steamed treatment had the lowest at 6.63%.

Based on table 1, CPH prepared by boiled treatment has the best results, seen from the lowest ash content and the highest crude fiber content. Crude fiber is the part of the flour that cannot be hydrolyzed by strong acids and bases. The fiber content in food can improve functional properties. In addition, customers tend to prefer high-fiber diets since they are more natural than supplements created from synthetic materials [8]. Although referring to SNI 3751:2009 for flour products [9], the ash and protein content have distinctive differences. Ash content is usually used as an indicator to determine food quality flour with a high ash concentration might have a negative effect on food quality [10]. A high ash level in CPH flour indicates that the flour is rich in minerals [11]. Moisture content indicates the amount of water content per unit weight of CPH flour expressed in percent wet weight. All of the samples for all of the treatments have a moisture content that is less than the SNI maximum (14.5 percent). Flour that has a moisture content of less than 14% can last longer from the effects of microbes during storage, whereas flour with a higher moisture content will reduce the shelf life of flour [12]. The higher the flour's water content, the lower the quality because it increases the potential for the development of microbes that can reduce the quality of the flour [13].

Table 1. Proximate composition of CPH flour with treatments variation

Treatment	Crude fibre content (%)	Protein content (%)	Fat content (%)	Ash content (%)	Water content (%)
Control	34.0±0.55^{b}	4.23±0.17^{a}	1.13±0.27^{a}	10.50±0.27^{b}	9.96±0.05^{b}
Steamed	35.07±1.82^{ab}	4.11±0.17^{a}	2.06±0.55^{a}	14.20±1.05^{a}	6.630.04^{c}
Boiled	37.74±0.61^{a}	4.13±0.1^{a}	1.39±0.43^{a}	10.38±1.5^{b}	10.11±0.015^{a}
P-value	0.019	0.624	0.091	0.008	0.000

Note: Different letters in the same column showed significantly different ($p < 0.05$) based on the Tukey test

3.3 Colour analysis

According to Table 2, it is evident that treatment methods greatly influenced the lightness (L), a, and b. Meanwhile, neither the brightness index nor the whiteness was impacted by any treatments. Thermal processes such as boiling and steaming increased the lightness of CPH powder significantly. Meanwhile, BI and WI values are not affected by the treatments. CPH powder with boiling treatment has a higher lightness value (68.25) than steaming treatment (62.45). However, it has the lowest redness value (a) (-0.96) compared to steamed and without control. In terms of yellowness, CPH flour without treatment and with boiling treatment both had values of 20.06 and 19.09, respectively, whereas CPU with steaming treatment had the highest value of 21.29. Grob, et al. [14] report that L* (lightness) and chromaticity (a* and b*) coordinates of CPH powder, which represent redness and yellowness, rose during milling. In addition, the CPH raw material showed the same redness and yellowness values as the milled CPH, but it was darker. As a result, the color of the CPH became brighter as the particle size decreased.

One of the crucial physical factors used to assess the color quality of flour is the whiteness index (WI) because it is one of the key characteristics that influence consumer approval. As stated by [3], the color of the product change during processing. The difference in the WI value is influenced by several factors, such as the length of the drying process and the heating temperature [15]. The WI produced by flour can be affected by the level of fruit maturity. Green fruits make somewhat brown white flour. The whiter of the flour, the riper the fruit [16]. The significant difference in the values of L, a, and b for the boiled and steamed samples can be attributed to the inactivation of the enzyme. If the powder were to be applied as a natural coloring additive for confectionary products, the color change might work to the manufacturer's advantage. As a result, an appropriate formulation of the powder's color could increase in value.

Table 2. Colour parameters of CPH flour with treatments variation

Treatment	L	a	b	BI	WI
Control	59.67±0.005 c	1.26±0.01 a	20.06±0.02 b	552.33±5.815 a	54.89±0.03 a
Steamed	62.45±0.025 b	1.16±0.03 b	21.29±0.055 a	494.19±17.45 a	56.82±0.005 a
Boiled	68.25±0.055 a	-0.96±0.015 c	19.09±0.035 c	-735.47±8.725 a	62.830.145 a
P-value	0.000	0.000	0.000	1.000	0.999

Note: Different letters in the same column showed significantly different ($p < 0.05$) based on the Tukey test

4. CONCLUSION

Material handling and preparation of CPH powder have been observed. CPH transported from the field in a cold box equipped with ice gel resulted in a fresher endocarp. Meanwhile, the CPH transported in dark sacks equipped with ice gel had browning in the endocarp. The storage of CPH in the ambient room (25±2℃) has drastically changed, while cocoa pods stored in the freezer (-5±1℃) are protected from mold. The yield of CPH powder obtained was 7,2, 7.3, and 9.2 % for steamed, boiled, and without pretreatment, respectively. The boiling method produces the best results, as seen by the lowest ash level and highest crude fiber content. CPH powder with boiling pretreatment has the highest lightness (L) value and the lowest redness (a) value. However, pretreatment has no significant effect (p,0.05)on BI and WI.

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