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CARBON INK CHARACTERIZATION FROM BANANA AND CASSAVA PEELS BY CARBONIZATION METHOD

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ABSTRACT

Banana and cassava plants are the most growing plants in the world. The use of both plant's peel is usually for animal feed. This research is intended to utilize banana and cassava peel as a raw material of whiteboard ink markers by varying concentration of the carbons to see its effect on the characteristics of the ink. The carbon concentration variations are 25 g, 30 g, 35 g, 40 g, and 45 g, which is dissolved in 100 ml of the solution. The steps of this research include the carbonization of banana or cassava peel, and then its carbon powder is sifted by 200 mesh. The powder will be dissolved in 50 ml of Arabic gum 10%, 15 ml of PEG-7, and 35 ml of alcohol 70%, then the solution stirred until homogeneous. The result showed that the addition of the Banana or cassava peels carbon concentration effect on the value of density, viscosity, pH, and pigment ink. The characteristic whiteboard ink markers from the banana peel that accordance with the commercial ink. It is consists of 30% Banana peel carbon concentration with a density value of 1.0077 g/cm^3, viscosity value of 6.2049 cP, pH value of 10.55, and the ink pigment are close enough with the commercial refill ink. While the characteristic from cassava consists of 35% cassava peel carbon concentration with a density value of 1.0893 g/cm^3, viscosity value of 15,2427 cP, pH value of 8,75, and the ink pigment are close enough with the commercial ink.

Keywords: *carbon, Banana, cassava, peels, carbonization.*

INTRODUCTION

Banana plants are plants that grow a lot and spread in the world, especially in Indonesia. Apart from the fruit, the banana plant also has various benefits, such as the leaves that can be used to wrap food, the sap to heal wounds or insect bites, while the banana peel is usually only used as animal feed such as cows, buffaloes or goats. Banana peel is also found in the banana processing industry in a considerable amount. This process produces a lot of banana peel waste, so innovation is needed to make banana peels more useful and more economically valuable [1]. Same with the Banana, the cassava also give the contribution. Most people used the cassava for some meal, animal feed, and chips. It resulted in the peel that unuseful.

Banana peel has a high carbon content with carbonization value reaching 96.56%[2][3] and can be used as activated carbon which is useful as an adsorbent [4][5]. Aside from being an adsorbent, this banana peel carbon can also be used as an essential ingredient in making ink, such as printer ink

[6], markers [7], pens [8], and textile [9]. The presence of carbon elements from a material, which is the result of the combustion process will produce black pigments so that it can be used as a source of dye in ink making.

The cassava peel also has a high carbon content with a carbon content of 59.13% [10]. The increasing production of cassava plants, the more waste of cassava peel will be wasted. The potential carbon content possessed by cassava peels makes a contribution to making carbon ink.Almost all of the carbon inks in circulation use additives such as Volatile Organic Compound (VOC). Some commercial ink markers have high levels of Volatile Organic Compound (VOC) and can endanger health. The carbon element used in commercial ink markers comes from the type of xylene [11]. Where if xylene enters the human body, it will endanger health [11].

The carbon from this material has a function as an ink pigment. The components needed in the manufacture of ink include pigment dyes (dyes/dyes), polymers/resins, solvents, and additives, or auxiliary materials [12]—the pigment functions as a color giver considered to be the main constituent of ink. The resin binds ink together into the film layer and attaches it to the surface. Solvents are used to make the flow of ink so that it can be transferred to the printed surface, and additives function to make the physical properties of the ink to suit different situations [13]. Both have chemical adsorption in terms of chemical bonding by several interactions, such as completion due to ionization, and hydrogen bonds may be involved. On the other hand, the materials contain various organic compounds such as lignin, cellulose, and hemicellulose with different functional groups [14].

The absorption is an accumulation or concentration of components on the surface/ interface in two phases. When the two steps interact with each other, a new stage will be formed, which is different from each of the previous phases. This is due to the attraction between molecules, ions or atoms in these two phases[15]

The ink consists of several components such as pigments that give color to ink, binding agents as media to bind dyes, fillers, Volatile Organic Compound (VOC), and coloring materials [16]. The parameters of a good ink such as density, viscosity, gray level, characteristics, and its removal power for ink markers [17]. Research on making eco-friendly ink markers that have been carried out [9] with basic ingredients is perylene acid. Perylene acid, which has a tannin compound, is classified into a natural phenol group with a flavonoid structure. So, if perylene acid in an alkaline atmosphere will give red color, and if added $FeCl_3$ with saturated alcohol and saturated NaOH will produce blue to black.

METHODS

The materials used in the study were 70% alcohol from Merck, aqua dest, Arab gum, banana peel, cassava peel, and PEG-7.

1. Carbonization

The method of the carbonization taken from the research by Mondal [1] First, the banana peel or cassava peel is washed clean, then dehydrated in the oven at 140ºC for 7 hours. The carbonization process is done by burning the waste of banana peel or cassava peel that has been collected. The charcoal is crushed using a blender. In order to have the same particles of charcoal, filtering using a sieve with a size of 200 mesh, with this can pass charcoal with a size of 200 mesh while charcoal with a larger size will be held.

2. Process for Making the Whiteboard Ink.

The process of making whiteboard markers is done by means of banana peel carbon powder or cassava peel mixed and composed with resin from acacia gum (Arab gum), 70% alcohol, distilled water, and additives (PEG-7). Because Arab gum is hydrophilic so it must be dissolved in water at a temperature of 80ºC-90ºC, this slurry is stirred with a magnetic stirrer until it is homogeneous. In making this ink is done by varying the concentration of slurry carbon to determine the characteristics of the ink of each variation. The variation of the concentration of banana peel carbon ink is the same as the cassava peel listed in Table 1.

3. Characterization of Ink

a. Density

The density test is done by measuring the ink mass in the pycnometer using an analytical balance. After obtaining the mass and volume of ink, the ink density is calculated by equation (1):

$$\rho=\frac{\text{mass of ink}}{\text{volume of ink}} \quad \text{.............................(1)}$$

Where:

ρ = Ink density(g/ml)

Table 1. The Composition of Ink Making

Sample	Mass of Carbon (gram)	The volume of Aquades (ml)	Mass of Arabic Gum (gram)	The volume of Alcohol (ml)	The volume of PEG (ml)
A	25				
B	30				
C	35	50	5	35	15
D	40				
E	45				

b. Viscosity

Viscosity test to measure the thickness of the ink. The viscosity test is carried out using the Oswald Method, where ink is measured by a viscometer, and data on flow time from the ink is obtained. The ink viscosity can be calculated by equation (2):

$$\mu=\mu_0\times\frac{\rho\times t}{\rho_0\times t_0} \quad \text{..............................(2)}$$

where :

μ = ink viscosity (g/cm.s)
μ_o = water viscosity (0,0089 g/cm.s)
ρ = ink density (g/cm^3)
ρ_o = water density (1 g/cm^3)
t =the time needed for ink to cross the boundary line, (s)
t_o =the time needed for water to cross the boundary line, (s)

c. pH of ink

Ink pH test aims to determine the acidity or alkalinity of ink. The pH test is done by measuring the pH of the ink with a device called a pH meter. The pH level of the ink should not be too low because it will cause irritation to the peel, so the pH of the ink is expected to be non-acidic.

d. Evaluation of the Pigment Ink

The pigment is one of the components of the ink that functions to give color to the ink. The ink pigment test is done by carving ink on the surface of the whiteboard so that the difference in ink pigment is obtained for each variation in carbon concentration.

4. Flowchart of The Research

Stages of research can be done using a flow diagram in Figure 1.

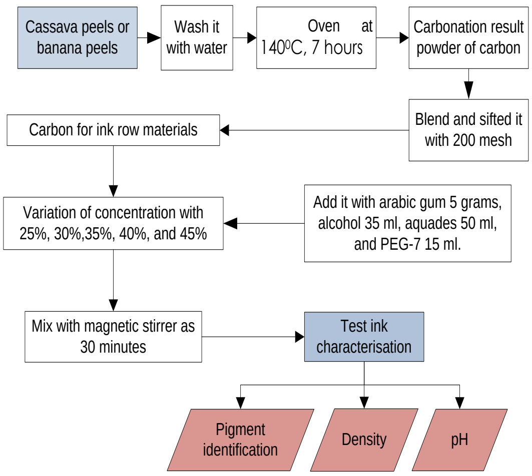

Figure 1. Flowchart of the Research

RESULTS AND DISCUSSION

Based on the Indonesian National Standard (SNI) for ink having the quality number 06-1567-1999, it has a density of 0,9 -1,00 gram/cm^3. Carefully, the results of the blackboard marker ink density can be seen in Table 2. The carbon concentration of cassava peel and the banana peel has a linear relationship with the mass of a substance. Density is the ratio of the mass of a substance to its volume, if the mass of a substance increases, its density will also increase. It can also be stated that the increase in the concentration of substances can increase the density. These results are in line with previous research. That is making ink markers from garlic extract that the solution concentration is proportional to its density [18]. There are several factors that cause such as limited accuracy in measuring the volume of ink in the measuring cup, or it could be because the Arabic gum used is not completely dissolved in the aqua dest.

The highest density value is found in ink markers from cassava peel. This is because there is still carbon in the cassava peel ink that has not been dissolved, causing carbon deposits in the ink. When compared with ink refill markers, it is known that the ink density of the refill markers is 0.8871 g / cm^3.

Table 2. The Comparison of Ink Density

No	Mass of carbon (g)	Density of cassava (g/cm^3)	Density of banana (g/cm^3)
1.	25	1.0508	0.9939
2.	30	1.0593	1.0077
3.	35	1.0839	1.0686
4.	40	1.0868	1.0864

Viscosity is a measure of fluid viscosity, which states the size of friction in the fluid. The greater the viscosity, the harder it is for a fluid to flow, and the more difficult a moving object is in the fluid. The results of the whiteboard marker ink viscosity from cassava peel and banana peel comparison can be seen in Table 3. It is known that the higher the carbon concentration, the higher the viscosity of the ink. This result is because viscosity is directly proportional to a density where the more carbon concentration is used, the thicker the ink will be. A solution with high concentration will have a high viscosity value because the concentration of a solution is the number of particles of the substance dissolved in units of volume[19]. The more particles are dissolved, the higher the friction between particles, and the higher the viscosity. Also, viscosity is also influenced by molecular size and weight. The use of small particle size will affect the area of the reaction. The smaller the particle size, the wider the area of the reaction. A broad reaction area will accelerate the reaction rate so that the pigment dissolves faster and does not thicken. The greater the density means, the denser the particle is[20]. The particle density causes the viscosity value to become larger or thicker. the bonding factor used also affects the density of the ink.

The ink pH tested to state the degree of acidity or alkalinity of the ink. PH testing is done using a pH meter. From Table 4, it is known that the pH of ink from cassava peel and banana peel lies in alkaline conditions. In the ink markers of cassava peel, the greater the carbon concentration of cassava peel, the greater the pH of the ink. But this is inversely proportional to the pH of the ink from banana peels where the higher the carbon concentration, the pH of the ink will decrease. This decrease is because the banana peel contains a large amount of acetic acid, so the more carbon the banana peel has, the pH of the ink decreases [2]. As with banana peels, cassava peel also contains acetic acid [21]. This triggers an increase in pH at each increase in the carbon concentration of cassava peel.

A good pH range for ink is neutral to alkaline. Species exist as positively charged ions in solution have a high concentration of H^+ ions.[2]. At low pH or acid, it has corrosive properties so that it has an impact that is not both long and short term for human health and will cause irritation if exposed to the peel [22].

Table 3. The Comparison of Viscosity

No	Mass of carbon (g)	The viscosity of Cassava (cP)	The viscosity of Banana (cP)
1.	25	8.8409	5.7312
2.	30	12.1690	6.2049
3.	35	15.2427	14.0990
4.	40	17.1698	17.2218

Table 4. The comparison of pH

No	Mass of Carbon (g)	pH of Cassava	pH of Banana
1.	25	8.595	10.58
2.	30	8.685	10.55
3.	35	8.725	10.32
4.	40	8.765	10.29

This alkaline condition of the ink from cassava peel and the banana peel is due in part to the supporting materials in making alkaline inks, such as carbon powder, cassava peel, and banana peel. The alkaline pH of the carbon powder of cassava peel and the banana peel is known from the comparison of pH and pH measurements of aqua dest added with carbon powder. From the comparison, the aqua dest pH is neutral, and if added with carbon powder, the pH of the solution increases. And it is known that PEG-7 pH is 5-8, pH of 70% alcohol is 7.33, and other ingredients such as Arabic gum with a pH of 3.9-4.9.

When compared with the pH of the ink refill markers sold in the market, the pH of the ink from cassava peel charcoal and the banana peel is much greater. Ink refill markers have a pH of 4.83 or acid. It can be concluded that the ink from cassava and banana peel charcoal is safe to use because it has an alkaline pH [23].

One of the components of the ink arrangement is coloring or pigment. Dyes or pigments serve to give color to the ink and form the body in ink. Pigments are considered to be the main constituents of ink[24]. The ink pigment test is done by inking the ink on the whiteboard so that different ink pigments are obtained at each carbon concentration to find out the ink with the best ink pigment results. Figure 1 shows the results of testing the ink pigments inscribed on the whiteboard.

The test results of ink pigments from cassava peel charcoal indicate that the higher the carbon concentration of cassava peel, the ink pigment increases. Where the black pigment gets thicker as the carbon concentration increases. These results are in line with the results of research by [25]. This result is due to the influence of the distribution of pigment particles, where the higher the carbon concentration in the cassava peel, the more pigment particles are. If more pigment particles, the particle distribution becomes more tightly. The dense and evenly distributed pigment particles will produce a thicker black color because the pigment particles carry the nature of carbon, which is black.

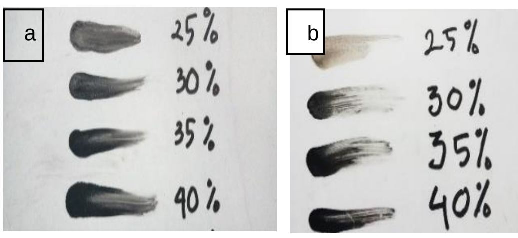

Figure 2. (a) Pigment of Cassava, (b) pigment of Banana

In Figure 2a and Figure 2b show that at a concentration of 25% having a low color pigment, this is due to the small pigment particles. Whereas in the carbon concentration of banana peel, 35% and 40% have very high color pigments; this is due to the large number of pigment particles that bind to each other so that the particles become denser. In Figure 2, charcoal ink is black pigment particles which descend to the bottom of the incision due to the influence of gravity. The ability of Arabic gum is less maximal in binding to pigment particles so that there are downward pigment particles that cannot attach to the substrate. The ink from cassava peel 35% and banana peel 40% have high adsorption. This result is thought to be due to the binding of water molecules to the activated carbon by the activator, causing the pores on the activated carbon to get bigger. The larger the pores, the more the surface area of activated carbon increases [15].

CONCLUSION

Cassava and banana peels can be used as an alternative in making ink markers. The concentration of carbon in ink making greatly influences the characteristic properties of the ink. The density, viscosity, and thickness of the ink pigments are directly proportional to the concentration of carbon added in the manufacture of ink. The higher the carbon concentration, the higher the value of the characteristics of the ink measured (density, viscosity, pH, the thickness of the pigment). The characteristic of the ink from banana peels is better than ink from cassava peel. The ink from cassava peel has a higher density and viscosity.

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