Organic Pigment from Cassava Peel as Intermediate Material Marker Ink

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ABSTRACT

Cassava is the third staple food after Rice and corn, and its production is increasing every year. Cassava production for food produces waste in the form of skins containing carbon. The utilization of cassava skin is still very limited, so that more and more waste is produced. Cassava husk waste contains 59.31% carbon element. Viscosity test results showed that the more the addition of gum arabic, the viscosity value will be greater. While the faster the stirring, the viscosity of the ink will be lower. The resulting ink color will be more concentrated when the amount of gum arabic mass used more and more. The stirring speed will also make the light intensity will be higher. In the adhesion test proved that the adhesion value is greater if the speed of stirring and the amount of gum arabic mass used is greater.

1. Introduction

Indonesia as a country that is heading towards the era of industrialization needs to find a suitable form for the development of its industry. Most of Indonesia is an agrarian society. Therefore, there is a need for a bridge so that the use of natural resources, especially in agriculture, can be associated with industry [12]. In Indonesia cassava (Manihotutillisima) is the third staple food after Rice and corn [20]. This plant can grow easily in the tropics and is very easy to cultivate because it can adapt to soil conditions so that people can easily plant cassava in their yards. In 2011 Indonesia produced cassava as much as 24,044,025 tons and increased in 2012 to 24,177,327 tons [1]. All parts of the cassava plant ranging from leaves, stems, and skin are used by the community. Generally, cassava skin is used as animal feed or discarded. Until now, Indonesian people have not been able to make maximum use of all parts of cassava, especially cassava skin which is often thrown away.

For example, processing 1 ton of cassava into tapioca flour produces about 4,000-6,000 liters of liquid waste and 0.114 tons of skin [8]. Cassava husk waste contains 59.31% carbon element [9]. It is known that carbon is used in the paint and ink industry. The purpose of this study was to reduce the amount of cassava skin waste, provide added value to cassava skin waste, and become a solution to the problem of non-organic ink that can be dangerous if contaminated with human senses. Then in general, marker ink has a fairly expensive price, is not environmentally friendly and contains high Volatile Organic Compound (VOC) and Polyvinyl Chloride (PVC) resins and can cause irritation to the eyes, throat, damage to important organs and the central nervous system [20]. Carbon from cassava peel can be used as organic ink that is environmentally friendly and safe for health by using natural resins in the form of gum arabic, alcohol solvents and PEG as a release agent that causes ink

to be erased on the board. By doing this research, Indonesian people are able to process cassava skin waste well so that cassava skin waste can be reduced little by little.

2. Research Methodology

2.1. Materials

Cassava (singkong kayu) peel waste contains 59.31% carbon element, carbon is an important element in the manufacture of ink as a black color pigment. Seeing the carbon content in the cassava peel is quite high, it can be ascertained that the cassava peel can be used as an organic pigment in the manufacture of ink.

Fig.1. Arabic Gum

Arabic gum is made from the sap of the acacia tree *(Acasiasenegal)* and is classified as a heteropolysaccharide complex. Arabic gum can be dissolved in hot water or cold water. At a large pH range Gum Arabic can stabilize emulsions. The formation of gel by arabic gum is caused by the heat of the gel, which forms a chewy texture and is quite soft. Arabic gum is a unique gum compared to other gums, because of its high solubility, low viscosity solution, and the solution thickens at a concentration of 20% then arabic gum can be used as a natural resin [3].

Polyethylene Glycol (PEG) is used as a releasing agent in the manufacture of organic inks. PEG will make the ink become more easily removed on the whiteboard. The use of PEG should not be more than 10% of the mass of the ink composition because it will make its viscosity higher and difficult to remove.

2.2. Procedures

Dewatering stage, Cassava peels as much as 50 grams that have been reduced in size and cleaned of dirt, and put in the oven. Dried cassava peel is burned in a furnace at a temperature of 300°C for 1 hour and cooled at a temperature of 25°C. The charcoal obtained is then mashed with a blender. Then filtered with screen T200 to obtain a homogeneous powder.

A solution of Arabic gum with a mass variation of 6 grams, 12 grams, and 18 grams was prepared and added aqua dest little by little as much as 42 mL. Then stir until homogeneous at a temperature of 70°C - 80°C. With the variation of stirring speed 600 Rpm, 650 Rpm, and 700 Rpm then carbon powder in the first stage weighed as much as 6 grams and 1.2 grams of PEG coupled with alcohol as much as 12ml. Then stirring to mix evenly using a magnetic stirrer.

The ink testing phase includes a viscosity test using a simple set of viscosity test equipment, an adhesion test using a cross-cut tape test on a whiteboard substrate, and a transmittance test with lauxmeter device and light source.

3. Results and Discussion

3.1. Characteristics of Obtained Whiteboard Marker Ink

Generally, inks are made from several main components in the form of pigments (dyes), adhesives and solvents. In this study, the solvent used is 70% alcohol which has a boiling point of 78oC so that it is expected to dry easily at room temperature. Alcohol serves to speed up the drying of the ink (drier agent) while natural ingredients are used for adhesive made from dried acacia tree sap (arabic gum).

Commonly used inks are generally easy to dry but can still be easily removed. Thus, PEG (Polyethylene Glycol) is used as a releasing agent. When used on a PEG whiteboard it will make the ink easier to remove. The use of PEG should not be more than 10% of the mass of the ink composition. Because it will make the viscosity higher and difficult to remove, it will leave marks when used on a whiteboard. Organic pigment from cassava peel in ink has a particle size that passes the T200 screen mesh filter stage as shown in Fig 1.

Fig.2. Cassava Peel Pigment Powder

The size of this powder can be used and produces ink that is smooth and does not clump. The particle size of the pigment will affect the density of the ink where a small component size will cause a higher density value. The density or density of the ink will affect the level of ink blob. The tighter it is, the less likely it is to clump together. Based on calculations using a pycnometer by reducing the mass of the liquid sample and the volume of the liquid which then dividing by the volume of the liquid in the pycnometer, the ink density data is obtained as follows.

Table 1. The Produced Ink Density

No	The Produced Ink Density		
	Mass (grams)	Stirring Speed (Rpm)	Density (g/cm^3)
1	6		0.75
2	12	600	0.83
3	18		0.93
4	6		0.80
5	12	650	0.83
6	18		0.94
7	6		0.85
8	12	700	0.88
9	18		0.96

The resulting density is close to the ink density value in general, which is 0.96 g/cm3. In addition, the contact area can be affected by the size of the component. The small component size

will make the reaction area wider. The reaction field causes the dissolution rate to be faster so that the pigment will dissolve faster.

3.2. Effect of Arabic gum on Ink from Cassava Peel

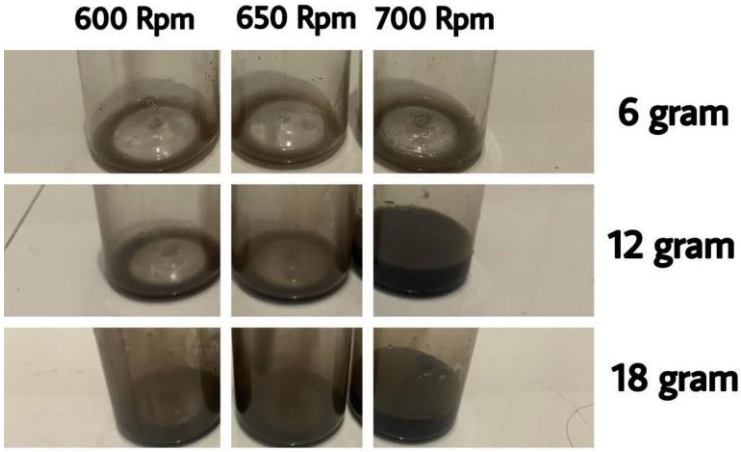

Fig.3. The Resulting Precipitate

The ink in Fig 2. is grouped based on several variations in the mass of arabic gum and stirring speed ranging from 6 grams, 18 grams, and 12 grams as well as 600 Rpm, 650 Rpm, and 700 Rpm. Some inks do not experience precipitation, however, in inks with a mass variation of arabic gum 18 and 12 grams at a speed of 700 Rpm, the pigments experience precipitation as much as 5 and 2.5 cm. This is caused by an unbalanced composition between solvent and adhesive where there is too little adhesive and too much solvent so that the adhesive cannot bind all the pigment particles together and settle to the bottom of the container. Stirring too fast also causes uneven stirring so that a precipitate is formed [4].

3.3. Results of Testing Procedures

3.3.1. Viscosity Test

Test the viscosity of the ink by perforating the bottom of a plastic cup and given a volume scale.

Table 2. Viscosity of Produced Ink

No	Arabic gum mass (grams)	Stirring Speed (Rpm)	Viscosity ($N.s/m^2$)
1.	6		0.0225
2.	12	600	0.0228
3.	18		0.0220
4.	6		0.0220
5.	12	650	0.0225
6.	18		0.0229
7.	6		0.0181
8.	12	700	0.0188
9.	18		0.0206

In Table 2 it can be seen that the more mass of Arabic gum, the greater the viscosity, this is because arabic gum will increase the viscosity of the ink, the addition of mass of arabic gum will increase the density of the ink, if the mass of arabic gum used to bind pigments is less then the density of ink will decrease. Arabic gum has hydrophilic properties, which means it will easily dissolve homogeneously in water so that it is dissolved in distilled water, to speed up the dissolution process, the mixture is heated at a temperature of 70°C - 80°C ink viscosity affects the ink flow rate,

the ink flow rate is hampered due to the large ink viscosity. Marker ink that is not too thick and can flow well so that the ink does not clump can produce good marker ink and is suitable for use [10].

3.3.2. Transmigration Test

In this transmission test, a substrate in the form of HVS paper with a weight of 80 grams was used without being smeared with ink which obtained a transmission value of 12 lux. With the addition of arabic gum mass, there is a decrease in the transmission value of the ink as shown in Table 3.

Table 3. Produced Light Transmittance

No	Produced Light Transmittance		
	Mass Gum Arabis (grams)	**Stirring Speed (Rpm)**	**Transmittance (Lux)**
1.	6		4
2.	12	600	3
3.	18		1
4.	6		4
5.	12	650	2
6.	18		1
7.	6		5
8.	12	700	4
9.	18		3

The more arabic gum used, the pigment will be bound to arabic gum so that the color of the pigment is more concentrated and spread evenly. Ink with a large mass of arabic gum on the substrate will block the light from being transmitted, so that the value of the transmittance intensity is reduced. The substrate will be completely covered and block the light that will be transmitted [1].

3.3.3. Adhesion Test (Adhesiveness)

A cross-cut tape test method was used to test the adhesion of the ink to the substrate. In this research, a substrate is needed for adhesion test, the substrate is a whiteboard. Then the ink is inscribed on the whiteboard by letting it sit for a few minutes until the ink dries and then the insulation is attached to the ink and pulled. to determine the adhesion of the ink to the substrate (whiteboard). The stickiness of the ink is determined by observing how much ink is still attached and left on the substrate (whiteboard).

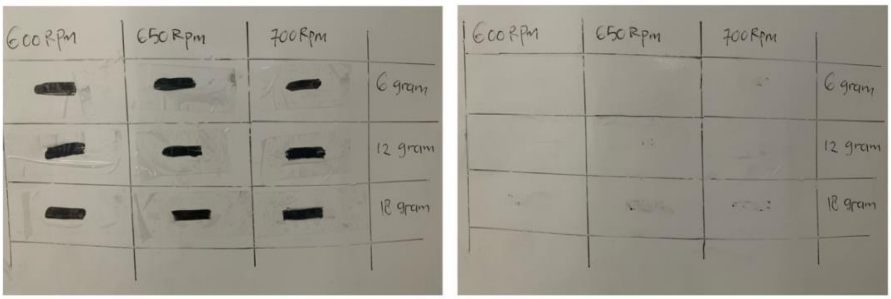

Fig.4. Adhesion Test Result on Samples

Adhesion is a force that occurs between two different components that attract each other. The adhesion value is proportional to the amount of arabic gum, the addition of arabic gum mass will make the adhesion of the ink higher so that it increases its adhesion to the substrate. After the erase

test is carried out in less than 24 hours the ink produced can be easily removed but in more than 24 hours the ink is difficult to be erased to become semi-permanent.

3.4. Effect of Stirring Speed on Ink from Cassava Peel Produced

Stirring is a homogeneity process of a mixture, based on this experiment the following data were obtained:

Table 4. Produced Viscosity

No	Produced Viscosity		
	Stirring Speed (Rpm)	**Mass Gum Arabis (grams)**	**Viscosity (N.s/m^2)**
1.	600		0.0225
2.	650	6	0.0220
3.	700		0.0181
4.	600		0.0228
5.	650	12	0.0225
6.	700		0.0188
7.	600		0.0330
8.	650	18	0.0229
9.	700		0.0206

Stirring too fast can cause uneven stirring so that a precipitate is formed. In Figures 3 and 4 it can also be seen that the faster the stirring, the lower the viscosity. Stirring causes a wider contact area, so the homogeneity of the solution will increase. Stirring can reduce the interfacial tension and expand the surface of the globules.

The smaller the light transmittance value, the more concentrated the ink is and the better it is to be used as ink so that it can sharpen the color of the ink so that the color can be seen clearly in the eyes. The transmission value of marker ink sold in the market is 0 Lux and the most optimum value obtained from the ink in this study is 1 lux which can be seen in Table 5.

Table 5. Produced Light Transmittance

No	Produced Light Transmittance		
	Stirring Speed (Rpm)	**Mass Gum Arabis (grams)**	**Viscosity (Lux)**
1.	600		4
2.	650	6	4
3.	700		5
4.	600		3
5.	650	12	2
6.	700		1
7.	600		1
8.	650	18	1
9.	700		1

With faster stirring, it turns out that the resulting transmission value is even greater because stirring too quickly makes the distribution of carbon particles uneven and clumps so that light can still be transmitted. In the adhesion test, increasing the stirring speed can cause the ink to be more difficult to remove on the substrate (whiteboard). This is because the process of mixing arabic gum with other ingredients is getting faster so that it can stick stronger.

4. Conclusion

Cassava peel can be used as the basic material for making ink. The resulting density value is close to the ink density value in general, which is 0.96 g/cm3. The results of the viscosity test prove that with the addition of a large mass of arabic gum, the viscosity value will be greater. The results obtained are viscosity values that lead to the viscosity values of whiteboard marker inks in general. Meanwhile, the faster the stirring, the lower the ink viscosity. The color of the ink produced will be more concentrated if the amount of arabic gum mass used is increasing. Stirring speed will also make the light intensity will be higher. The adhesion test proves that the value of adhesion is greater when the stirring speed and the amount of weight of arabic gum used is greater. The ink with a viscosity value of 0.0229 g/cm.s is the best organic ink produced, the light transmittance intensity is 1 lux, and the adhesion to the blackboard is quite good, namely ink with a mass of 18 gram Arabic gum with a stirring speed of 650 Rpm.

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