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# Characteristics of Eco-Friendly Marker Ink by Utilizing Natural Dyes From Noni Leaf Extract (*Morinda Citrifolia L.*)

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**Abstract:** Marker ink created from natural ingredients can be used as an alternative to ink with high VOC (Volatile Organic Compound) levels, which can be harmful to one's health. Noni leaf extract includes tannins, which can be utilized as a basic dye/pigment in marker ink. The goal of this study is to use natural dyes derived from noni leaf extract as a replacement for synthetic ink VOC and as an innovation in green marker ink. The study was undertaken with various adjustments, including the inclusion of noni leaf tannins (0.6 gr, 0.8 gr, 1.0 gr, 1.2 gr, 1.4 gr) and gum arabic (4 gr, 5 gr). The analytical findings of the best arker ink products are presented in formula 5, which includes tannins mass 1.4 gr and gum arabic mass 4 gr, with a viscosity of 3.1 cp, density of 1.14 g/ml, pH 6, and concentrated pigment production. Based on these findings, marker ink products fulfill the quality standards of the SNI 06-1567-1999 test.

**Keywords**: marker ink, natural dyes, noni leaf extract

## 1. Introduction

Marker or boardmarker is a tool that plays an important part in the educational process. Today, board markers are still frequently used as a basic tool for teaching and learning by lecturers, instructors, and mentors in mentoring institutions [1]. Boardmarkers or markers are common writing instruments used in education. This stationery is used for writing and sketching with a soft tip on paper medium, whiteboards, and so on. Until then, this facility was still often utilized, even though many people now use projectors. [2].

Ink may be defined as a liquid that can be used for coloring, writing words, creating images, and so on. Marker inks on the market contain dangerously high levels of volatile organic chemicals. Volatile organic compounds (VOCs) containing carbon are a major source of air pollution because they rapidly evaporate at particular pressures and temperatures, causing direct effects on the respiratory system when breathed [1]. This volatile organic compound (VOC) includes xylene carbon, which is utilized as a black pigment in ink manufacturing [3]. Because of its potent effect, it is critical to find a substitute or, at the at least, a means to mitigate the danger by employing natural ingredients. This necessitates the use of environmentally friendly ink markers derived from readily available natural resources.

Producers utilize tannin chemicals to color paints and inks. Noni leaves (Morinda citrifolia L.) are one of the plants that contain tannin compounds [5], and because of the tannins, they may be used to manufacture ink. [4] produced marker ink using rambutan peel extract, which met SNI in terms of concentration and viscosity. It is thought that marker inks derived from natural sources will be safer for human health and more environmentally friendly. In this study, noni leaf was used to create a novel and unique marker ink product.



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*Figure 1 Noni Leaves*

Noni is a perennial (annual) plant with short stems and huge, spherical leaves. The noni plant consists of various components, including roots, stems, leaves, fruit, and seeds. Noni plants have deep taproots (radix). Hairy roots and branches extend out in every direction. The caulis and ramus are round and frequently twisted, with rough, dark brown bark. The plant may grow to be 6 meters tall, with branches that are 0.5 cm in diameter, 9 nodules, and a pair of leaves measuring 12 cm × 28 cm at each node. Each noni node or branch produces two leaves, or folium. Each noni node or branch generates two leaves (folium). The leaves are round and hairless, dark green with pinnate veins. The noni plant's flowers (flos) are tiny and emerge in bunches between two leaves. Flower buds will grow into fruit bunches. Noni plants are classified into the following categories: Kingdom Plantae, Division Magnoliophyta, Class Magnoliopsida, Order Rubiales, Family Rubiaceae, Genus Morinda, Species Morinda Citrifolia L.

# 2. METHOD

### *2.1* Tool and Material

The main ingredients utilized in this study were noni leaf and several additives such as gum arabic, aquadest, PEG, and 96% ethanol. The tools utilized include rotary vacuum evaporators, beaker glass, erlenmeyer, graduated pipette, porcelain cup, mortar, watch glass, filter paper, scoopula, sieve, oven, hotplate, analytical balance, magnetic stirrer, graduated cylinder, dropper pipette, pH paper, pycnometer, and viscometer.

### *2.2* The stage of Research

2.2.1 The procedure of producing noni leaf extract

Noni leaves are cleaned, cut, and dried in an oven at 70°C for 5 hours. The noni leaves are then crushed to produce simplicia powder, which is subsequently extracted using the maceration process at a ratio (w/v) of 1:3 simplicia powder to 96% ethanol, with maceration lasting three times 24 hours. The simplicia is next filtered, and the resulting macerate is evaporated with a rotary vacuum evaporator to form a thick extract. The thick extract was then dried in the oven at 60 ℃ until dry.

2.2.2 The procedure for creating ink

To make inks, dissolve 4gr and 5gr of gum arabic in 7 ml of aquadest on a hotplate at 70 ℃ and stir with a magnetic stirrer until homogeneous. Then, add 0.6gr, 0.8gr, 1.0gr, 1.2gr, 1.4gr of noni leaf extract and 0.2ml of PEG to the solution. The solution was agitated until homogenous and chilled to 0 ℃. After cooling, 10 ml of 96% ethanol was gently added using a dropper pipette and swirled with a magnetic stirrer.

2.2.3 Test of ink characteristics

**Density**

The density test is performed by measuring the mass of ink in the pycnometer with an analytical balance. The test is done out with a 5 ml empty pycnometer. Then, place the ink sample in the pycnometer and weigh it with [6]. Then count the specific gravity of marker ink using the following formula:

$$Density\ (\rho) = \frac{m}{v} = \frac{(mass\ of\ picno+sample)-empty\ picno}{volume\ of\ picno} \quad (1)$$

Information ρ = density (g/cm$^3$)
$m$ = massa (gr)
$v$ = volume (cm$^3$)

**Viscosity**

The viscosity of ink is measured with a falling ball viscometer. To do the viscosity test, place the ink sample into the falling ball viscometer tube, then a ball. Then, invert the tube with the limit up and down facing you, and use the adjuster time to calculate how long it takes the ball to go from one to the other [7]. Then, use the formula below to calculate ink thickness:

$$\mu = K(\rho t-\rho)\ t \quad (2)$$

Infromation:
μ = Viscosity (cp)
ρt = Ball density (gms/ml)
2.53 for glaass ball
8.02 for steel ball
16,6 for tantalum ball
ρ = Density of sample (gms/ml)
t = Descent time (minute)
K = Viscometer constant (0.3)

**pH of Ink**

Use pH paper to measure the pH. The measurement is performed by dipping the paper into the sample, matching the color of the pH paper, and observing the pH value of the sample.

**Pigment of Ink**

The pigment test is performed by streaking ink liquid over a white paper surface with a dipping pen tip and scratching it on paper, yielding variances in ink pigment for each mass variation of noni leaf tannin extract.

# 3. Result and Discussion

### *3.1 Tannin compound content*

The content of tannin compounds is tested by adding $FeCl_3$ solution to the extract, and if the color changes to blackish green, the extract contains tannin compounds [4].

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Figure 2. Noni leaf extract

The photo above shows that the noni leaf extract becomes blackish green after adding the Fecl3 solution, indicating that it contains tannin components and may be utilized as a pigment in marker ink. Noni leaf extract can substitute volatile organic compounds (VOC) in ink manufacture.

### *3.2 Density Test Result*

The density test is performed by measuring ink mass in the pycnometer using an analytical balance. Density is the ratio of a substance's mass to its volume, so that as the mass grows, so does the density [8]. According to the Indonesian National Standard (SNI 06-1567-1999), the ink density ranges from 0.9 to 1 g/cm$^3$. This is a density measuring chart:

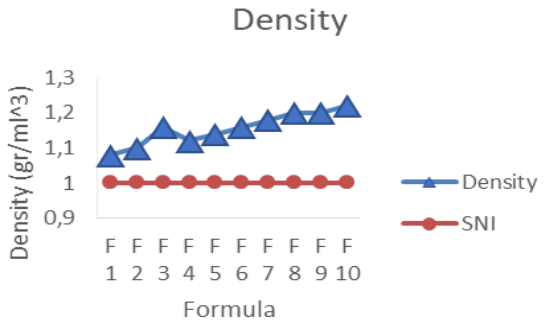



Figure 3. Graph depicting the results of testing the density of marker ink

Figure 3 indicates that the ink density fluctuated between 1.08 and 1.22 g/cm3. This density measurement is already within the SNI range of 0.9 to 1 g/cm3. The lowest density on the graph is 1.08 g/cm3, while the highest is 1.22 g/cm3. The graphic above shows that the ink density rose from formula 1 to formula 10, which is due to the amount of gum arabic added to each formula. Yudista et al (2022) The concentration of gum arabic is directly related to the density of the ink, with higher gum arabic mass resulting in higher ink density. The greatest density values on the chart are from ink samples with a gum arabic content of 5 gr. The concentration of the pigment added to each ink recipe also contributes to the rise in density [6]. The graph shows that increasing the quantity of tannins added to the ink solution influences the specific gravity of the ink, with larger mass resulting in increased ink density. However, the third ink showed a greater rise than the fourth ink, indicating that the density of the third formula was lower than that of the fourth ink. This density increase can be attributed to human error, namely poor stirring on the third step, resulting in lumps that impact the specific gravity of the ink. Ink density or density impacts the level lump of ink; the denser (higher density), the larger the lump. On the contrary, the lump becomes smaller as the density decreases (small density).

### *3.3 The Results of Viscosity Test*

The viscosity test is carried out using a falling ball type viscometer, where the ink is placed into the tube, and the ball slides down the tube. The liquid travels through the crescent-shaped opening between the balls and the tube. The most common way for releasing the ball is to rotate the end of the tube to its end and then measure the time it takes to traverse [7]. Viscosity refers to the degree of friction inside fluids [6]. According to the Indonesian National Standard (SNI 06-1567-1999), the viscosity of ink is 1.12 cp. Here is a viscosity chart:

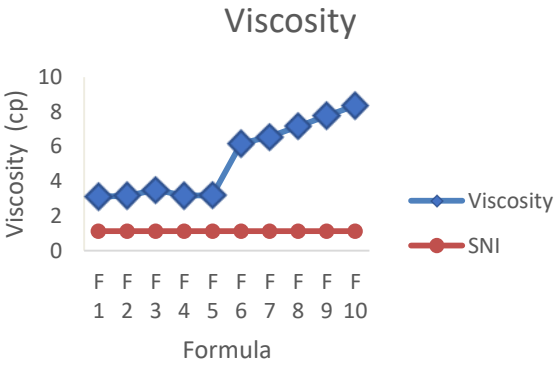



Figure 4. Graph of marker ink viscosity measurement results

Figure 4 shows that the lowest viscosity value obtained is 3.123 cp, while the greatest viscosity is 8.364 cp. The higher viscosity value is caused by the concentration of noni leaf extract utilized. When there is more solute or less solvent, dissolved particles are forced to collide and rub against each other more frequently, resulting in dissolution. In other words, the increase in viscosity is caused by the mass of tannins added to each ink formula; the more tannin mass, the higher the ink viscosity [3]. However, the viscosity value of the third ink is higher than that of the fourth ink; this can be attributed to human error, specifically the less-than-perfect mixing of gum arabic, which causes lumps that affect the viscosity of the ink, as well as the temperature at the time of stirring on the hotplate being too high.

Figure 4 demonstrates how the addition of gum arabic (4 and 5 g) enhances the viscosity of the ink. This is due to an increase in the bulk of gum arabic, which increases the viscosity of the ink. If more gum arabic is used to bind pigments, the ink will be thicker (lower density), whereas using less gum arabic will result in a thinner (higher density) ink [10]. In addition to being a thickening, gum arabic may be used as a binder or adhesive. So, increasing the amount of gum arabic causes the viscosity of the ink to rise. Gum arabic is hydrophobic, therefore it dissolves uniformly in water when given aquadest. The speed at which ink flows is determined by its viscosity; the higher the viscosity of the ink, the more difficult it is to flow. Good ink should flow easily and without clumping. Ink is anticipated to have low viscosity.

### *3.4 Result of pH Test*

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The pH of ink is determined by performing a test that shows how acidic or alkaline the ink is. The pH test is carried out with pH paper.

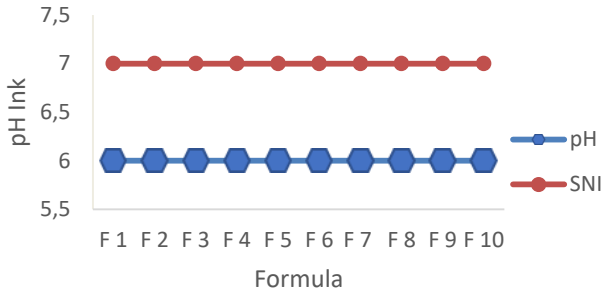



Figure 5. Graph of marker ink pH analysis results

The pH of the marker ink developed is 6, which corresponds to the SNI pH standard, which ranges from neutral to alkaline. A low pH value can cause skin irritation, hence the predicted pH value should not be acidic, since an acidic pH value will make the ink corrosive [6]. The pH value derived from the results of the ink analysis is 6, indicating that the pH level is nearing SNI. The average pH of all ingredients used to make this ink is acidic. The substance employed is 96% ethanol with a pH of 7.33, the pH of gum arabic is 3.9-4.9, and the pH of PEG is 4-7.5, indicating that the components are acidic. The same pH value from ink 1 to ink 10 can be created by components such as ethanol (10 ml) and PEG (0.2 ml), resulting in the same pH value. The ink's pH should vary from neutral to alkaline.

### *3.4 Pigment of Ink*

Pigment, often known as ink coloring, is one of its basic components. Density and viscosity have an influence on pigment ink; the greater the density and viscosity values, the more pigment ink is produced [6]. This is due to the amount of gum arabic employed; the capacity of gum arabic to bind pigment is maximized if aquadest is not used in excess. The aquadest volume used to make gum arabic solution is 7 ml. Thicker ink pigments can also be created by adding tannins or noni leaf extract to marker inks. The change in ink density with mass variations due to additional tannins is shown in the table below. It should be noted that the fifth ink has a thick or concentrated pigment, while the tenth ink contains tannins and weighs 1.4 grams.

| | |
|---|---|
|  | 0,6 gr tannin 4 gr gum arab |
|  | 0,8 gr tannin 4 gr gum arab |
|  | 1,0 gr tannin 4 gr gum arab |
|  | 1,2 gr tannin 4 gr gum arab |
|  | 1,4 gr tannin 4 gr gum arab |
|  | 0,6 gr tannin 5 gr gum arab |
|  | 0,8 gr tannin 5 gr gum arab |
|  | 1,0 gr tannin 5 gr gum arab |
|  | 1,2 gr tannin 5 gr gum arab |
|  | 1,4 gr tannin 5 gr gum arab |

## 4. Conclusion

Conclusions can be drawn based on the study's findings and the discussion that has occurred. The best analysis results are in formula 5 with the use of noni leaf extract (pigment) 1.4 gr and gum arabic 4.4 gr, as well as the results of the density test of 1.14 g/ml, viscosity of 3.1 cp, pH of 6, and the pigment produced is concentrated or thick. Based on this study, optimize the composition of ink production markers in compliance with SNI 06-1567-1989 as a reference for product quality.

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