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Formulation of Natural Dye Stock Solution Extracted from Rambutan's Peel (*Nephelium lappaceum L*) and Evaluation of its Colour Fastness Properties on Cotton Fabric

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Abstract : Rambutan (*Nephelium lappaceum L*) peel contain anthocyanin and flavonoid compounds which can be used as natural dyes of fabric. this research aims to study the producing of natural dye stock solution extracted from rambutan's peel (*Nephelium lappaceum L*) with adding of some preservative substances and evaluating its colour fastness properties on cotton fiber. Preparation of natural dye solution of rambutan fruit was made with concentration of extract at 25% (w/v) and some substances used as a preservative (citric acid, sodium benzoate, benzoic acid, potassium sorbate and tamarind) at various concentration (1%, 3%, and 5%).. Extraction of natural dye from *Nephelium lappaceum L* peel's waste was performed using maceration method with water as a solvent. The extracts were stored in a closed container at ambient temperature for 3 months, then tested the color fastness parameters of each sample. It is recommended that the use of sodium benzoate and citric acid are the best preservative to produce natural dye stock solution extracted from rambutan's peel (*Nephelium lappaceum L*) with good result.

1. Introduction

Fabric dyeing can be done using synthetic and natural dye. Synthetic dyes are derived from petrochemical sources¹. It has a wide range of colors of remarkable fastness properties make their way into the market. Although to its superiorities, synthetic dyes also possesses drawbacks, it result in chemical substances which are hazardous to human health and environment¹ due to their eco-friendliness, natural dyes are gaining importance and need new natural sources to be explored²⁻⁵.

Natural colorant are generally known as pigments or dye molecules, which could be obtained from plant, animal, or mineral sources. Natural dyes and pigments can be considered as an important alternative to harmful synthetic dyes and generally give soft and lustrous pastel colors⁶. A great sources for natural dyes can be found right in own back yard like roots, nuts, leaf and flowers are just a few common natural ways to get natural dyes⁷. The necessity of low cost natural dye production influenced the people to use waste as a dyestuff such as food, beverages, and parts of plants⁸.

One of the prospective plants that possibly applied as natural dyes and abundantly obtained in Indonesia is the rambutan peel (*Nephelium lappaceum L*). The rambutan (*Nephelium lappaceum L*) peels are waste and have not been used⁹, it contains ascorbic acid and high phenolic compounds (flavonoid, anthocyanin, tannin, ellagic acid, corilagin, and geraniin)^{10,11,12,13}. Flavonoids contained in plants are possibly used as mordant-dyes, which is need to combine the natural dyes of flavonoid with metal compound from mordant liquid to define the dyes on the fibers¹⁴. Paramita, et al. was study the efficacy of rambutan (*Nephelium lappaceum*) peel of anthocyanin and flavonoid, on the shades produced on



cotton fabric and optimize its dyeing process parameter (rambutan peel concentration and fixative concentration)¹⁵.

One of the limitation of the using of *Nephelium lappaceum L* peel's extract as a natural dye on cotton fabric was the preparation of its extract. It should be sliced and boiled the material every time we need to use it, which can spend more time of production. While the growth of mold in extract solution cant be avoided within a few weeks of storage. For this reasons, this research aims to study the producing of natural dye stock solution extracted from rambutan's peel (*Nephelium lappaceum L*) with adding of some preservative substances and evaluating its colour fastness properties on cotton fiber.

2. Materials and Methods

2.1 Materials

Dried peels of *Nephelium lappaceum L* and tamarind was supplied from traditional market in Semarang Indonesia. Cotton fabric of "primisima" was purchased from Pekalongan district. Distilled water was used in extraction and other chemicals (sugar, lime, acid, sodium benzoate, benzoic acid and potassium sorbate) used in this work were obtained from Chemical Engineering Laboratory Diponegoro University.

2.2 Methods

2.2.1 Production of *Nephelium lappaceum L* Peel's Stock Solution

Nephelium lappaceum L were dried at room temperature, sliced and then boiled in distilled water until 1/3 of its solution was evaporated. After extraction, the extract was filtered and the filtrate was used in the dyeing experiments. Extraction of natural dye with distilled water from *Nephelium lappaceum L* peel's waste was performed using concentration at 25% (w/v). The preservative substances (acid, sodium benzoate, benzoic acid, potassium sorbate and tamarind) in various concentration was then added to the extract solution. The extracts which have been stored in a closed container at ambient temperature for 3 months

2.2.2 Dyeing of Cotton Fabrics

The dyeing process of cotton fabric in extract solution following with mordanting by dipping 50 x 50 cm of cotton fabric in sugar solution which repeated three times. Mordanting applied to increase the affinity for both the colouring matter and the fibre¹⁶. The effect of fixative and its concentration were also studied. For this purpose, the dyeing were following with fixation process using lime by preparing an 50 g/l aqueous solution of fixative as a mother liquor. The dyed fabric was then rinsed with cold water and shade and dried before testing color fastness.

2.2.3 Evaluation of Colour Fastness

The extracts which have been stored in a closed container at ambient temperature for 3 months, then tested the color fastness parameters of each sample Wash fastness was assessed according to ISO 105-C06:2010, ISO 105-A02:2010, ISO 105-A03:2010 using Launderometer.

3. Results and Discussion

Table 1 shows the effect preservative substances regarding to the extract concentration of *Nephelium lappaceum L* peel on the colour fastness on cotton fabric. As can be seen, the value of stain in colour for almost all the treated samples show good (4) properties, while the changing colour value were different for each samples.

It is found that without preservative added to the extract solution, the colour fastness for changing colour shows fair to good result (3-4) which is decrease during 3 months storage. The reducing value of colour fastness properties for colour changing also happened on Potassium Sorbate at and Tamarind as a preservative. Both of the preservative show fair to good results (2-3) at the third month. Applying Sodium Benzoat as a preservative reduce the colour fastness properties at the first month and increase at the third month with good result (3). While using Citric Acid on the extract solution, the value of colour fastness increase at concentration of 5% with good result (3).

Preservatives are defined as substances able to inhibit, stop or delay the growth of microorganisms or any deterioration of aliments due to microorganisms¹⁷. Preservative substances used in this research were chemical (citric acid, sodium benzoate, benzoic acid, potassium sorbate) and natural preservative (tamarind). TAC content on tamarind show the highest value during 3 month storage, it is due to the presence of water soluble red-rose anthocyanin pigment on tamarind fruit¹⁸, but the using of tamarind show poor to fair results in colour fastness properties, it may be due to the growth of microorganism during storage. Although have the same value of colorfastness properties with non preservative extract, citric acid found to be the most effective in colorfastness properties, it may be due to reduction of bacteriological load and also in shelf life extension¹⁷.

Tabel 1. Colour fastness of dyed cotton fabric and TAC content on its extract during 3 month of storage

Storage time (month)	Preservative	Change in Colour			Stain in Cotton			TAC content ($\mu\text{g}/\text{cm}^2$)		
		a	b	c	a	b	c	a	b	c
0	WP	4			4 - 5			3184,05		
	WP	2 - 3			4 - 5			16425,68		
1	CA	2 - 3	4	3	4	3 - 4	4	8692,97	7429,46	7783,24
	SB	2 - 3	2 - 3	4	4	4	4	6924,05	6570,27	7328,38
	PS	3 - 4	3 - 4	2 - 3	4	4	4	8440,27	7783,24	8187,57
	T	3 - 4	4	4	4	4	4	8490,81	8945,68	8642,43
3	WP	3 - 4			4			505,41		
	CA	3	3	3	4	4	4	1061,35	2628,11	1010,81
	SB	3	3	3	4	4	4	404,32	1314,05	1617,3
	PS	2 - 3	2 - 3	2 - 3	4	4	4	101,08	1667,84	1667,84
	T	2 - 3	2 - 3	2 - 3	4	4	4	6165,95	1566,76	3790,54

Preservative substances : WP-Without Preservative; CA-Citric Acid; SB-Sodium Benzoate; PS-Potassium Sorbate; T-Tamarind

Concentration of preservative : a(1%); b(3%), c(5%)

Grey scale rating : 5-excellent; 4-good; 3-fair; 2-poor; 1-very poor

TAC : Total Anthocyanin Content

4. Conclusion

Preservative substances used in this research were chemical (citric acid, sodium benzoate, benzoic acid, potassium sorbate) and natural preservative (tamarind). Although have the same value of colorfastness properties with non preservative extract, citric acid found to be the most effective as a preservative with excellent result for colorstaining and good result for changing color and TAC content up to $1060 \mu\text{g}/\text{cm}^2$ (TAC non preservative sample : $505,41 \mu\text{g}/\text{cm}^2$), it may be due to reduction of bacteriological load and also in shelf life extension¹⁷.

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