RESEARCH ARTICLE

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Application of Flavonoid and Anthocyanin Contents from Rambutan (*Nephelium lappaceum*) Peel as Natural Dyes on Cotton Fabric

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The application of natural dyes on material fabric gain attention, recently. An alternative prospective plant that possibly applied as natural dyes and abundantly obtained in Indonesia is the rambutan peel (*Nephelium lappaceum*). This work evaluated the potential of anthocyanin and flavonoid contents of rambutan peel (*Nephelium lappaceum*), a worthless waste and continuously exist annualy as a natural dye application on the cotton fabric. It focused the study on the rambutan peel concentration (15, 20, 25%) by using alum (aluminium sulfate) as fixative agent. After the mordanting process, the TFC were decreased 5.15, 11.99 and 35.19% at each concentration observed, respectively. The higher concentration of rambutan peel provided the less degradation of anthocyanin compounds during mordanting. These results were opponently comparing to the flavonoid content.

Keywords: *Nephelium lappaceum* Peel, Natural Dyes, Flavonoid Content, Anthocyanin Content.

1. INTRODUCTION

At the early period of the emergence of batik, its artisans dyed the batik with natural dyes from various peel of plants, fruit, or leaves.[1] The advantage of the natural coloring process is its environmentally friendly,[2] besides cheaper and produce a distinctive color than the synthetic ones.[3] The weakness of the natural dyes application is the relatively poor quality of the color fastness and color intensity or aging. Currently, the process of batik staining is widely using synthetic dyes because of its easiness to apply, strong intensity color productivity and un-easily faded during washing. However, the harmful effects of synthetic dye waste on the environment, led the reversal of the batik artisans tendencies to the application of natural dyes.

The dye process from natural plans is started by the breaking of the glycosidic bond and forming new bonds between the fiber and the dye which produced a water insoluble and washable coloration.[4] One of the prospective plants that possibly applied as natural dyes and abundantly obtained in Indonesia is the rambutan peel (Nephelium lappaceum). Rambutan peel extract contains ascorbic acid and high phenolic compounds (flavonoid, anthocyanin, tannin, ellagic acid, corilagin, and geraniin).[5–8] 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 fibers.[4] Anthocyanin is a water soluble pigment and can be found in various plants that exist on land but cannot be found in marine plants, neither animals or microorganisms. Antosianin plays a role in giving the color of flowers or other plant parts, with the exceptin of green color.[9]

Color fastness is the key element on the determination of the batik coloring quality. In order to obtain the good quality of color fastness, the staining process has to follow by the color fixation process. The fixation process is an immersion process of fabric after the staining process by applying the fixative agent (e.g., alum, $Al_2(SO_4)_3$) in order to lock the dye into the fiber and to avoid the dyes faded easily.[4] This fixative agent is containing a metal complex of Al^{3+}. This metal complex are going to form a coloring complex compounds which is not soluble in water with the natural dyes as metal oxides.[10]

This research utilized the waste of rambutan peel as natural dyes to increase its usage values and to get new color variations with high quality against color fastness. The staining process were fixating by using alum as the complex compounds forming. The cotton fabric staining by using rambutan peel with alum fixation needs the further investigation in order to obtain the data empirically. There are many data publishing the application of rambutan peel as natural dyes,[9] antioxidant[6,7,11] or lignocellulosic material,[12] however there are no published data of the efficacy of flavonoid and anthocyanin content from rambutan peel, regarding to its active contents before and after the coloring process on the cotton fabric of "primisima."

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2. EXPERIMENTAL DETAILS

2.1. Materials

Rambutan peel was obtained from the local rambutan gardener in Semarang area. Cotton fabric of "primisima" was purchased from Pekalongan district. Quercetin standard was purchased from Sigma.

2.1.1. Cotton Fabric Dyeing by Using Rambutan Peel Extract

Cotton fabric dyeing was preceded by rambutan peel extraction process at 40 °C with varied concentration (15, 20, 25%). The prepared cotton fabric is then immersed using a cooled rambutan skin extract, followed by mordanting dye (in a brown sugar solution) followed by second immersion followed by mordanting, until third immersion. After immersion, the wet but non-dripping fabrics were fixating by using alum. After the fixation process, the cotton fabric was ready for analyzing.

2.1.2. Determination of Total Flavonoid Content (TFC)

Total flavonoid content (TFC) were measured by applying colorimetry test of aluminium chloride.[13] An aliquot (1 ml) extract or standard quercetin solution (20 to 100 μg/ml with intervals of 20 μg/ml) was added to a 10 ml measuring flask containing 4 ml of distilled water. Subsequently, 0.30 ml of 5% sodium nitrite was added, after five minutes, then added 0.3 ml of 10% $AlCl_3$. After the next five minutes, then added 2 ml of 1 M NaOH and distilled water until the volume achieved 10 ml. The solution was mixed and the absorbance of the blank was measured at 510 nm. The TFC are showed as mg quercetin equivalent (QE).[14]

2.1.3. Determination of Total Anthocyanin Content (TAC)

Total anthocyanin content (TAC) were determined according to the pH spectroscopic differential method.[15] 3 ml of extract was diluted in 5 ml of two different buffers; respectively, 0.025 M of potassium chloride at pH = 1.0 and 0.4 M of sodium acetate at pH = 4.5. After incubtion for 30 min at room temperature, absorbance (A) was determined at wavelengths of 510 and 700 nm. After incubation at room temperature for 30 min, the absorbance (A) was measured at wavelengths of 510 and 700 nm. The results were calculated by using the equations according to Giusti and Wrolstad[16] as:

$$A_{sp} = (A_{510} - A_{700})\text{pH}_{1.0} - (A_{510} - A_{700})\text{pH}_{4.5} \tag{1}$$

The calculation of total anthocyanin content (TAC) follows the equation:

$$\text{TAC} = (A_{sp} \times M \times DF \times 1000)/(\varepsilon \times \lambda \times m) \tag{2}$$

where, DF is the dilution factor, ε is the molar absorption coefficient, 29.600 M^{-1} cm^{-1}, 17 M is the molecular weight, 448.8 g/mol, λ is the long quadrilateral optical path, 1 cm, and m is the sample weight (g).[18] The TAC are expressed as mg anthocyanin per 2 cm^2 of the fabric cotton test of sample area and per 100 ml of the rambutan peel extract solution.

3. RESULTS AND DISCUSSION

Figure 1 presents the effect of concentration of rambutan peel on the TFC and TAC regarding to the mordanting process. The TFC determined on the extract rambutan peel at the concentration of 15, 20 and 25%, before mordanting, were found 3.52, 3.63 and 7.11 μg/ml, respectively (Fig. 1(a)). These TFC result were not considerable different to the result of Gusman and Tsai[19] who obtained the TFC in the range from 6.41 to 8.57 (mg quercetin/g D.W). After the mordanting process, the TFC were decreased 5.15, 11.99 and 35.19% at each concentration observed, respectively. This result indicated that the higher concentration of rambutan peel extract, there are considerable decreasing TFC content then the lower concentration of rambutan peel extrant. Higher rambutan peel concentration seems to easily degrade, although there is no temperature treatment. Some researcher reported that natural dyes are poorly resistance to the thermal degradation at 100 °C[20] and more than 120 °C for flavonoid.[21]

Before mordanting, the TAC were found at 3.03, 4.55 and 6.06 μg/ml on the extract rambutan peel at the concentration of 15, 20 and 25 %, respectively (Fig. 1(b)). After mordanting process, the anthocyanin obtained from the rambutan peel extract were decreased into 1.52, 3.03 and 4.55 μg/ml of each extract peel rambutan concentration at 15, 20 and 25%. The higher concentration of rambutan peel provided the less degradation of anthocyanin compounds during mordanting. These result

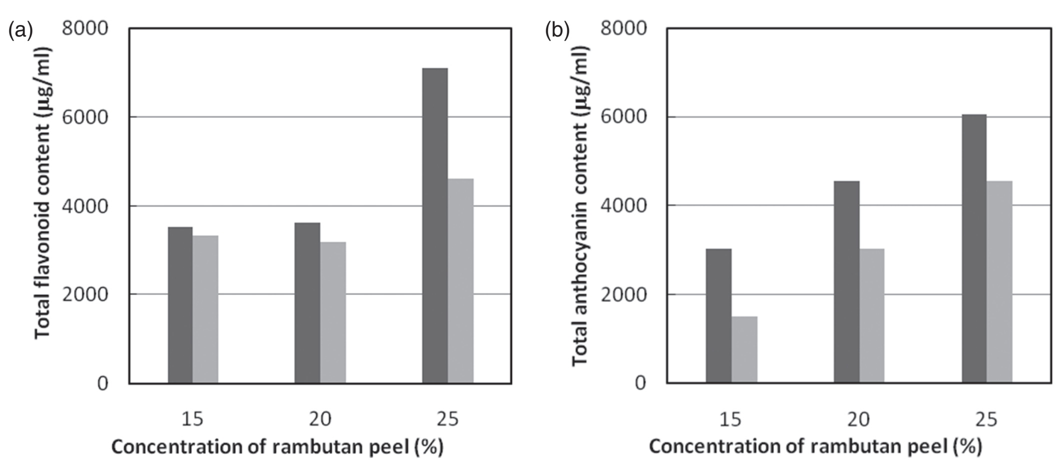

Fig. 1. Total flavonoid (a) and anthocyanin (b) content of rambutan (*Nephelium lappaceum*) peel, before (■) and after (■) mordanting, on the concentration of rambutan peel at 15, 20 and 25%.

were opponently comparing to the flavonoid content. West and Mauer[22] reported that anthocyanins are pH, temperature and relative humidity depending on their chemical stability. Treatment the anthocyanin from grape pomace extract at 40 °C with pH 3–4 were resulting the yellowish color regarding to the destruction of anthocyanins.

4. CONCLUSION

After the mordanting process, the TFC were decreased 5.15, 11.99 and 35.19% at each concentration observed, respectively. The higher concentration of rambutan peel provided the less degradation of anthocyanin compounds during mordanting. These results were opponently comparing to the flavonoid content.

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