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The Influence of Washing Process Using TRO on Indigosol Dyeing Quality, Leaching Percentage, and Mechanical Strength of Mori Fabric.

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ABSTRACT

Generally, the purpose of this research is to obtain optimum conditions of the mori fibers dyeing process using indigosol. More specifically, this research aimed to determine the influence of the washing process using Turkish Red Oil (TRO) to color quality produced from dyeing process using indigosol dye and also the leaching percentage that was produced. To achieve that goal, on this research has been done washing process of mori fibers using the Turkish Red Oil (TRO), with a variation of soaking time 2; 4; 6; and 24 hours. An analysis of the reflectant percentage is carried out to determine the intensity of dyeing for each variation of soaking in the TRO and the difference in color between dyeing quality which resulting from mori dyeing that not through washing process and through a washing process. Based on the results obtained from reflectant measurement using DRUV instrument, mind that before leaching process indigosol green dyes have the highest compatibility level with mori fiber, which respectively reached 97,60%, after immersed in the TRO for 24 hours. This color intensity is 2.93% higher compared to the indigosol green color intensity on the mori fiber which not through the washing process before dyeing. While the lowest compatibility level with the mori fiber generated by indigosol violet dye, where the color intensity obtained is 84.21% for mori fiber which has been immersed in TRO for 24 hours. This color intensity is 34.46% higher compared to the indigosol violet color intensity on the mori fiber which not through the washing process before dyeing. After leaching process, known that despite the color intensity of indigosol green on the fiber is the highest, but the fade resistance level of indigosol yellow dye is the highest. The fade level average of indigosol dyes are of 0.61%; 9.97%; 11.70%; and 16.10%, respectively for the indigosol yellow, indigosol green, indigosol violet, and indigosol pink dyes. Thus, it can be said that the color generated by the indigosol yellow has the most excellent fade resistance. In the meantime, based on the results obtained from the mechanical strength measurement using the autograf instrument, note that the value of Young's modulus will be smaller when the mori fibers washing process carried in the longer time. Based on the mechanical strength data also, it can be seen the mechanical strength of colored mori fibers which not immersed on TRO are in the range 12,406.68 N/m^2 – 22,272.48 N/m^2,while the mechanical strength of colored mori fibers which was immersed on TRO 2 hour, 4 hour, 6 hour, and 24 hour, each are 9,344.29 N/m^2 – 14,518.38 N/m^2; 9,219.61 N/m^2 – 14,038.71 N/m^2; 4,399.34 N/m^2 – 11,216.53 N/m^2 and 3,161.97 N/m^2 – 10,900.14 N/m^2.

Keywords: Batik, Mori Fabric, Washing, Reflectant, Leaching

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INTRODUCTION

Batik is an ancient art in which melted wax is applied in intricate designs on fabric which is then dyed and the wax is removed, leaving the design area the color of the fabric [1]. Artists in Indonesia, India, Africa, China and many other parts of the world have created beautiful batik fabrics that are unique to the materials, symbols and ideas of their own culture [2]. Indonesia, most particularly the island of Java & Bali, are the areas where batik has reached the greatest peak of accomplishment [3]. In East Java, batik is scattered in various areas, especially in the area of Madura, Tuban, Pasuruan, Sidoarjo, Pacitan, and Surabaya. A Total of batik craft industry in East Java was as much as 191 small-medium industrial centers. The total number of business units recorded is as much as 5.926, with labor as much as 21,000 more people. Total production value is not less than $ 243 billion a year. Batik industry, though still in the scale of home industry, has been able to contribute significantly to the economic growth of East Java province. The economic growth of East Java in 2012 reach 5.01 percent, more or less amounted to 53.4% comes from the majority of the SMEC is a craftsman, and among them was batik craftsmen [4].

But unfortunately, the development of batik industry rapidly is not accompanied by an increase in awareness of batik craftsmen to observe and manage waste production. During this time, the volume of waste by an average of 3-8 m^3 produced daily by the small medium batik enterprises, directly dumped unceremoniously into a body of water [5]. This condition is certainly very worrying given the 15-85% of total textile dyes used, not bonded to the fabrics fiber and wasted as sewage effluents [6,7]. Large percentage of dye that qualify as effluents, is caused due to lack of research and development efforts made by SMEC to optimizing batik dyeing process. So far the process of coloring is only done using hereditary recipes [8]. Therefore, it becomes important to do research on the optimization of dyeing process on the mori fiber as a basic ingredient of batik, which in the study was done by examining the influence of washing process to color quality, fade resistance (leaching percentage), and mechanical strength of mori fabric.

In the dyeing process, generally required pre-treatment process of materials that will be colored to get the perfect coloring result [9]. This pre treatment process includes : singieng, dezising, scouring, bleaching, and mercerizing [10]. Given the importance of the pre-treatment process on the dyeing optimization that will culminate at a minimum dyes waste generated by batik industrial, through this research will study the influence of dezising process on quality of color, leaching persentage and mechanical strength of fiber mori. Dezising is the process to phasing out the starch substances which coat the fabric surface, so that with loss of the starch, the absorption of dyes into the fabric is not obstructed.To achieve that goal, on this research has been done washing process of mori fibers using the Turkish Red Oil (TRO), with a variation of soaking time 2; 4; 6; and 24 hours.

EXPERIMENTAL

Material

Materials research include : (a) indigosol dyes component, such as : indigosol dyes and nitric, (b) batik raw material, such as : mori fabric and also aquadest; and (c) washing agent, Turkish Red Oil (TRO). Overall batik raw material obtained from Indonesian batik SMEs which act as partner in this experiment activity.

Instrument

Research equipment includes: a watch glass, spatulas, beaker glass, measuring cups, glass plate and magnetic stirrer. Becide that, in this experiment also used Fourier Transform Infra Red (FTIR) (Nicolet IS10 Thermo Scientific), autograph (Shimadzu AG-10TE) and spectrophotometer (Shimadzu UV-2401-PC) instrument.

Mori Fabric Washing Process (Before Dyeing Process)

The washing solution was made by dissolving 2 grams of Turkish Red Oil (TRO) in 1 liter water. To ensure the formation of a homogeneous solution, stirring process is done using a magnetic stirrer for 5 minutes. Furthermore, once the washing solution available, 3 pieces of mori fabric (20 x 25 cm) put into it and then soaked for 2 hours. Next mori fabric rinsed as much as 3 times, each of which uses 1 liter water. The

process of mori fabric washing was terminated by drying process for 2 hours. The same procedure is also applied to the process of mori fabric washing with long submergence 4; 6; and 24 hours.

Indigosol Dye Preparation

Dye types indigosol obtained by dissolving 0,7220 gram indigosol dye and 1,2440 gram nitric in 200mL of boiling water. Then, added 100 mL cold water to the solution. Each solution was stirred until homogeneous using a magnetic stirrer for 5 minutes. The same procedure is also used to prepare other kind of indigosol dye.

Mori Fabric Dyeing with Indigosol Dyes

Mori fabric 20 x 25 cm dipped in indigosol dye for 30 minutes. After that, the fabricis dried in the sun for 5 minutes. The fabric then soaking in the tunjung fixer ($FeSO_4$) for 10 minutes, to inhibit the rate of colors washed out. The process of fabric coloring with indigosol terminated by drying out mori fabric under the sun for 15 minutes. The solar heat which used to drying out the mori fabric in this experiment restricted between 11 am-2 pm.

Mori Fabric Leaching Process (After Dyeing Process)

The mori fabric leaching solution is made by dissolving 1 gram x-detergent in 100 mL water. To ensure that leaching solution has been homogenized, the solution was stirred using magnetic stirrer for 1 minute. Then, after leaching solution available, mori fabric was inserted into the leaching solution and marinated for 30 seconds. Leaching process is terminated by drying, where the mori left in the open air for 1.5 hours.

Dyes Functional Groups Analysis

Both kind of mori fabric, which is blanko and colored mori (as the result of coloring process using naphthol and indigosol dye), then analyzed using Fourier Transform Infra Red (FTIR) instrument at wavenumbers 4000-666cm^{-1}.

Physical and Chemical Characterization of Mori Fabric

To determine the physical characteristics (mori fabric color intensity, before and after washing process) and mechanical strength of the mori fabric (resistance to stress and strain), conducted an analysis of the mori fabric, with the following information: (a) Measuremenet of fabric color intensity by scanning Diffuse Reflectant Ultraviolet Visible (DRUV), and (b) Measurement of mori mechanical strength with autograph.

RESULT AND DISCUSSION

Indigosol dye is dye which can produce good fade resistance, median and bright-colored. On batik production, this dye can be used to imersion dyeing and brushing dyeing process. The color of indigosol dye can arise after raised with sodium nitrite and sulfuric acid or flouride acid. Acid uses as color raising of indigosol dye can be replaced by heat up the coloring object in the sun.

The selection of the appropriate color to the fiber is an important thing. The matches level of color and fiber must be considered because it is a major factor that determining the quality of textile products. In addition, in order to get good immersion, dye results and fade resistance, the interaction between dyes and fiber must be greater than the interaction between dye and water. Therefore, to maximize the interaction that occurs between dye and fiber, on this research was done optimization of fibers washing process prior to dyeing using TRO. This washing process is expected to eliminate pollutant on mori fiber, which is largely dominated by fat compounds. In figure 1 seems the interaction that occurs between the mori fiber with fat (contaminant) and in figure 2 seems the interaction that occurs between the mori fiber with indigosol dye (without fatty compound presence).

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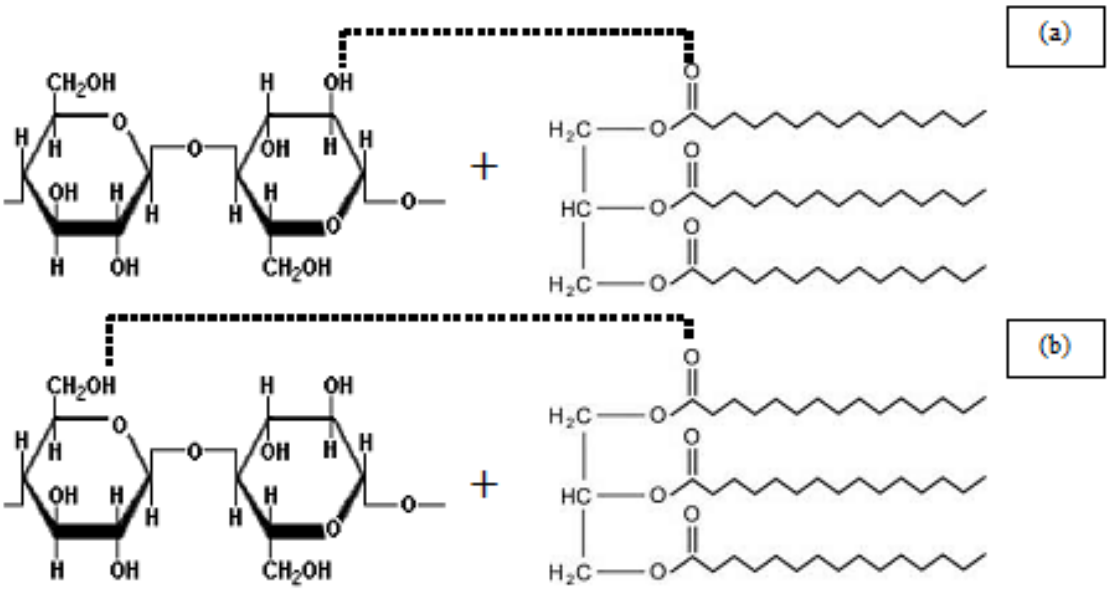

Figure 1: Interaction between mori fiber and fat : (a) hypothetic 1; and (b) hypothetic 2

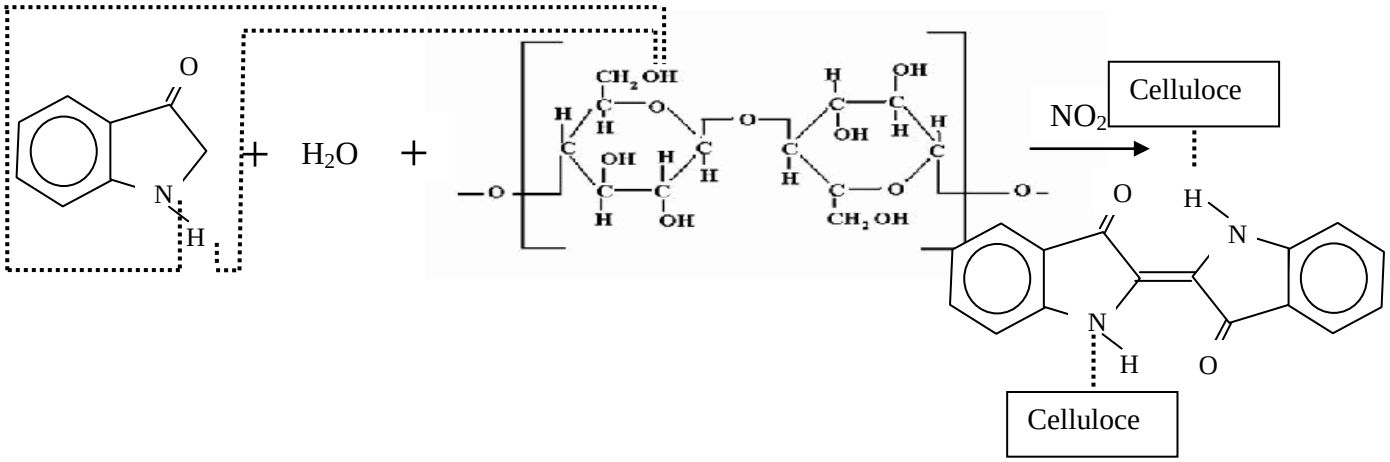

Figure 2: Interaction between indigosol, mori fabric, and nitrite (Kusumawati et al., 2013)

Functional group analysis of mori fiber blank and colored mori fiber

The presence of electrostatic interaction between the oxygen atoms in the fatty compounds with active group (hydroxyl) in fiber mori will hinder indigosol dyes interactions on mori fibers. This condition will cause the mori fiber dyeing process cannot optimum and leaving a high dye levels in effluents of batik waste.

To strengthen the hypothesis, on this research has been conducted functional groups analysis of the blank of mori fiber with and without washing process, as well as colored mori fibers as coloring results on mori with and without washing, by Fourier Transform Infra Red (FTIR) instrument. In figure 3 appear functional group analysis results of mori fiber (blank) and mori fiber (dyeing results), with and without the washing process.

Based on the results of the comparison of infrared spectra between the white mori fiber (a) with the colored mori fiber as a result of dyeing process using indigosol pink dye (c), it is known that there is any change in spectra, which the presence of peak with significantly reduction on intensity observed at the wavenumbers 3,200 cm^{-1} – 3,400 cm^{-1}. This suggests the existence of an interaction between indigosol pink dyes and mori

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fibers which occurs between the nitrogen atom (N) of an indigosol dye with hydrogen atoms in the –OH functional group belongs to the mori fiber and also between hidorgen atoms (H) of indigosol dyes with the oxygen atom (O) from the –OH functional group of the mori fiber. Engagement of –NH functional group in interaction between mori fiber with indigosol pink dye compound is also strengthened by the disappearance of the peak from indigosol pink spectra in the range of wavenumbers 1,500 cm^{-1} – 1,515 cm^{-1}, which indicates the lack of free –NH (2°) functional group. Meanwhile, the peak loss on wavenumber 1,100 cm^{-1} – 1,250 $cm^{-1}$of the indigosol dye spectra, strengthening the involvement of the nitrogen atom (N) of indigosol dyes in interaction with mori fibers.

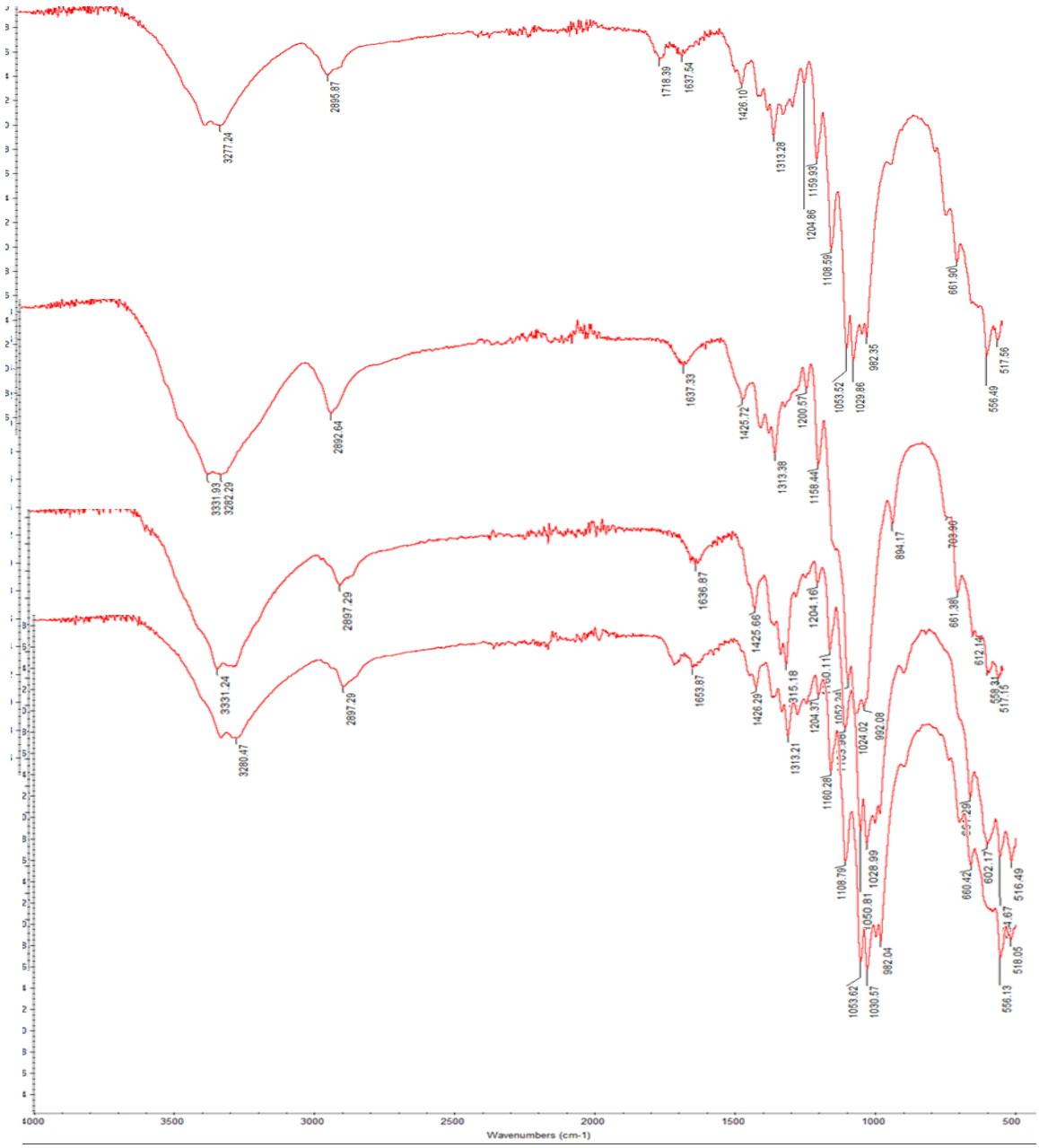

Figure 3: Infra red spectra of : (a) mori fiber blank without washing; (b)mori fiber blank with washing; (c) colored mori fiber without washing; and (d) colored mori fiber with washing

The declining existence of the -OH functional group with the presence of C-H that overlap in the molecular structure of the samples compound analyzed, are marked with the emergence of the more obtuse peak at wavenumbers 2,800 cm^{-1} – 2900 cm^{-1}. This is caused by the growing number of –OH functional groups

that interact with other functional groups in the molecule to form interactions, thus precipitating strecthing and bending vibration. In addition, also observed the presence of peak with significantly reduced intensity in the range of wavenumbers 970 cm^{-1} – 1,250 $cm^{-1.}$ This indicates that the interaction between indigosol pink dyes and mori fibers also occurs through the –CO functional groups. Meanwhile, the emergence of a peak at wavenumbers 1,100 cm^{-1} – 1,105 cm^{-1}, which did not exist previously, both at the white mori spectra also indigosol pink dye spectra show–CN functional group of the indigosol dye molecular structure. Thus, it can be predicted that the interaction between mori fiber, nitrite, and indigosol dye as it appears in figure 2.

While from the infrared spectra comparison between the white and colored mori fiber, with (b) and without (a) washing process using TRO (for 24 hours), observed the emergence of a similar peak withmore smoother spectra structure. This indicates that the leaching process using TRO that is done before dyeing process, has been able to eliminate the pollutant and maximize the dyeing process on mori fiber.This is confirmed by the existence of a more significant intensity differences between white and colored mori fibers which was leaching with TRO for 24 hours, compared to the fiber mori which not washed by TRO.

Mechanical strength analysis of mori fiber

Not all types of fibers can be processed into textile products (batik). To be processed into textiles products, fibers must have properties such as having resistance to stress and strain. This is important, because with high resistance against stress and strain means mori fiber has high ability in maintaining the pore size when receiving external loads. However, the treatment which applied to the fiber is sometimes just cause a loss on fibers endurance against the stress and strain. This parameters can be used to evaluate the suitability or appropriateness level of the treatment and dyes type with the fibers. Therefore, on this research has been done young's modulus measurement of colored fiber mori which resulting from the dyeing process with washing time variation. In figure 4 looks data graph of young's modulus of colored mori fiber on different washing time variation.

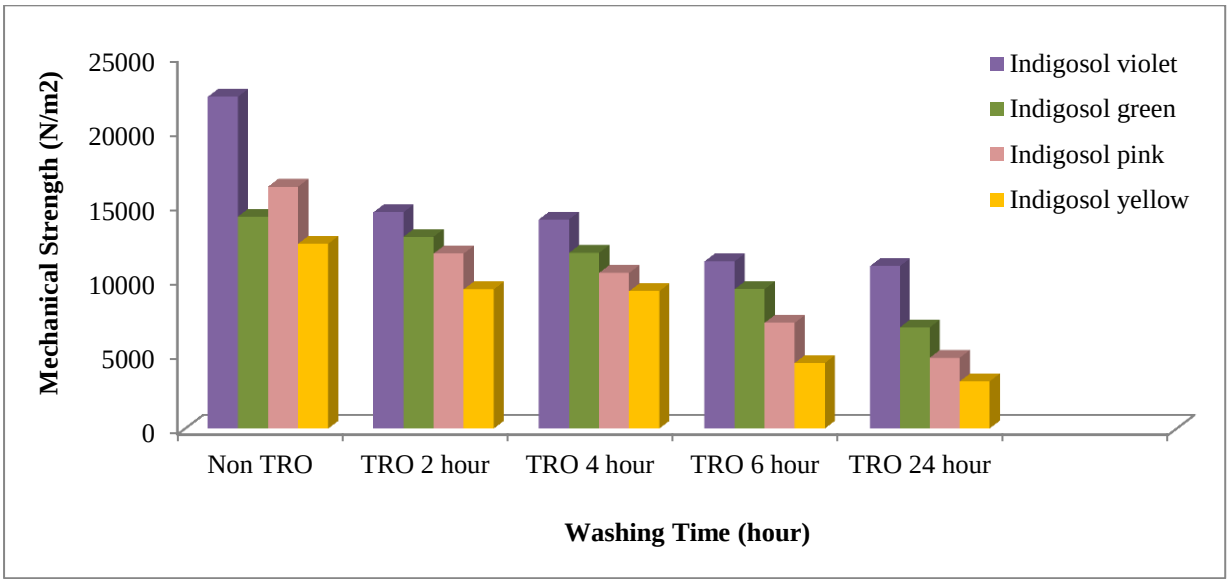

Figure 4: Young's modulus of colored mori fiber on different washing time variation

Based on Young's modulus data, as shown in figure 4, note that the value of Young's modulus will be smaller when the mori fibers washing process carried in the longer time. This is due to the washing process of mori fibers using TRO, has removed impurities that also interact with the fiber and strengthen the fiber resilience to the external load. Based on the mechanical strength data also, it can be seen the mechanical strength of colored mori fibers which not immersed on TRO are in the range 12,406.68 N/m^2 – 22,272.48 N/m^2, while the mechanical strength of colored mori fibers which was immersed on TRO 2 hour, 4 hour, 6 hour, and 24 hour, each are 9,344.29 N/m^2 – 14,518.38 N/m^2; 9,219.61 N/m^2 – 14,038.71 N/m^2; 4,399.34 N/m^2 – 11,216.53 N/m^2 and 3,161.97 N/m^2 – 10,900.14 N/m^2.

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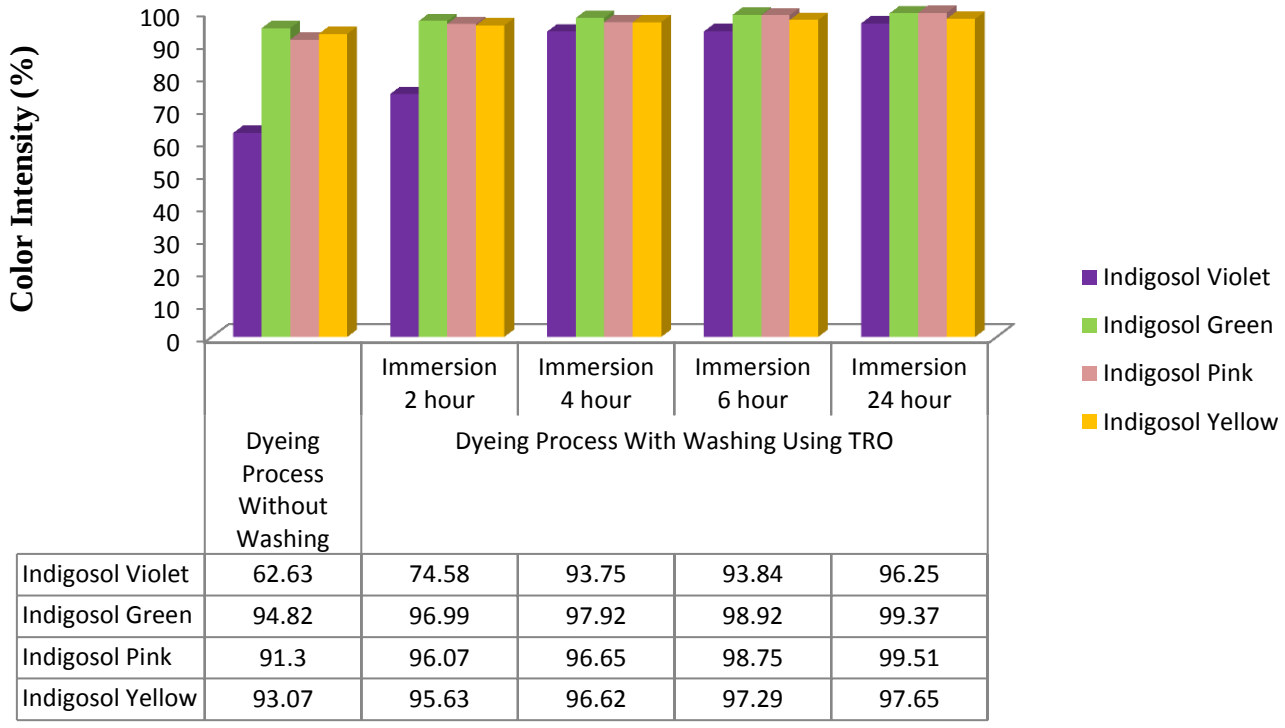
The indigosol color intensity test of mori fiber

In addition to mechanical strength, to evaluate the compliance level of dyes with fibers, on this research also has been conducted indigosol color intensity test of the mori fiber using instruments DRUV. In addition, from the color intensity measurement results of the mori fiber on a variety of washing time, knowable reflectant percentage that describing the indigosol dye absorption magnitude on each washing time. In figure 5 appears color intensity percentage value of colored mori fiber, where the dyeing process done with and without washing process using TRO before. Meanwhile, in figure 6 appears the color intensity percentage data of colored mori fiber after done the leaching process.



	Dyeing Process Without Washing	Immersion 2 hour	Immersion 4 hour	Immersion 6 hour	Immersion 24 hour
		Dyeing Process With Washing Using TRO			
Indigosol Violet	62.63	74.58	93.75	93.84	96.25
Indigosol Green	94.82	96.99	97.92	98.92	99.37
Indigosol Pink	91.3	96.07	96.65	98.75	99.51
Indigosol Yellow	93.07	95.63	96.62	97.29	97.65

Figure 5:Color intensity of colored mori fabric (without and with washing process using TRO) before leaching

Based on the data graph in figure 5, appears that before leaching process indigosol green dyes have the highest compatibility level with mori fiber, which the average reach 97,60%, after immersed in the TRO for 24 hours. While the lowest compatibility level with the mori fiber generated by indigosol violet dye, where the color intensity average which obtained is 84,21% for mori fiber which has been immersed in TRO for 24 hours.

Based on the data in figure 6, it is noted that despite the color intensity of indigosol green on the fiber is the highest, but the fade resistance level of indigosol yellow dye is the highest. This is can happen most likely because there are some indigosol dyes particles that does not interact with fiber and deposition only on the fiber surface. The dye particles on the fiber surface, will be easily leached out and cause a decrease in the color intensity of the dye in question. The fade level average of indigosol dyes are of 0.61%; 9.97%; 11.70%; and 16.10%, respectively for the indigosol yellow, indigosol green, indigosol violet, and indigosol pink dyes. Thus, it can be said that the color generated by the indigosol yellow has the most excellent fade resistance.

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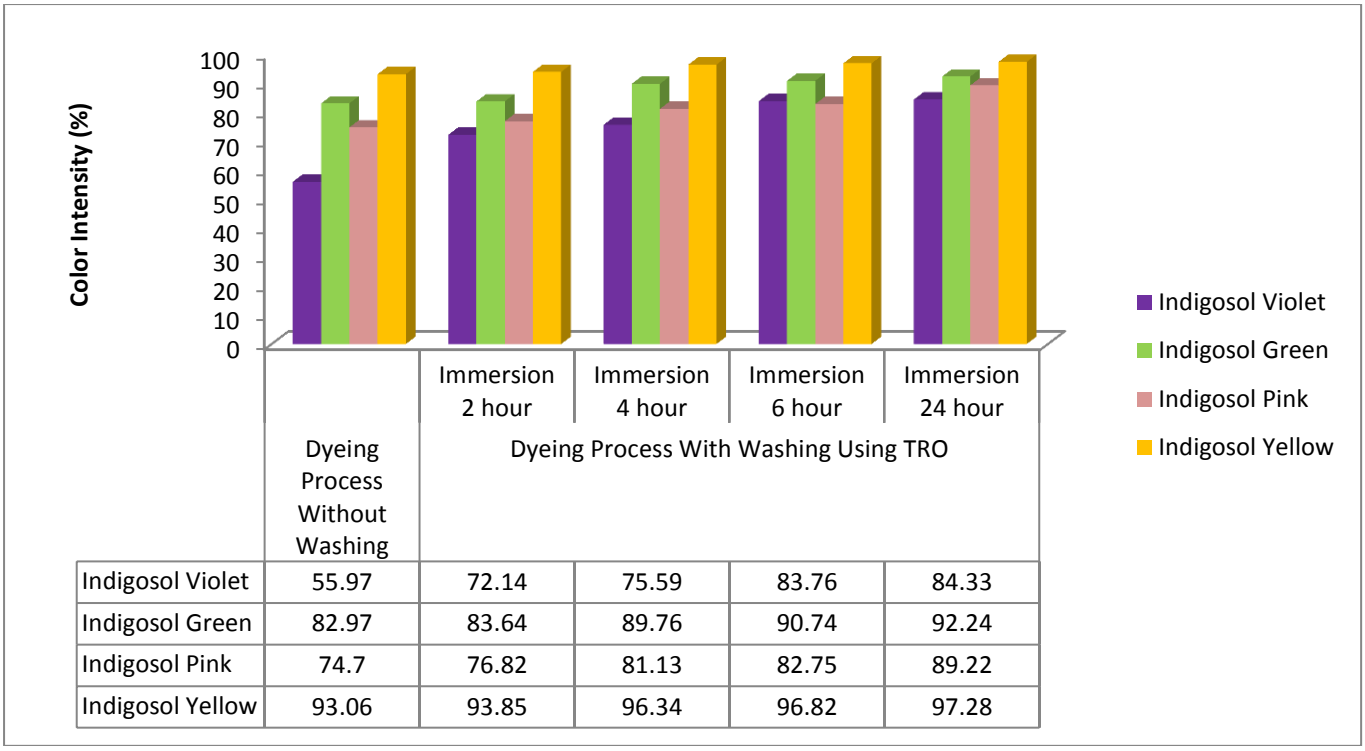

	Dyeing Process Without Washing	Dyeing Process With Washing Using TRO			
		Immersion 2 hour	Immersion 4 hour	Immersion 6 hour	Immersion 24 hour
Indigosol Violet	55.97	72.14	75.59	83.76	84.33
Indigosol Green	82.97	83.64	89.76	90.74	92.24
Indigosol Pink	74.7	76.82	81.13	82.75	89.22
Indigosol Yellow	93.06	93.85	96.34	96.82	97.28

Figure 6: Color intensity of colored mori fabric (without and with washing process using TRO) after leaching

CONCLUSION

Based on the results obtained, it can be concluded that the washing process affect the color intensity produced by the indigosol dye and also have an effect on the mechanical strength of the colored mori. Influence of washing process to the indigosol color intensity is characteristic for each type of such dyes. Meanwhile, the TRO uses in the washing process is apparently capable to lowering the mori fiber mechanical strength significantly, where the longer time washed in the TRO, the lower mechanical strength generated by the mori fiber.

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REFERENCES

[1] http://www.cdnet.edu.cn/mirror/indonesia_college/www.undip.ac.id/riset/risetpub/phdpn.htm.
[2] Sumarsono, Hartono, Ishwara, Helen, Yahya, Supriyapto, Moeis, Xenia. 2013. Benang Raja: Menyimpul Keelokan Batik Pesisir. Kepustakaan Populer Gramedia, Jakarta.
[3] Tirta, Iwan, Steen,Gareth, Urso, Deborah, Alisjahbana, Mario. 1996. Batik : a play of lights and shades, volume 1. Gaya Favorit Press, Jakarta.
[4] Dinas Perindustrian dan Perdagangan (Disperindag). 2012.
[5] Kusumawati, N., Wijiastuti, A., Rahmadyanti, E. 2012. Operating Conditions Optimization on Indonesian"Tekstil" Dyes Wastewater Treatment by Fenton Oxidation and Separation Using Ultrafiltration Membrane. Journal of Environmental Science and Engineering 1.
[6] Christie, R.M. 2007. Enviromental Aspect of Textile Dyeing. CRC Press, Boca Raton, USA.
[7] Hunger, K and Sewekow, U. 2003. 'Health and safety aspects', in Hunger K, Industrial dyes: chemistry, properties, applications, Weinheim, Wiley–VCH, 625–641.

[8] Kusumawati, N., Budi, A., Koestiari, T., Muslim, S. 2014. Recovery (Reuse) Potential of Naphtol and Indigosol Batik Dyes Based on The Deposition Behaviour and Separation Difficulty. International Journal of Environmental Research and Development, 4 (1) : 37-50.
[9] Christie, R.M. 2007. Enviromental Aspect of Textile Dyeing. CRC Press, Boca Raton, USA.
[10] Crini, G. 2006. Non-conventional low-cost adsorbents for dye removal; a review. Bioresour. Technol. 97: 1061–1085.