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Quality Of Tie Dye Using Papaya Leaves Extract *(Carica papaya L.)*

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Abstract. *Papaya plant is one type of plant that is widely cultivated in Indonesia. Papaya leaves contain chlorophyll, tannins, flavonoids, alkaloids, steroids, saponins and triterpenoids which can be used as basic ingredients for the manufacture of natural dyes for textiles. Utilization of papaya leaves as natural dyes can reduce the impact of environmental damage caused by synthetic dyes. This study aims to determine the quality of color strength, color fastness to detergent washing and motive sharpness on primissima mori fabric using tie dyeing technique with variations in the pH of papaya leaf extract and the mordant used is mordant alum, quicklime, and tunjung. This research is a type of experimental research. The data collection technique used was a laboratory test. The data analysis technique used is descriptive analysis. The results of the descriptive analysis showed that the darkest color strength test results were produced by mordant tunjung pH 6 with a reflectance value of 3.51% and a transmittance value of 96.49% including very dark criteria. The best test values for color fastness to detergent washing were alum mordant at pH 2 and pH 12 and quicklime mordant pH 2 with an average gray scale value of 4-5 in the good category. The test value for the sharpest tie dye motive is the mordant tunjung pH 6 with a reflectance value of 3.51% and a transmittance value of 103% including very sharp criteria. The conclusion from several test results shows that the use of different pH variations and types of mordant can affect the results of the quality of dyeing on fabrics.*

Keywords: *mordant, pH, papaya leaf, tie dye*

INTRODUCTION

One of the textile finishing processes is the coloring process. Coloring requires the presence of dyes which are divided into two, namely natural dyes and synthetic dyes (Sunarto, 2008). The tie dye technique is a coloring process with the technique of giving motives to the cloth, which is done by filling the cloth, folding the cloth or tying the cloth in a certain way (Nanda and Ramadhan, 2019). Reporting from the CNN Indonesia Team (2020) tie dye has again become a trend amid the Covid-19 pandemic situation that the world is currently experiencing. The large market demand has caused the production of tie-dyed fabrics to increase. Tie dye cannot be separated from the coloring process using dyes. This will certainly cause problems in the form of environmental pollution from synthetic dyes. If you cannot process synthetic dye waste properly, it will pollute the surrounding environment.

Seeing this situation, to reduce environmental pollution, it is necessary to use natural dyes as a substitute for synthetic dyes. Natural dyes are dyes obtained from plants, animals and minerals (Visalakshi and Jawaharlal, 2013). Natural dyes generally come from plants which are easily decomposed and friendly to the environment. One of the plants that can be used as a natural coloring agent is papaya leaves (Carica papaya L.) (Azizah and Utami, 2016). Based on data from the Central Bureau of Statistics, it is recorded that the cultivation of papaya plants has increased every year, causing many papaya leaves to not be used properly. A'yun and Laily (2015) stated that papaya leaves contain compounds in the form of alkaloids, triterpenoids, steroids, flavonoids, saponins, and tannins. The tannins in papaya leaves are divided into two groups and each group gives a different color reaction. Hydrolyzed tannins will produce a black-blue color and condensation tannins will produce a black-green color (A'yun and Laily, 2015). Collection of natural dyes is done by extraction, including hot extraction and cold extraction. According to Sonja et al. (2020) extraction is the process of breaking down plant cell walls to develop dyes in the media. In general, natural dyes are influenced by several factors such as light, temperature, pH, and oxygen (Inggrid and Iskandar, 2016). The pH of natural dye extraction affects the absorbance value of the resulting dye solution (Souissi et al., 2018). Dyeing of fabrics using natural dyes has the disadvantage of producing strength colors and low fastness, so a fixation process is needed to lock in the colors. According to Angendari (2015), the fixation process is one of the most important processes in color dyeing, because this process is designed to lock the dye that has stuck to the textile so that it has good fastness. The fixing agents used in this study were mordant alum, quicklime, and tunjung.

Based on the environmental problems described above, research will be carried out using papaya leaves as a natural coloring agent in primissima mori cloth dyeing with the tie dye technique to be used as a product that has a sales value. This study aims to evaluate the quality of the dyeing results of primissima mori cloth by tie-dyeing technique using papaya leaf extract in terms of the color strength test, the color fastness test to detergent washing and the tie-dyeing motive sharpness test.

METHODS

This research is a type of experimental research. Sugiyono (2014) said experimental research is a research method used to look for the effect of certain treatments on others under controlled conditions. The experiment carried out was the manufacture of natural dyes from papaya leaves using cold extraction with fixed agent mordant alum, quicklime, and tunjung. In this study there were three variables, namely: 1) the independent variables in this study were variations of mordant alum, quicklime, and tunjung. 2) the dependent variable in this study was the quality of dyed tie-dye fabric dyed with papaya leaf natural dyes, including color strength, color fastness to detergent washing, and motive sharpness. 3) the control variables in this study were papaya leaf extract, primissima mori cloth, tie-dyeing technique, 15 times dyeing frequency, 10-minute immersion time and 10-minute fixation time. The data collection technique used was a laboratory test. Methods of data analysis use descriptive analysis.

RESULT AND DISCUSSION

Standard mori primissima staining results using the tie-dye technique on the color strength test with papaya leaf extract using the Spectrophotometer UV-PC Model ISR-2200. The test results are measured at the maximum wavelength, namely the wavelength with the smallest reflectance value (R%). The smaller the R% value, the darker the resulting color, whereas the greater the R% value, the lighter the resulting color. However, if the reflectance value R% is converted to a percentage transmittance (T%), then the maximum wavelength lies at the largest T%. The greater the T% value, the darker the resulting color, and vice versa. The standard color strength test values can be seen in table 1 below:

Table 1 Color Strength Criteria R%

Color Strength Value	Criteria
0-20	Light
21-40	Fairly Light
41-60	Medium
61-80	Dark
81-100	Very Dark

(Table Source: Sulistiyani, 2015)

The results of the color strength test on the dyeing of primissima mori cloth with the tie dye technique using papaya leaf extract can be seen in table 2 below:

Table 2 Color Strength Test Value

Fabric Sample	Mordant Type	Test to	Color Strength Test Value R%	Mean (R%)	Mean T% (100-R%)	Criteria
pH 2	Alum	1	60.51	61.09	38.91	Fairly Light
		2	65.22			
		3	57.56			
	Quicklime	1	21.72	23.30	76.7	Dark
		2	22.58			
		3	25.62			
	Tunjung	1	12.39	13.70	86.3	Very Dark
		2	15.45			
		3	13.28			
pH 6	Alum	1	22.29	26.68	73.32	Dark
		2	33.59			
		3	24.16			
	Quicklime	1	13.43	14.05	85.95	Very Dark
		2	17.86			
		3	10.86			
	Tunjung	1	3.95	3.51	96.49	Very Dark
		2	3.56			
		3	3.02			
pH 12	Alum	1	37.63	38.28	61.72	Dark
		2	45.78			
		3	31.43			
	Quicklime	1	38.79	35.25	64.75	Dark
		2	40.98			
		3	25.98			
	Tunjung	1	4.08	4.50	95.5	

	2	4.33	Very
	3	5.11	Dark

Based on the research data in table 2, it can be concluded that the lightest color gain was found in the treatment of papaya leaf extract pH 2 using alum mordant with a reflectance value (R%) of 61.09% and a transmittance value (T%) of 38.91% in the fairly light category, while the color gain was the lowest. The darkest color was found in the treatment of papaya leaf extract pH 6 using mordant tunjung with a reflectance value (R%) of 3.51% and a transmittance value (T%) of 96.49% in the very dark category.

Results Of Descriptive Analysis Of Color Fastness To Detergent Washing

The criteria for testing color fastness for detergent washing use the Gray Scale, namely by looking at the gray scale value to determine the quality of the level of difference or color contrast from the lowest level to the highest level. The resulting color fastness value is then converted into CD (Color Difference) value units. The higher the gray scale value, the better the fastness. On the other hand, the lower the CD (Color Difference) value, the better the fastness. This color fastness test aims to determine the color attached to the fabric sample after the detergent washing process is carried out. The results of testing the color fastness of detergent washing on primissima mori cloth with papaya leaf extract based on variations in pH are presented in table 3 below:

Table 3 Color Fastness Test Value To Detergent Washing

Fabric Sample	Mordant Type	Test to	Color Fastness Test Value To Detergent Washing		Mean		Criteria
			Grey Scale	CD	Grey Scale	CD	
pH 2	Alum	1	4-5	0.8	4-5	0.8	Good
		2	4-5	0.8			
		3	4-5	0.8			
	Quicklime	1	4-5	0.8	4-5	0.8	Good
		2	4-5	0.8			
		3	4-5	0.8			
	Tunjung	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			
pH 6	Alum	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			
	Quicklime	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			
	Tunjung	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			
pH 12	Alum	1	4-5	0.8	4-5	0.8	Good
		2	4-5	0.8			
		3	4-5	0.8			
	Quicklime	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			
	Tunjung	1	4	1.5	4	1.5	Good
		2	4	1.5			
		3	4	1.5			

Based on the research data in table 3, it can be concluded that the best color fastness for detergent washing was shown in the treatment of pH 2 mordant alum, pH 2 mordant quicklime and pH 12 mordant alum, which resulted in a gray scale value of 4-5 and a color difference value of 0.8 included in the category "good".

Results Of Descriptive Analysis Of Motive Sharpness

The results of the motive sharpness test were obtained by looking at the color strength test data and primissima mori cloth that had not been dyed. The white primissima mori cloth data was then reduced by the color strength test data (T% white primissima mori cloth – R% value of each sample) to then be analyzed descriptively. The greater the T% value, the sharper and clearer the motive is. Data on the results of the motive acuity test are presented in table 4 below:

Table 4 Motive Sharpness Test Value

Fabric Sample	Mordant Type	Test to	Motive Sharpness Test Value R%	Mean (R%)	Mean T% (106.51-R%)	Criteria
STD-Fabric Plain	_	_	106.51	_	_	_
pH 2	Alum	1	60.51	61.09	45.42	Fairly Sharp
		2	65.22			
		3	57.56			
	Quicklime	1	21.72	23.30	83.21	Very Sharp
		2	22.58			
		3	25.62			
	Tunjung	1	12.39	13.70	92.81	Very Sharp
		2	15.45			
		3	13.28			
pH 6	Alum	1	22.29	26.68	79.83	Sharp
		2	33.59			
		3	24.16			
	Quicklime	1	13.43	14.05	92.46	Very Sharp
		2	17.86			
		3	10.86			
	Tunjung	1	3.95	3.51	103	Very Sharp
		2	3.56			
		3	3.02			
pH 12	Alum	1	37.63	38.28	68.23	Sharp
		2	45.78			
		3	31.43			
	Quicklime	1	38.79	35.25	71.26	Sharp
		2	40.98			
		3	2598			
	Tunjung	1	4.08	4.50	102.01	Very Sharp
		2	4.33			
		3	5.11			

Based on the results obtained in table 4, it can be concluded that the acquisition of the highest motive sharpness was found in the treatment of papaya leaf extract pH 6 with a reflectance value of 3.51% and a transmittance value of 103%, while the lowest motive sharpness was obtained in the treatment of papaya leaf extract with a pH of 2 mordant alum and reflectance value of 61.09% and transmittance value of 45.42%.

Discussion

Based on data from the color strength test on primissima mori cloth which was colored using papaya leaf extract with certain pH variations, it showed that the nine samples produced different colors according to the type of mordant and the pH of the papaya leaf extract used. The results of the coloring can be seen in table 5 below:

Table 5 Tie Dyeing Results

Papaya Leaf Extract	Tie Dyeing Results		
	Alum	Quicklime	Tunjung
pH 2			
pH 6			
pH 12			

In the treatment of cloth samples stained with papaya leaf extract, pH 2 (acid), pH 6 (neutral) and pH 12 (alkaline), mordant alum produced a faded green color with different strength levels and at pH 2 it was the lightest color. Samples on cloth stained with papaya leaf extract pH 2, pH 6, and pH 12 mordant quicklime produced a cream color with different levels of color strength. Meanwhile, in the cloth samples which were stained with papaya leaf extract at pH 2, pH 6, and pH 12, the tunjung mordant produced a greenish-brown color with different levels of strength and was the darkest color. This is in accordance with Rosyida's research (2015) which states that the results of dyeing fabrics dyed with different pH and the same mordant will produce the same color at different levels of strength, in the following order of strength: the alkaline pH produces the darkest color, a neutral pH produces medium color strength and an acidic pH produces the lightest color.

The different levels of color strength are caused by variations in pH and the type of mordant used. The use of alum mordant will create a slightly faded color because alum is a colorless chemical compound, so the result will only strengthen the color (Rosyida and Achadi, 2014). Alum does not affect the color direction, so it tends to be the same as the original color of the dye extract (Atika et al., 2016). Quicklime solution used in coloring will produce lighter or faded colors because quicklime is an alkaline anhybrid, and when it reacts with water it will produce slaked lime or calcium hydroxide. The quicklime solution also emits a lot of heat, is slightly alkaline in nature and easily attracts carbonic acid gas from the air so that the water becomes cloudy easily (Angendari, 2015). While staining with mordant tunjung will produce colors that tend to be darker than the others (Angendari, 2015).

This research is relevant to the results of a study conducted by Angendari (2015) which stated that the color quality using alum mordant produced brighter colors than those using quicklime mordant and tunjung mordant. While the color quality produced by quicklime mordant is faded and the color quality produced by tunjung mordant is darker than the others. This study was also supported by Kristijanto and Soetjipto (2013), who stated that coloring batik cloth using green tea waste extract with tunjung mordant produced the darkest color, whereas those using quicklime mordant produced medium colors and alum mordant produced the lightest color.

This research is slightly different from the research conducted by Rahmawati and Wahyuningsih (2020) which showed that the quality level of color strength in color dyeing using kareumbi peel extract (Homalanthus populneus) with quicklime mordant produces the lightest color strength, mordant alum produces medium colors, and the tunjung mordant treatment produces the darkest color strength.

Based on the data from the test results for color fastness on primissima mori cloth, which was colored using papaya leaf extract with variations pH and mordant variations, the gray scale values were generally almost the same. In the cloth samples using alum mordant pH 2 and pH 12 and quicklime mordant pH 2, the same gray scale values were obtained, namely 4-5 (very good) with a color difference value of 0.8. Whereas in the other samples, namely alum mordant pH 6, quicklime mordant pH 6 and pH 12, tunjung mordant pH 2, pH 6, and pH 12, a gray scale value of 4 (good) was obtained with a color difference value of 1.5. This is because mordant alum has the best quality of color fastness compared to quicklime and tunjung (Pujilestari, 2014). However, the alum mordant pH 6 had a gray scale value that differed by one level when compared to the pH 2 and pH 12 alum mordant samples. The results of research by Rosyida and Achadi (2014) stated that color fastness to detergent washing using mordant alum can increase the fastness of color-dyed fabrics. The fastness of alum gives the best value due to the strong complex bond between alum and tannins (Chintya and Utami, 2017).

The results of this study are relevant to research conducted by Amalia and Akhtamimi (2016), Anzani et al. (2016), and Maghfiroh and Widowati (2020), where the results of color fastness for soap washing showed that the alum mordant treatment had the best quality compared to quicklime and tunjung mordant. In the study by Amalia and Akhtamimi (2016), they stated that the dyeing of batik cloth using rambutan peel waste treated with a fixation concentration of 5% obtained the best on a gray scale value of 4 (good) for alum and quicklime, a gray scale value of 3-4 (pretty good) for tunjung. Meanwhile, the color fastness for washing at a fixation concentration of 25% and a concentration of 45% showed that the alum mordant had the best results for its fastness, namely the gray scale value of 5 (very good). While Anzani et al. (2016) stated that the dyeing of primissima mori cloth using natural dyes from soursop leaves with mordant alum treatment at concentrations of 10%, 15%, and 20% resulted in a gray scale value of 3 (sufficient). In the treatment of mordant quicklime, a concentration of 10% produces a gray scale value of 3 (sufficient), a concentration of 15% produces a gray scale value of 2-3 (low) and a concentration of 20% produces a gray scale value of 2 (low). Whereas in the study of Maghfiroh and Widowati (2020) stated that the results of dyeing mori primissima cloth using red dragon fruit peel waste with mordant alum produced a gray scale value of 4 (good), while mordant quicklime and tunjung produced a gray scale value of 3-4 (quite good).). It can be concluded that mordant alum has excellent color fastness for soap washing.

Analysis of the results of the motive sharpness test showed that the sharpness of the motive in the tie dye dyeing process using papaya leaf extract pH 2 obtained the sharpest results, namely the tunjung mordant type with a reflectance value of 13.7% and a transmittance value of 92.81%. The sharpness of the motive in the tie dye dyeing process using papaya leaf extract pH 6 obtained the sharpest results, namely the tunjung mordant type with a reflectance value of 3.51% and a transmittance value of 103%. While the sharpness of the motive in the tie dye dyeing process using papaya leaf extract, pH 12 obtained the sharpest results, namely in the tunjung mordant with a reflectance value of 4.5% and a transmittance value of 102%. Based on this explanation, it can be concluded that the sharpness of the motive at all pH variations is best shown by the tunjung mordant. This is due to the reaction between tannins from natural dyes and Fe2+ metal from mordant tunjung, which produces complex salts (Ferotanate), so that it gives sharpness to motives that tend to be sharper than mordant alum and quicklime (Lestari and Satria, 2017).

This motive acuity test study is relevant to research conducted by Sulistiyani (2015) which stated that banana blossoms can be used as a natural dye in the dyeing process of dyed fabrics that use various mordanting processes and types of mordant. The results of the analysis of the use of variations in the mordanting process obtained the best motive acuity test values, namely those using tunjung mordant. The results of this study were also supported by research conducted by Nisa' and Singke (2018) which showed that the tie dye staining technique with natural dyes from tamarind peels produced a tie dye motive with a mass of 200 gram mordant tunjung very good motive results compared to the mass of the mordant tunjung 100 grams and 300 grams.

This research is different from the results of research conducted by Warsiti and Russanti (2019) on the coloring of denim dresses using the tie dye technique with natural dyes from cherry leaves (Muntingia Calabura). This research resulted in coloring of cherry leaves (Muntingia Calabura) with the tie-dyeing technique in terms of the clarity of the tie-dye motives on the salt mordant to get very good results, the alum mordant in the good category, and the soda ash mordant in the moderate category. Salt mordant is viewed from the aspect of clarity of motives to produce the best motives. This is because salt mordant has hygroscopic characteristics, which means it easily absorbs water. This property makes fibers that have been dipped in a solution of mordant salt easily absorb dyes in the form of liquids so that the color of the cloth is sharper.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the quality of the coloring results of primissima mori cloth using the tie dyeing technique with variations in the pH of papaya leaf extract and alum mordant, quicklime, tunjung in terms of color strength produces the lightest color in the treatment of papaya leaf extract using alum mordant and the darkest or darkest color is found in the tunjung mordant treatment. While the quality of the coloring results when viewed from the color fastness to detergent washing showed that the mordant alum treatment produced the best fastness, namely the gray scale value of 4-5 (good). While the quality of the staining results in terms of the sharpness of the motives produced, the sharpest motive sharpness is shown in the mordant tunjung treatment at all pH variations.

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