Productum: Jurnal Desain Produk (Pengetahuan dan Perancangan Produk)
Vol 5 No 2 Juli-Desember 2022 131-138
ISSN 2477-7900 (*printed*) | ISSN 2579-7328 (*online*) | terakreditasi Sinta-4
DOI: https://doi.org/10.24821/productum.v5i2.5048

The effect of dyeing duration and fixative on the final results of textile dyeing using purple sweet potato peel

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Abstract

The fashion industry is one of the creative sectors that has significantly impacted Indonesia's economic growth. During this pandemic, the Ministry of Industry held a training program to spur the competitiveness and productivity of the textile and textile product (TPT) industry so that they can continue to run their businesses amid the pressure of the Covid-19 pandemic impact. The industries must be more innovative to be competitive in domestic and foreign markets. In this study, purple sweet potato peel was applied as a textile coloring pigment, considering its novelty and innovation value. It is expected to be an innovation in Indonesian creative industry products. So far, in the realm of textiles and fashion, purple sweet potato peel has been used as a natural textile dye, but it is less popular than other natural dyes. In addition, in Indonesia, purple sweet potato is a plant that grows throughout the year, with high quantity production and consumption rates, so that the waste of it can be used as a natural textile dye. To optimize the use of purple sweet potato peel, this study analyzes the effect of indicators on the dyeing process: the dyeing duration and the fixative used.

Keywords: *natural pigment, textile, dyeing, fixative, duration, sweet potato*

1. Introduction

The fashion industry is one of the creative sectors that has significantly impacted Indonesia's economic growth. The fashion industry is considered capable of being a driving force in the development of Indonesia's creative industries. Many original Indonesian designers are now recognized by the foreign public (Tumbelaka, 2021). Based on data from the Ministry of Industry in 2016, it was noted that the export value of the fashion industry reached USD 11.7 billion. In addition, based on data from the 2016 Economic Census, the creative economy's number of businesses or companies in the fashion industry reached 15.01%, ranking second after the culinary industry with 67.66%. The fashion industry also contributed 18.01% or around Rp. 116 trillion in Indonesia's Creative Economy Passion. Therefore, the government held several programs to support the productivity of the fashion industry and some related industries, such as the textile and crafts industry.

The current global market significantly affects the development of the industrial field. Industry 4.0 forces product designers to innovate to produce new products (Wahmuda, 2020). During this pandemic, the Ministry of Industry held a training program to spur the competitiveness and productivity of the textile and textile product (TPT) industry so that they can continue to run their businesses amid the pressure of the impact of the Covid-19 pandemic. This is because industries must be more innovative to be competitive in domestic and foreign markets.

Fashion trends keep changing in a short span of time. To survive and be able to compete in the market, the industry must be able to adapt quickly and innovate products responsively. As stated by Ramadhan (2022), creativity is one of the strengths in designing fashion products so the industry can produce innovative fashion items, have a value of novelty, have uniqueness or originality, and contain a high aesthetic value. Apart from the ever-changing trends, and product innovation, public consumerism has become the driving force for the fashion industry. Consumer needs and demands encourage business actors to develop and create new products that follow consumer demand. In this situation, innovation is needed; therefore, product innovation can affect business performance (Lorensa, 2022).

In this study, using purple sweet potato peel for textile dyes is an effort to add novelty value and innovation to creative industrial products, especially textiles and fashion. Using natural dyes is an effort to

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obtain new and more exclusive colors (Heruka, 2018). Natural Dyes in the form of color pigment can be obtained from plants or animals. The pigments often found are chlorophyll, carotenoids, tannins, and anthocyanins (Lestari, 2017). Therefore, the peel of purple sweet potatoes, which have anthocyanins, is the potential to be extracted and used as a natural dye (Fatimatuzahro, 2019). In contrast with Batik dyeing, which is done repeatedly and at room temperature, the dyeing process in this study was carried out at high temperatures to optimize the absorption of color pigments. The determining factors of the process's final result analyzed in this study were the dyeing duration and the fixative or final mordant. The fixation process aims to sharpen the color and make the pigments do not fade easily (Paryanto, 2018). The type of fixative is a factor component that can affect the direction and color produced (Pujilestari, 2017).

Purple Sweet Potato

Sweet potato plants (Ipomea batatas L.) consist of 3 varieties: yellow, red, and purple sweet potatoes. Based on these varieties, sweet potatoes have a variety of colors, namely white, yellow or orange, and purple. Purple sweet potato is a variety that has advantages over other sweet potato varieties, namely that it contains higher anthocyanin pigments (Rustanti in Tuhumury, 2018). The total content of purple sweet potato anthocyanins ranges from 110.51 mg / 100 grams (Siagian, 2015). As stated by Mahdavi in Yunilawati (2018), Anthocyanins are widely used as food coloring, especially in soft drinks, candy, ice cream, yogurt, and powdered drinks. However, anthocyanin dyes have drawbacks in their use, namely their instability and easily degraded during storage.

Picture 1. Purple Sweet Potato

According to Setiawan (2020), purple sweet potato is a local tuber with high productivity in Indonesia, but its utilization has yet to be maximized. In 2015 the productivity of purple tubers reached 160.53 quintals/hectare (Badan Pusat Statistik, 2015).

The systematics of purple sweet potato plant are as follows:

Kingdom	: Plantae
Division	: Spermatophyta
Subdivision	: Angiosperms
Class	: Dicotyledonae
Order	: Convolvulales
Family	: Convolvulaceae
Genus	: Ipomoea
Species	: I. batatas
English name	: Sweet potato
Indonesian name	: Ubi
Local Name	: Ketela rambat (Java), huwi boled (Sundanese)

Synonyms: Convolvulus batatas L. (1753), Convolvulus edulis Thunb. (1784), Batatas edulis (Thunb.) Choisy (1833).

Meanwhile, in the fashion and textile industries, sweet potatoes, especially purple sweet potatoes, are used as natural coloring agents because of the anthocyanin content in the skin and tubers. Furthermore, due to the production and high anthocyanin content, textiles with natural dyes are currently in high demand, so purple sweet potato peels for textile dyes are very potential. Mukhlis in Chintya (2017) states that natural dyes are safe and environmentally friendly and are also preferred by consumers because they have beautiful and distinctive colors that are difficult to imitate with synthetic dyes. However, compared to other natural dyes such as turmeric, secang, soybean, indigofers, and mangosteen peel, textile dyes from purple sweet potato are still relatively rare.

2. Methodology

This research is qualitative research with an experimental method approaching. According to Hadi in Payadnya (2018, p2), experimental research is research conducted to know the consequences of a given treatment intentionally by the researcher. In this study, the experiment was done by conducting a series of explorations to determine the effect of dyeing duration and fixatives that produce the most optimal color result using purple sweet potato peel. The first exploration stage is dyeing the fabric with different duration ranging from 10 minutes to 60 minutes, and the second exploration is using various substances on the fixation stage.

In the dyeing process, several fabrics made from natural fibers, such as 100% cotton, linen, dobby, silk, and organdy silk, are used to identify the fabric type with the most optimal color absorption of purple sweet potato peel.

3. Results and discussions

Purple Sweet Potato Peel Extraction Process

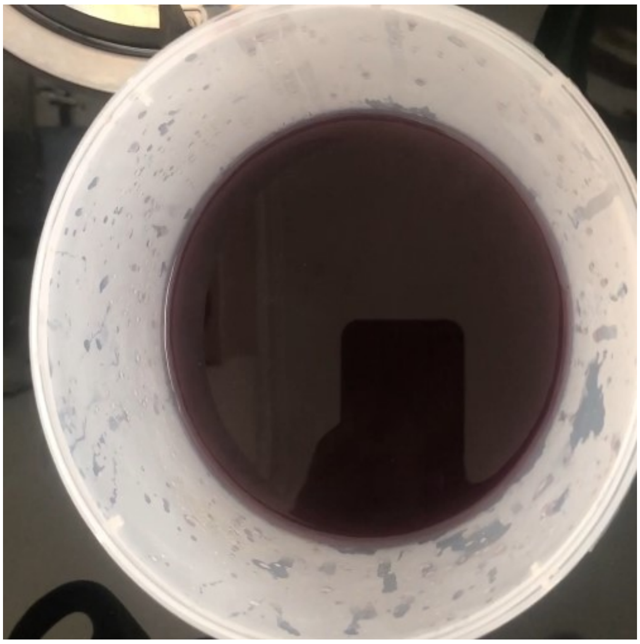
The color pigment extraction process conducted in this study is the extraction method that uses water or the aqueous method (Nugraha, 2020). The following are the stages of the purple sweet potato peel extraction process: (1) Wash the sweet potato clean from the soil that sticks; (2) Peel the sweet potatoes; from 500 grams of sweet potatoes, produce about 50 grams of sweet potato peel; (3) Boil the peel of the sweet potato (50 grams of sweet potato skins: 500 ml of water), boil it until the water is half (Picture 2); (4) Wait for it to cool, then strain. Use the water for dyeing fabrics (Picture 3).

Mordanting and Dyeing Process

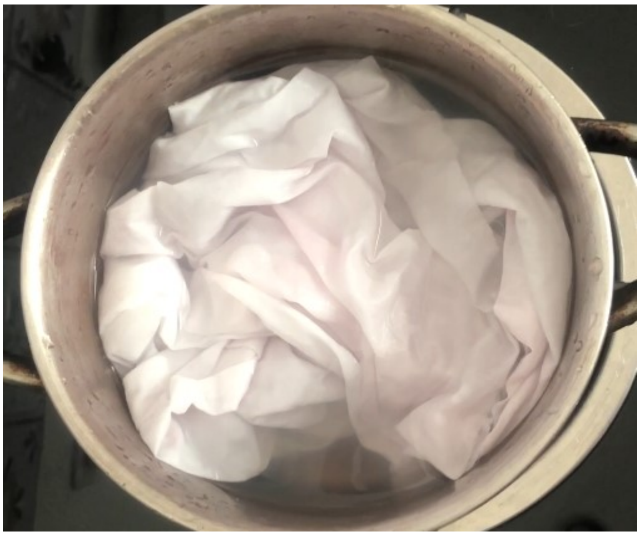
This study's fabrics made from natural fibers consist of 100% Cotton Fabric, Linen Fabric, Dobby Fabric (Cotton and Viscose), Silk Fabric, and Organdy Silk Fabric. Before going through the color dyeing process, all the fabrics go through the mordanting process using alum solvent water (Picture 4). As stated by Robertson in Zerin (2016), dyeing with natural dyes usually requires the use of one or more mordants, metallic salts of aluminum, iron, chromium, copper, and others for ensuring a reasonable fastness of the color to sunlight and washing. Some researchers have proven that mordanting process can increase fabric color strength (dye uptake), color fastness, and UV protection (Zhang, 2022). The following are the stages of the mordanting process held in this study (Picture 4): (1) Soaked fabric with alum solvent for one night (ratio 30 grams of alum: 3-liter); (2) Rinsed the fabric with clean water, then soaked in a solvent of alum again and boiled for 1 hour; (3) After 1 hour, wait for the alum solvent to room temperature. Remove the fabric and rinse thoroughly; and (4) Dry the fabric.

Once the fabric is dry, each type of fabric cut into 6 pieces (approximately 10x10 cm). After that, all pieces of fabric dyed in the purple sweet potato peel extraction and boiled over low heat. 1 piece of fabric

Picture 2. Extracting Purple Sweet Potato Peel



Picture 3. Purple Sweet Potato Peel Extract



Picture 4. Mordanting Process

Picture 5. Dyeing Process

of each type is picked out of the vessel every 10 minutes. Then the fabric moves onto fixation process.

Fixation Process

Fixation process is the stage to add colorfastness towards the dyed fabric. According to Lestari in Ahmad (2018) the fixation process serves to strengthen the color and change the natural dye according to the type of metal that binds it and locks the dye that has entered the fabric fiber. There are acidic fixative substances and some are alkaline. In this research, lemon is used for acidic fixative substances, while for alkaline fixatives, alum is used. In addition, FeSO4 or commonly called tunjung is used, because it is a fixative substance commonly used by the batik industry in Indonesia. Each type of fabric is going through fixation process using those 3 different fixative substances, and also without being fixation at all to determine the difference in color produced.

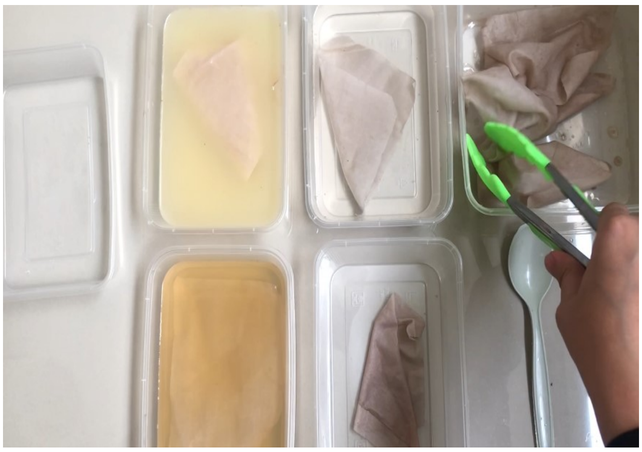
The following are the stages in the fixation process using alum (Picture 6): (1) Dissolve 70 grams of alum in 1 liter of water; (2) Soak the fabric using the alum solvent for about 30 minutes; (3) Rinse the fabric under running water, then dry it under a shade, do not dry it directly under the sun. The following are the stages in the fixation process using a $FeSO_4$: (1) Dissolve 20 grams of $FeSO_4$ in 1 liter of water; (2) Soak the fabric using the $FeSO_4$ solvent for about 30 minutes; (3) Rinse the fabric under running water, then dry it under a shade, do not dry it directly under the sun. The following are the steps in the fixation process using lemon juice: (1) Dissolve 100 ml of lemon juice in 1 liter of water; (2) Soak the fabric using the lemon solvent for about 30 minutes; (3) Rinse the fabric under running water, then dry it under a shade, do not dry it directly under the sun.

Discussions

The whole series of exploration processes is aim to find the effect of dyeing duration and color results differences by using various fixative substances. The results of dyeing 5 types of fabrics using purple sweet potato peel and 3 kinds of fixatives are outlined in the Table 1.

From the Table 1, it can be concluded that the results of dyeing cotton fabric using purple sweet potato peel are as follows: (1) Without fixative, the color result is bluish pink. The longer the dyeing duration, it gradually changed to purplish-pink color; (2) With lemon fixative, the color result is a very pale bluish pink. The longer dyeing duration, the color result gradually changed to purplish-pink, with better pigment absorption; (3) With FeSO4 fixative, the color result is greyish purple. The duration of dyeing has no effect on the color results; (4) With alum fixative, the color result is bluish pink. The longer dyeing duration, the color result gradually changed to purplish pink with better pigment absorption.

From the Table 2, it can be concluded that the results of dyeing linen fabric using purple sweet potato peel are as follows: (1) Without fixative, the color result is purple. The longer the dyeing duration, it gradually changed to the purplish-pink with better pigment absorption; (2) With lemon fixative, the color result is a very pale pink. The longer dyeing duration, the color result gradually become darker.; (3) With FeSO4 fixative, the color result is greyish pink. The duration of dyeing has no effect on the color results; (4) With alum fixative, the color result is bluish pink. The longer dyeing duration, the color result gradually become slightly darker.



Picture 6. Fixation Process

Table 1.
Results of dyeing purple sweet potato peel on 100% cotton

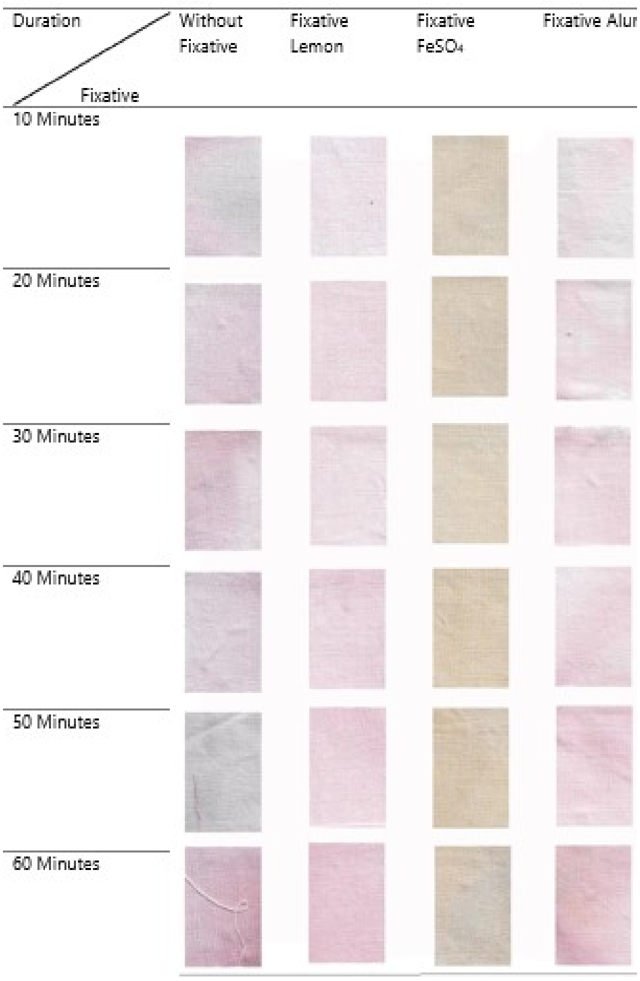
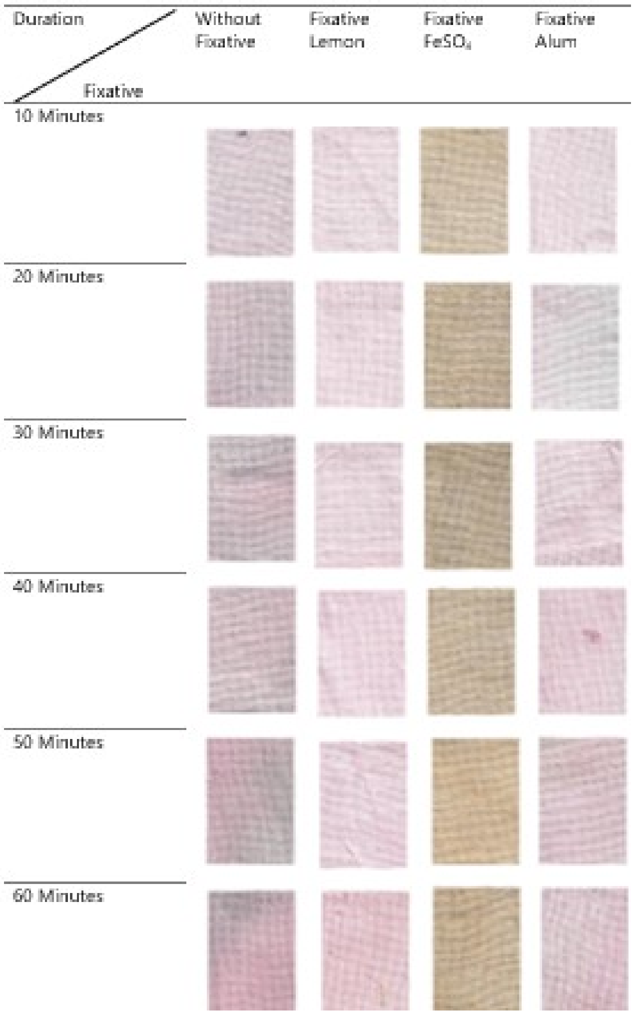


Table 2
Results of Dyeing Purple Sweet Potato Peel on Linen



From the Table 3, it can be concluded that the results of dyeing dobby fabric using purple sweet potato peel are as follows: (1) Without fixative the color result is purple. The longer the dyeing duration, it gradually changed to blue with better pigment absorption; (2) With lemon fixative, the color result is a very pale pink. The longer dyeing duration, the color result gradually become slightly darker; (3) With FeSO4 fixative, the color result is greyish pink. The duration of dyeing has no effect on the color results; (4) With alum fixative, the color result is bluish pink. The longer dyeing duration, the color result gradually changed to pink with better pigment absorption.

From the Table 4, it can be concluded that the results of dyeing silk using purple sweet potato peel are as follows: (1) Without fixative, the color result is purple. The level of pigment absorption is proportional with the dyeing duration; (2) With lemon fixative, the color result is a pink. The level of pigment absorption is proportional with the dyeing duration; (3) With FeSO4 fixative, the color result is greyish pink. The duration of dyeing has no effect on the color results; (4) With alum fixative, the color result is purplish pink. The longer dyeing duration, the color result gradually changed to pink with better pigment absorption.

Table 3
Results of Dyeing Purple Sweet Potato Peel on Dobby (Cotton and Viscose)

Duration / Fixative	Without Fixative	Fixative Lemon	Fixative $FeSO_4$	Fixative Alum
10 Minutes				
20 Minutes				
30 Minutes				
40 Minutes				
50 Minutes				
60 Minutes				

Table 4
Results of Dyeing Purple Sweet Potato Peel on Silk

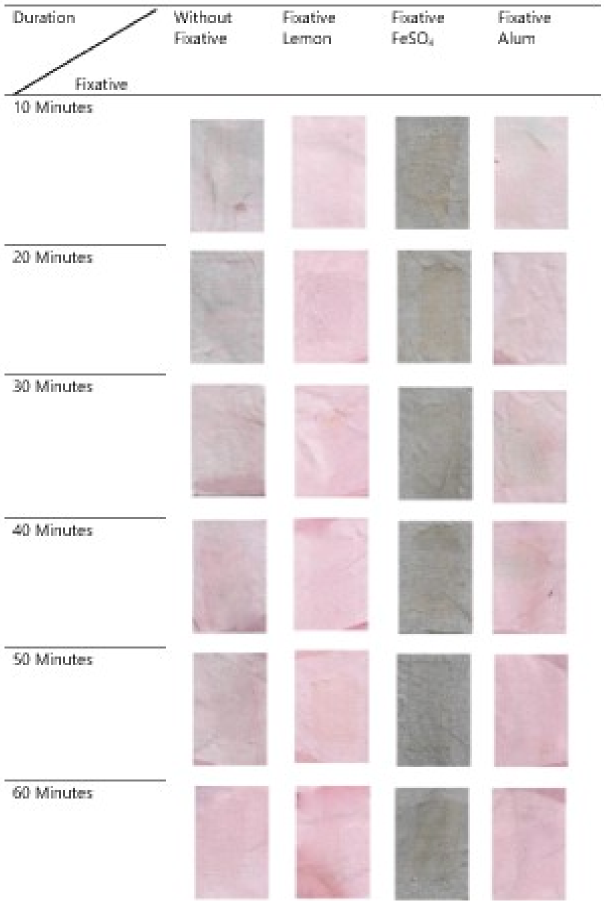
Duration / Fixative	Without Fixative	Fixative Lemon	Fixative $FeSO_4$	Fixative Alum
10 Minutes				
20 Minutes				
30 Minutes				
40 Minutes				
50 Minutes				
60 Minutes				

From the Table 5, it can be concluded that the results of dyeing silk using purple sweet potato peel are as follows: (1) Without a fixative, the color result is bluish-purple. The longer the dyeing duration, it gradually changed to pink; (2) With lemon fixative, the color result is pink. The level of pigment absorption is proportional to with dyeing duration; (3) With FeSO4 fixative, the color result is grey. The duration of dyeing does not affect color results; (4) With alum fixative, the color result is purplish pink. The longer the dyeing duration, the color result gradually changed to pink with better pigment absorption.

4. Conclusion

Through a series of dyeing processes on 5 types of fabrics using 3 kinds of fixative, it can be concluded that the fabric which has the best absorption of purple sweet potato peel pigment is silk, while the fabric with the weakest absorption of purple sweet potato peel pigment is linen. The fixative has been proven affecting the color result, with different effect on each type of fabric. The duration of dyeing has been proven affecting the color result, but this not applied for dyeing with $FeSO_4$ fixation. In the dyeing process

Table 5
Results of Dyeing Purple Sweet Potato Peel on Organdi Silk



with other fixative and also dyeing without fixation, the longer the dyeing duration, the darker the color result.

In this study, the color resistance test has not been conducted. Further research is expected to analyze the pigment absorption resistance of purple sweet potato peel pigment in each type of fabric and also with the effect of the fixative used. Color fastness is an indicator of whether a natural fabric dye is feasible or not to be used in traded products, including on a home industry scale that produces in limited quantities and large industries that produce in massive quantities.

Acknowledgement

The author would like to thank the DAKAB Foundation for funding this research. The author also expresses his gratitude to LPPM Trilogi University for coordinating the technical implementation of this research.

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