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THE ROLE OF WATER IN THE FABRIC DYEING PROCESS FROM A SUSTAINABLE FASHION PERSPECTIVE

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Abstract
Synthetic fabric dyes pollute rivers and other water sources due to poor waste management and the high demand to create fabric for the fast fashion industry. Although water is an essential source for fabric dyeing, the merit of water is contradictive in this point due to its role in dyeing fabric but having its source polluted. The subject of fabric dyes, their formulation, and their techniques were discussed the most in academia, not only in fashion but also in science. However, there needs to be more discussion regarding how fresh water became a primary material to create fabric dyes or dye the fabric itself. This study focuses on how water plays a significant role in the fabric dyeing process for the fashion industry and its impact on the environment. Qualitative methods applied in this research include data collection, such as a literature review. Citarum river and its watercourses became an example of how freshwater resources support the factories' production process in the fashion industry. Data collection is analyzed based on the sustainable theory applied in textile and fashion. Water was a significant primary material in the fabric dyeing process in this study. Furthermore, fresh water is needed to produce a coloured fabric using synthetic dyes. Additionally, there is a concern regarding waste treatment to avoid water pollution. Water waste from natural dyes does not pollute the environment and could be a better alternative to reduce water usage and pollution from synthetic dyes.

Keywords: fabric dyeing, sustainable, water

INTRODUCTION

Java is the main island for manufacturing goods, with no less than 80 per cent of factories actively exporting value-added goods worldwide. The province of West Java in Indonesia is well known as a centre of the modern textile and fashion industry, with many factories operating in the regency areas of Bandung [2]. The proximity to Jakarta, resources, and infrastructure made regency areas in Bandung, West Java, a potential manufacturing site for significant companies in goods, specifically in textile and fashion products. Furthermore, this area is one of the economic contributors to Indonesia for manufacturing textile and fashion products and exporting to other developed countries. Approximately 60 per cent of the national textile companies resided along the Citarum river, the main river that flows through eleven regencies and cities in West Java province [3]. The textile factories in Bandung regency alone, around 800, are primarily located near the Citarum river or its watercourse [4].

Citarum and its watercourse are one of the most important rivers in West Java [2]. People who live near the Citarum river or its watercourses rely on its role in creating livelihood

and supporting the economy of its people. The Citarum river is also a source of drinking water supply for residents of West Java and the capital city of Jakarta. In Bandung regency, the Citarum river and its watercourse are also a source of water for its surrounding agricultural areas where rice is the main crop [3].

The textile dyeing industry has a long history along the Citarum river. The name tarum originates from the tarum plant that grows along the riverbanks. In the past, this plant was used as a natural dye by batik makers from the surrounding areas. The practice of dyeing fabric from the Tarum plant that grows along the Citarum river became part of the culture of the people who make their livelihood near the river [4]. Over time, the river's ecology changed due to massive development along the river, and no efforts to reproduce or save the Tarum plants made it difficult for batik makers to source the plant for fabric dyeing. Since then, batik makers who live along the Citarum river have switched to synthetic dyes, which are cheaper and easily sourced.

Massive textile factories are now replacing the batik makers who live along the Citarum river's riverbanks that mainly use synthetic dyes because of the ease of sourcing in vast quantities in the market. However, synthetic dyes contain hazardous chemicals for the environment, including animals and human beings [2]. The existence of textile factories in the surrounding areas of the Citarum river and its watercourses had added waste and pollution to the river. Most textile factories guarantee they will manage their waste and not pollute the river [4]. However, textile waste is not the only cause of pollution but also household and other factory waste [3]. Citarum was once the most polluted river in the world because the government did not adequately manage the pollution from household waste and factories around the river or its watercourses.

The process of dyeing fabrics using synthetic dyes is now starting to be a concern for the public at large because the impact of synthetic waste management is increasingly uncontrollable. Furthermore, pollution of clean water sources has always been a significant problem with synthetic dyes, so it is always a case study of problems by academics, especially in the textile and fashion fields.

This study focuses on how water plays a significant role in the fabric dyeing process for the fashion industry and its impact on the environment. In addition, this research focuses on better alternatives to synthetic fabric dyes and how water plays a significant role in the production process. Citarum river and its watercourses became an example of how freshwater resources support the factories' production process in the fashion industry. Hazardous and toxic waste from the textile dyeing process became the factories' responsibility as part of their obligation to the government. However, the need for more efforts to manage its waste is evident in the existing condition of the river and its watercourses.

RESEARCH METHOD

This study focuses on how water plays a significant role in the fabric dyeing process for the fashion industry and its impact on the environment. Qualitative methods applied in this research include data collection such as a literature review. Citarum river and its watercourses became an example of how freshwater resources support the factories' production process in the fashion industry. Data collection is analyzed based on the sustainable theory applied in textile and fashion. Literature review on sustainable, sustainable fashion and natural dyes used to explain the role of water in the fabric dyeing process. Furthermore, it also explains the choice between synthetic or natural dyes and how natural dyes are a better alternative to synthetic dyes to protect the water source.

DISCUSSION

In the early 1990s, the concept of eco-design and green product design emerged as a strategy for industries to reduce the negative impact on the environment from the results of their industrial process [1]. In 1997 UNEP announced a statement regarding an agreement with the industries to implement eco-design and sustainable consumption. This statement is the forerunner to the birth of the current sustainable design concept today. In its development, when the issue of global environmental damage is increasingly visible, this has forced the world's industrial community to focus more on the environmental impact of their production waste. The excess of the world's industrial capacity is also one of the major causes of environmental damage. The rapid development of industry and the global economy supported by technological advances have turned developing countries into large industrial countries, for example, China, Brazil, and India [1]. As a result of this globalization, economic growth and development are outside of production capacity and market demand for consumption. The high demand encourages companies to be more innovative in their production process activities and create better products [1]. In order to regulate the pace of industrial development, environmental care groups expand their scope of reach by including social, economic, and environmental issues to give birth to the concept of sustainable design.

Sustainable Design is a design philosophy that seeks to maximize the quality of the built environment while minimizing or eliminating negative impacts on the natural environment [5]. The sustainable design addresses environmental damage due to air pollution, the greenhouse effect, and deforestation, which cause a big problem, namely global warming. Sustainable design is the mindset and intelligent human actions harmonizing and respecting nature [5]. In sustainable design, there are three main underlying factors, namely environmental, social and economic ecological factors.

The application of sustainable design is not only focused on environmentally friendly design but also on being responsible for the community's social life and creating economic value or increasing economic growth locally and globally. Fashion is one industry starting to adopt sustainable design concepts and practices. Sustainable fashion is one of the areas of implementing sustainability in the fashion realm, which aims to practice more environmentally friendly and sustainable product creation. Some of the developments of sustainable fashion include slow fashion, zero-waste fashion, and ethical fashion.

Ethical fashion refers to a condition when materials and production processes meet a certain standard according to animal, environmental, and human rights [5]. For example, in the case of pollution from textile waste in the Citarum river, environmental and human rights are violated based on the evidence. As a result, the river can no longer give livelihood to the people living in its surroundings due to the massive amount of household waste and hazardous chemicals from textile waste [4]. In addition, textile factories use a large amount of water in wet processing techniques, not only for dyeing but also for scouring, desizing, and bleaching [6]. The water for this process also came from the same source, the Citarum river. Big textile factories along the Citarum river apply sustainable strategies to ensure their chemical waste does not harm the environment. However, smaller textile factories might need more advanced technology to do so. Some strategies implemented in textile factories include eliminating chemicals in waste from textile factories, using less water during production, or recycling the water for production [6]. However, these strategies did not include using natural dyes as an alternative to synthetic dyes.

Natural dyeing is a process of coloring textiles with plants or insects and was mainly used by people until the mid-nineteenth century [7]. Most people still use natural dyes for another 50 years after the invention of synthetic dyes in 1856. In the past, dyers even used hazardous chemicals such as arsenic to achieve specific color effects in fabric. Therefore,

fabric dyeing using natural dyes is a solution to minimize the pollution of hazardous chemicals. However, the use of natural dyes is still considered not environmentally friendly in terms of the use of much clean water, starting from the need for water in the extraction process, the mordanting process, the coloring process, the fixation process to the application process [7]. In addition, the motifs on the cloth also have many background design techniques that require a lot of water discharge for the motif production process to the final washing. Natural dyes also have several disadvantages compared to synthetic dyes in terms of stability, brightness, availability, and price [6].

Some designers and researchers are still looking for the best solution when dyeing the fabric until several theories or principles of minimization and optimization of the production process emerge. One of them is the theory presented by Fletcher [5] regarding the principle of minimization and optimization of the production process, divided into:

1. Minimize the number of production processes, for example, combining two production stages to use less water
2. 'Clean' production techniques, for example, reusing dye baths for the next dyeing process
3. Minimize consumables which is unceccesary for production
4. Choose chemicals with a 'clean' process, for example, chemicals that have minimal risk in polluting the water source which can harm the people and environment
5. Reduce energy and water use, try to source locally to reduce carbon foot print
6. Reduce waste production and manage waste streams properly by researching a more advance technology for waste management

The theory of minimization and optimization of the production process presented by Fletcher [5] points to reducing the number of production processes. By combining several stages into the main points in this study, significantly minimizing and optimizing the use of clean water in the process of dyeing fabrics with natural dyes. Minimizing and optimizing water use is, of course, by understanding the characteristics and specifications of the water first because the quality of the water used for mordant and coloring will affect the final result.

Water quality from different sources can produce very different colors, as water can contain varying amounts of metals and calcium depending on the source location. Water can have acids or metals in it, as it dissolves and can absorb iron, copper, or metal from soil or metal pipes [7]. Acidic water will also dissolve minerals from metals, brass, or copper because when the acidity of the water increases slightly, the ability of water to dissolve minerals in metals also increases. Water containing calcium tends to be alkaline because calcium helps improve some colors [7]. In the production process of natural dyes, which of course, cannot separate from the use of water, checking the pH of the water is very important because it will produce color changes in the results of natural color coloring.

There are two types of dyes, water-soluble dyes and the other is known as vat dyes [7]. Most dyes are water-soluble except indigo and classical purple dyes, known as vat dyes. In the natural dyeing process, there is a mordanting process as a color enhancer or binder on the fabric. When tannins are absorbed by cellulose fibers and combined with the mordanting process, the dyeing results experience a balance of tannins in the textile. However, if too much water is used, it can reduce the number of tannins attached to the fiber. Therefore, most of the soluble dyes are considered mordant dyes. In the dyeing process, the water-soluble dye penetrates the fiber, where it combines with a mordant.

Most natural dyes are mordant dyes, which require a mordant to be fixed into the fabric fibers, so they are resistant to light, water, and washing [7]. Besides the function of the mordant, it also has a wide range of pH to give effect to the color change reaction of natural

dyes. Mordant is generally made of chemicals, but it is usually relatively safe. However, it is also possible if mordant is made from natural ingredients such as acid from citrus, aluminum sulfate dodecahydrate (alum), liquid metal soaked in rust objects, and others that can change water pH. The objective of dyeing is to encourage as much dye as possible to penetrate the fibers, where it becomes fixed evenly [7]. Therefore, when the dyeing process is complete, the minimal dye should be left in the water. Natural dyes can be a possible alternative to synthetic dyes and, with further development and design, can replace synthetic dyes in the future.

CONCLUSION

One widely discussed solution to the synthetic waste in the water is to replace synthetic dyes with natural dyes used since our ancestors' time. However, natural dyes have several advantages related to their availability in massive quantities or the brightness of their colors. Moreover, despite their disadvantages, natural dyes have favorable conditions, such as the possibility of using less water and even lesser hazardous chemicals. This condition also allows textile factories to manage their waste thrown in the river or other water sources and to recycle the water for the following process.

The theory of the principle of minimization and optimization of the production process is the best conclusion that can be used as a common thread for designers and researchers in finding solutions to fabric dyes. Mordant is generally made of chemicals, but it is usually relatively safe. However, it is also possible if mordant is made from natural ingredients such as acid from citrus, aluminum sulfate dodecahydrate (alum), liquid metal soaked in rust objects, and others that can change water pH.

The primary importance of maintaining water sources is aligned with sustainable and ethical rights to the environment and its living beings. Furthermore, without water, the primary needs of humans, including clothing, will be less attractive. Textile dyes still rely on the availability of fresh water in their wet process, and water helps dyes dissolve in the fabric. The relationship between water used in the dyeing process and how its waste is thrown in the water source is reciprocal and needs an immediate solution.

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