Napthol Textile Dyeing Experiments on Various Types of Fabrics

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Abstract. This study conducted experiments on naphthol dyeing across several fabric types to strengthen students' comprehension of the visual outcomes of textile dyeing using naphthol. The key benefit of this research is that it provides State University of Surabaya students with a valuable reference for dyeing textiles based on the experimental findings. This study investigates the rendition of fabric following the process of dyeing. The results will elucidate the interaction between naphthol (at the same concentration) and fabric fibres. Furthermore, this study examined the effects of six distinct hues of naphthol on eight different fabric samples. The findings highlight that fabrics with higher yarn densities have enhanced dye absorption capabilities, leading to the production of more vibrant and concentrated colours. These analyses emphasize the key significance of fabric density in optimising dye absorption and colour saturation when applying naphthol. This research has yielded a novel comprehension of the relationship between naphthol dyeing and fabric properties, offering vital insights for both academic debate and practical applications in textile dyeing.

Keywords: textile, dyeing, experiment, fabrics.

1 Introduction

Indonesia's textile industry stands as a dynamic force in the country's economy, known for its extensive history and wide-ranging manufacturing capacities [1]. Having an extensive historical background over centuries, Indonesian textiles are widely recognised for their exceptional craftsmanship and profound cultural importance. Indonesia is a major player in the global textile market, taking advantage of its abundant natural resources, skilled workforce, and strategic location [2]. The growing textile industry in Indonesia is classified into three categories: upstream, medium, and downstream [3].

This sector contributes significantly to employment and export earnings, thereby driving economic growth and development throughout the archipelago. However, challenges such as competition from other manufacturing centres and environmental sustainability issues still exist, pushing the industry to innovate and adapt to changing market dynamics. Overall, Indonesia's textile sector continues to develop, combining

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tradition with innovation to maintain its position as a key player in the global textile landscape.

Textile production in Indonesia serves as both a means of expressing cultural identity and a source of subsistence for the communities involved. This highlights the intricate connection between heritage, craftsmanship, and communal existence in Indonesian textile traditions. The rich cultural heritage and craftsmanship that have been handed down through generations are embodied in the traditional textiles of Indonesia [3], which are produced through handmade processes. One of the most iconic examples is batik, where artisans use wax-resist dyeing techniques to create intricate patterns on cloth. This process involves meticulous attention to detail as the wax is applied to specific areas of the fabric to prevent dye from penetrating, resulting in beautiful layered designs. Initially, textile dyes were made from natural dyes. However, as technology develops with the discovery of synthetic dyes for textiles, the use of natural dyes is increasingly being eroded [4]. Synthetic dyes are dyes that are made by synthesizing or reacting chemicals [5].

Similarly, *jumput* techniques. *Jumput* or tie dye is a textile work made on fabric by pinching small or large pieces of fabric to be tied and then dyed in a dye solution [6]. Another example is *tenun* (handwoven textiles) that crafted on traditional looms using techniques that require skill and precision. Artisans carefully weave threads together to create intricate designs, often incorporating motifs/pattern inspired by nature, folklore, or religious beliefs. Each step of these carefully handcrafted processes, ranging from the formulation of pigments to the fabrication or colouring of fibres, showcases a profound attachment to cultural traditions and a commitment to preserving traditional craftsmanship. These textiles not only serve as functional garments or decorative pieces but also carry the stories and identities of the communities that produce them [7], making them invaluable treasures of Indonesia's cultural heritage.

Creating traditional textiles such as batik involves a variety of techniques, each requiring specific knowledge and skills. Artisans must possess expertise in various aspects, including the selection of colours and the choice of suitable fabrics [8]. Experimentation is key to determining which fabrics are optimal for dyeing with chemicals like naphthol. Understanding the characteristics of various textiles and how they interact with dyes are essential for achieving desired outcomes. Through trial and error, artisans discover which fabrics absorb colour evenly and retain vibrancy, ensuring the quality and durability of the finished batik.

One type of synthetic dye that is stable and widely used is naphtol. Naphtol dye consists of two components, namely As (anilid acid) and diazonium (salt). The As component is not soluble in water, so caustic soda and hot water need to be added to brew it. Diazonium or what is more often called napthol salt has physical characteristics in the form of powder and is white in color. Salt can be dissolved directly in cold water [9].

The first known naphtol dye was light purple discovered by William Henry Perkin in 1856 and quickly put into production. The purple color was originally obtained from shellfish and mollusks which only exist in the deep sea, making purple only suitable for rich people and the nobility. However, the results of Perkin's chemical

experiments on benzene made changes to the world of textile dyeing which quickly developed and spread to various countries because of the ease and practicality of using naphtol dyes and the strong absorption of textile materials [10].

Chemical dyes, such as naphthol, offer a convenient and reliable method for colouring textiles, providing consistent and vibrant hues. Naphthol dyes are known for their ability to adhere well to various types of fabrics, resulting in long-lasting and uniform coloration. The chemical composition of naphthol dyes allows for efficient penetration into the fibres of the fabric, ensuring even coverage and vivid shades. Additionally, these dyes offer a wide range of colour options, enabling textile manufacturers to achieve specific colour requirements with precision and ease [11]. The consistency of colour provided by naphthol dyes makes them a preferred choice in the textile industry for achieving high-quality and uniform results, meeting the demands of modern production processes while maintaining the aesthetic appeal of the finished products.

Experiment research of various types of fabric was carried out by Fadilah Rahmadani in 2020. This experimental research used the *suminagashi* technique with acrylic paint as the coloring agent [12]. The results of this research show that the type of fabric influences the results of making motifs as seen from the density of the weave, surface shape, fiber origin, stiffness of the fabric, and absorbency. This research has the same method as the research that the researcher will carry out. The difference is that this research uses acrylic dye which acts as paint and has a big effect on the surface of the fabric fibers, whereas the dye that the researchers will use is textile dye (dyes), which is a coloring that penetrates the fabric fibers so that the top and bottom sides of the fabric have the same color density.

Other research on the history and use of naphtol dyes in luxury fabrics in the Meiji era in Japan conducted by Pamela A. Parmal in this research states that initially robes in the Edo period were made using natural dyes from the petals of thistle, gromwell and safflower which bloomed during the hot season. To dye one robe requires as many as 12 kg of flowers and the process takes up to two years. So it is less effective and only people from certain circles can make and use it. Until finally synthetic dye technology entered which could replace natural dyes with rapid development because the color of clothes had its own symbol and meaning for Japanese people. In this research, Pamela A. Parmal tested HPLC on textile works from several museums to identify the dyeing process carried out by silk weavers. The results show that Japanese weavers did not only use available dyes but mixed them themselves so that the resulting colors were unique and varied [13]. This research shows that synthetic dyes can be explored from various angles.

The process of experimentation not only enhances artisans' understanding of their craft but also fosters innovation and adaptation, allowing traditional techniques to evolve while preserving their heritage. Thus, the journey of creating traditional textiles like batik is not only a testament to skill and creativity but also a celebration of the rich cultural traditions that have been passed down through generations.

This research aims to conduct a comprehensive examination of various fabrics in the dyeing process with naphthol, a crucial step in the creation of traditional textiles like batik. This research is particularly urgent due to its significance in the context of

higher education, where students studying subjects like batik need a deep understanding of different visualisations when applying naphthol to various fabrics. Mastery of this knowledge is paramount for their practical applications, ensuring they can produce high-quality batik textiles that meet artistic standards and market demands.

By investigating the interaction between naphthol dyes and different fabrics, this research aims to provide valuable insights that will enhance students' skills and proficiency in the batik-making process. Ultimately, this research contributes to the preservation and advancement of traditional textile techniques while equipping students with the expertise needed to excel in their field.

2 Methods

The experimental research methodology employed in this study focusses on exploring the dyeing process of naphthol for batik on various fabrics. With six colours of naphthol and eight different fabrics, this research aims to systematically examine the visualisations achieved through the interaction of naphthol dyes with each fabric type. The primary data collected in this research consists of the visual representations of naphthol colours on the different fabrics, offering valuable information on the efficacy and suitability of each combination for batik creation. Additionally, secondary data sources such as journals and recent books on batik dyeing are utilised to supplement the findings, offering theoretical frameworks and contextual information to enrich the analysis. By combining experimental observations with existing literature, this research methodology ensures a comprehensive understanding of the dyeing process and its implications for traditional textile production, contributing valuable insights to both academic discourse and practical applications in the field of batik craftsmanship.

3 Results and Discussion

3.1 Dying Fabrics with Naphthol

Dyeing batik using chemical colours, such as naphthol, is a meticulous and intricate process that blends modern techniques with traditional craftsmanship. Naphthol dyes, known for their vibrant and long-lasting colours, offer a wide range of hues that can be applied to various fabrics, enhancing the artistic possibilities of batik creation.

Naphthol is a developed azo dye because the colour only appears when combined with diazo salts and is not soluble in water. Naphthol AS (Anilid Saure) is a compound containing a cyclic core and aniline acid, replacing the position of beta-naphthol in colouring. In batik, naphthol was quickly accepted because its colour could replace previous batik colours, both in terms of durability and speed of processing [14].

The process typically begins with the selection of high-quality fabric, which serves as the canvas for the intricate batik designs. Next, the fabric is prepared by washing and drying to ensure optimal dye absorption. Then, the desired design is meticulously drawn or stamped onto the fabric using wax or other resist materials to create intricate patterns. Once the design is applied, the fabric undergoes the dyeing

process, where naphthol dyes are carefully applied to achieve the desired colours. This step requires precision and expertise to ensure even coverage and vibrant hues.

After dyeing, the fabric is often rinsed to remove excess dye, and the wax resists, revealing the intricate batik patterns. Finally, the fabric is washed and dried, completing the transformation into a beautiful piece of batik art. Dyeing batik with naphthol colours not only preserves the rich cultural heritage of traditional textile production but also allows for innovation and creativity in contemporary batik design.

In this research, naphthol dyes were employed in a spectrum of vibrant colours to explore their efficacy in the intricate art of batik-making. The specific dye combinations utilised were meticulously selected to achieve the desired hues: Naphthol Yellow (OGC + ASG), Orange (OGC + ASD), Red (Red R + ASBO), Purple (Bordo GP + ASBO), Blue (Blue BB + AS), and Chocolate (91 + Red B). Sequentially, the colour codes are A1, A2, A3, A4, A5, and A6.

Each combination was carefully measured and applied to the fabric, ensuring precise colouration and consistency throughout the dyeing process. To facilitate optimal dye penetration and fixation, a standardised measurement of water was employed, with one litre of water used per colour batch alongside one litre of naphthol dye and one litre of salt. This meticulous approach to dye application and measurement allowed for systematic experimentation and analysis, providing valuable insights into the interaction between naphthol dyes and various fabric substrates in the creation of batik textiles. The types of fabric tested and reported in this paper include Tulle, Hicon Siffon, Ceruti, Baloteli, Roberto, Diamond, Hayle, and Wolfiss, which are sequentially coded B1, B2, B3, B4, B5, B6, B7, and B8. Briefly, each of these fabrics has the following characteristics:

Table 1. Fabric Characteristics

Type of Fabrics	Fabric Characteristics
Tule (B1)	Light, thin, and transparent, with large pores that resemble a net
Siffon Hicon (B2)	Light, thin, fine fibre with a tighter weave compared to tule, and slightly transparent.
Ceruti (B3)	The texture is smooth and soft, relatively light but heavier compared to Hicon Chiffon, has medium transparency, and is more drapey.
Baloteli (B4)	Has a distinctive texture, is thicker (compared to ceruti), has a good draping ability, and is not transparent.
Roberto (B5)	It has two different sides; the outer part has a smooth and shiny surface like satin, has medium thickness, is not transparent, and has good drapery.
Diamon (B6)	At first glance, diamond fabric looks similar to ceruti fabric, but it is different in thickness, so it is less transparent.
Hayme (B7)	Thick, woven yarn resembles drill cloth but is finer and drapes better.
Wolfis (B8)	Soft texture, light but not transparent, has a drapey effect.

3.2 The Visualisation of Colouring Various Fabrics with Naphthol

The culmination of the dyeing colour experiment using naphthol is showcased in the figure below, offering a visual representation of the vibrant spectrum achieved through meticulous combinations and application techniques. This visual display

serves not only as a testament to the efficacy of naphthol in batik-making but also as a source of inspiration for future exploration and innovation in traditional textile production.

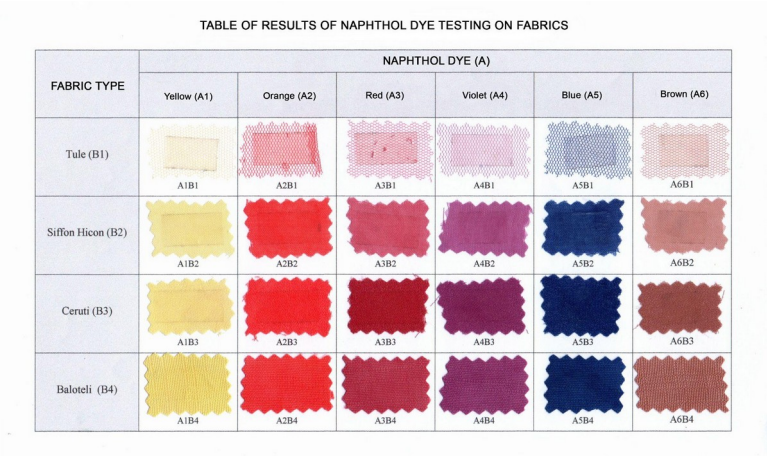

Fig. 1. Experiment on Tule, Sifon Hicon, Ceruti, and Baloteli Fabrics

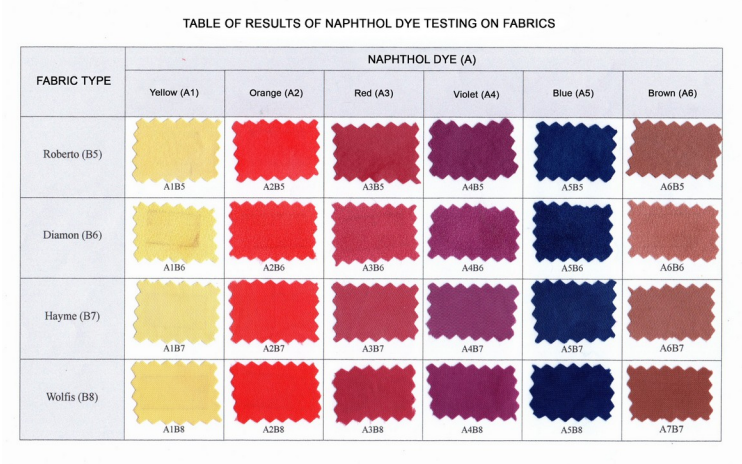

Fig. 2. Experiment on Roberto, Diamond, Hayme, and Wolfis Fabrics

These fabrics, ranging from tulle to wolfis, provide a diverse spectrum for analysis. The use of naphthol colours—such as yellow, orange, red, violet, blue, and brown—not only introduces a wide range of hues but also adds depth to the investigation by revealing how different chemical compositions of these dyes penetrate various fabric types, resulting in varied vibrancy and coverage.

4 Conclusion

Through meticulous examination, the experiment yields a significant conclusion: fabrics with tightly woven fibres tend to produce brighter hues. This finding underscores the intricate relationship between fabric composition and colour vibrancy, offering valuable insights for various applications in textiles and beyond.

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Disclosure of Interest. We need to state that the authors have no competing interests in asserting relevance to the contents of this article. We use the research results as a reference for students and hope that they can be used to develop learning, especially in Textile Craft and Batik courses.

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