The Development of Soga Tingi *(Ceriops tagal)* Natural Dye Paste Material for Block Printing on Textiles

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ABSTRACT

Block printing is a technique of carving motifs on a printing plate coated with dye and pressed repeatedly along the fabric to create patterns. One potential natural dye that can be applied is the Soga tingi *(Ceriops tagal)*. In today's textiles and fashion industries, the use of natural materials is increasing in line with the growing awareness of a sustainability lifestyle. This study aims to develop Soga tingi dye into the optimal paste formula for block printing techniques with fixation, plate material, and suitable fabrics. This research employs a mixed-methods approach, combining qualitative and quantitative data from literature reviews, field observations, interviews, and laboratory experiments. The results reveal the successful formulation of a Soga tingi natural dye paste with an optimal composition. The most effective thickening agent was found to be sodium alginate, a food-grade thickener used in a ratio of 10 g to 100 ml of liquid natural dye, resulting in a viscosity of 21,135 mPas. Thus, the block-printed cotton fabric made with the Soga tingi natural dye paste can be used for fashion products.

Keywords: *Block printing, Ceriops tagal, Natural dye paste, viscosity, eco-textiles*

INTRODUCTION

Block printing is a technique of engraving patterns onto a wooden plate, coated with dye, and repeatedly pressed along the fabric to create a design (Ramadhan et al., 2022). It is one of the oldest printing techniques, originating in China during the early 3rd century (Singh, 2023). Although it is more time-consuming than modern techniques, many regards block printing as one of the most artistic textile printing methods because its results are imperfect and cannot be replicated by machines. The flexibility in color mixing allows artisans to create unique works. Despite modern technology replacing many traditional methods, block printing continues to hold a special appeal among art and traditional craft enthusiasts, symbolizing cultural preservation with historical value (Seidu, 2019). The dyes used in block printing can be either synthetic or natural. Nowadays, synthetic dyes are more commonly used in block printing, whereas only a few artisans use natural dyes as the primary coloring

medium for this technique. However, the interest in sustainable practices and traditional craftsmanship has led artisans to re-evaluate the natural colorants, despite their challenges in consistency and color vibrancy compared to synthetic counterparts (Kavyashree, 2020).

Natural textile dyes are primarily derived from plants, with various parts such as roots, leaves, and flowers used as natural colorants (Angraini & Adriani, 2021). These dyes have been used for centuries, including textile and batik dyeing. According to Pujilestari (2016), using natural dyes dates back to 3500 BC in the Mohenjodaro and Harappa civilizations, while dyeing techniques were already known in the Indus Valley around 2500 BC. Natural dyes are made from sustainable materials, have a high level of biodegradability, and, most importantly, are more environmentally friendly (Chafidz & Lestari, 2021). In Indonesia, their abundance makes them a sustainable alternative to synthetic dyes (Lubis et al., 2020). The use of natural dyes can lead to a range of color shades, but this also introduces challenges concerning color stability (Lin et al., 2022). The stability issues are not limited to immediate fading; they can also include variability based on formulation and processing conditions (Kim et al., 2025). There is a need to enhance the quality and efficiency of natural dyes through advanced studies, to level up their bargaining position with synthetic dyes.

One potential natural dye is made from the Soga tingi *(Ceriops tagal)* tree bark. The species *Soga tingi*, which is identified as belonging to the *Rhizophoraceae* family, is a notable representative of the mangrove ecosystem in Indonesia (Indriaty et al., 2023). *Soga tingi* is a species notable for its resilience in high salinity environments and its various chemical constituents with significant biological activities. Soga tingi wood and bark contain significant amounts of polyphenolic compounds, including tannins, which can reach concentrations of up to 22.44 parts per million (ppm) in the bark (Paryanto et al., 2021). The bark's high tannin content, reaching up to 70.91%, highlights its potential as a natural dye and in applications for fabric treatment, providing brown to reddish-brown shades (Nurmasitah et al., 2022). In textile applications, Soga tingi dye is widely used for batik fabric dyeing, either on its own or mixed with other materials, such as tegeran and jambal, to create the distinctive *sogan* color characteristic of traditional batik (Pujilestari, 2016).

A previous study by Zulyus & Hendrawan (2021) utilized Soga tingi bark in paste form for screen-printing techniques. Based on the test results, the ferrous sulfate (iron) and potassium aluminum sulfate (alum) mordant produced a stronger and more vibrant print color than other mordants, avoiding a dull appearance. Additionally, washing and rubbing tests confirmed that this mordants color and print quality remained intact. To create color variations in screen printing, particularly gradient effects, the researchers combined the screen-printing process with the *mordant painting* technique, allowing for more diverse and artistic color transitions. In addition to the screen-printing, the natural dye paste also has potential for application using the block printing technique. The paste

is made with food-grade thickeners that are easily accessible and more environmentally friendly compared to other chemicals. The addition of a thickening agent serves to hold the dye in place, ensuring it is applied evenly to the areas of the fabric that are to be colored (Abdurahman & Kahdar, 2021). The natural dye paste must have optimal viscosity for use in block printing. Viscosity plays a critical role in maintaining the stability of dispersed systems, thereby reinforcing the importance of assessing viscosity in emulsion formulations (Cai et al., 2025). The higher viscosity serves to hinder the movement of dispersed phase particles, thereby strengthening emulsion stability (Damayani et al., 2021).

This study focuses on continuing previous research by exploring alternative techniques. The aims of the study are: (1) To develop Soga tingi natural dye using the block printing method, which differs from the screen-printing approach used by Zulyus & Hendrawan. (2) To formulate an optimal dye paste, fabric type, printing plate, and mordant to achieve the best color variations on fabric, considering the material's characteristics and the natural dye. This study adopts an experimental approach through literature review, interviews, and observations. The research is expected to enhance the potential of Soga tingi as a natural dye and serve as inspiration for its application in block printing. Additionally, it aims to produce distinctive fabrics that can be applied to fashion products.

METHOD

This study employed a mixed-methods approach to determine the optimal formula for Soga tingi natural dye paste, mordant, and printing plate combination for block printing. A literature review, interviews, observations, and exploratory studies were conducted to collect foundational data supporting this research.

The literature study was conducted to collect data related to research keywords, including block printing technique and Soga tingi natural dye, from various sources such as books, academic journals, and proceedings. Interviews were conducted with several relevant parties for this research, including Syamsi & Hendrawan (2021), the previous researcher, to obtain data on the types of thickeners, the formulation of natural dye pastes, and the application of natural dyes in textile crafts and fashion products. Observations were conducted to collect data through direct field analysis to gain a deeper understanding of the subject by visually examining it firsthand. Field observations were conducted at Inacraft 2024, Indonesia Fashion Week (IFW), and Sarinah. The last data collection in this research is exploration, which is divided into several stages. The first stage was the experiment, which was focused on identifying the best type of thickener, printing plate, and fixation method. In this stage, the natural Soga tingi dye paste formulation was used to apply the block printing technique to fabric sheets. The formula was differentiated by varying the amount of thickener:

Each formula was evaluated to determine the most appropriate consistency for achieving

Table 1. Soga tingi dye paste formulation
Source: Research Team, 2024

Formula	Sodium alginate	Liquid natural Soda tingi
1	8 g	100 ml
2	10 g	100 ml
3	12 g	100 ml

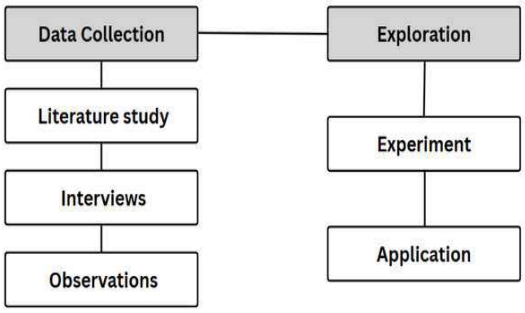


Figure 1. Research framework
Source: Research Team, 2024

optimal pattern clarity, color sharpness, and color evenness, using a viscosity test conducted in the laboratory. The second stage was the application stage, which implements the selected natural dye paste formula and develops motif design concepts. This stage involved applying the natural dye and motifs onto cotton fabric sheets, potentially developing these textiles into fashion products. The research methodology is summarized in the framework presented in Figure 1.

RESULT AND DISCUSSION

Experiment

The experiment consisted of four steps. The first step focused on determining the most suitable thickening agent, the second involved selecting the optimal printing plate, the third examined the effectiveness of different mordants, and the final step aimed to establish the ideal formula. Block printing techniques were applied throughout these steps without altering the core formula used in previous research. This process aimed to identify the most effective dye paste formula for block printing by observing color changes when the paste was active, how well it adhered to the printing plate, and its ability to produce an even color distribution on fabric surfaces. The experiment steps are illustrated in Figure 2.

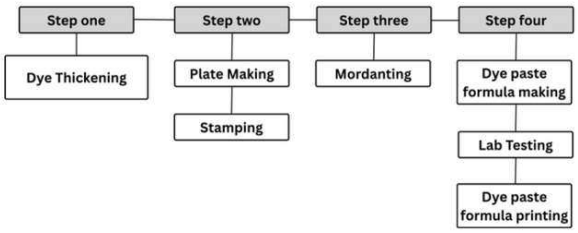


Figure 2. Experiment Step
Source: Research Team, 2024

In the first step, natural Soga tingi dye paste was created using two thickeners: Carboxymethyl Cellulose (CMC) and sodium alginate. For the initial composition, 10 g of each thickener was mixed with 100 ml of Soga tingi liquid dye and then applied to pre-scoured fabric. Scouring was the process of cleaning fabric from impurities accumulated during fabric production and shipping, such as starch, oil, wax, and dust attached to the fabric, before beginning the mordanting process (Utami et al., 2023). The scouring process was carried out by soaking the fabric in a Turkish Red Oil (TRO) solution, gently rubbing it briefly, and then rinsing it thoroughly until the fabric was clean (Lestari & Sakti, 2021).

The fabric used for applying a printing plate to achieve optimal results should have a smooth surface and contain little to no polyester fibers (Dumamika & Ramadhan, 2021). several types of fabric—Toyobo cotton, primisima cotton, rayon, and calico—were tested, and Toyobo cotton was found to produce the best color absorption results.

After mixing, the paste showed different characteristics depending on the thickener used. The CMC-based paste became slightly lumpy and had a sticky, slime-like texture. These lumps caused uneven color distribution on the fabric. In contrast, the sodium alginate–based paste exhibited a smooth, cohesive consistency, making it easier to apply and resulting in a more evenly distributed color on the fabric. It was concluded that the sodium alginate dye paste performed significantly better than the CMC dye paste.

After exploring the thickeners, the next step was investigating various alternative printing plates for block printing. Medium Density Fibreboard (MDF) wood, linoleum rubber, and sponge were the materials considered for the printing plates. After testing each one individually, the wood printing plate produced the most optimal results. The wood plate delivered a consistent and even print, with the paste adhering well to the stamp. The lino rubber yielded fairly neat prints, though some edges of the design extended beyond their intended shape. In contrast, the sponge produced prints with slight residue along the edges because the dye paste was absorbed into the sponge, causing extra paste to be released at the borders when pressed onto the fabric.

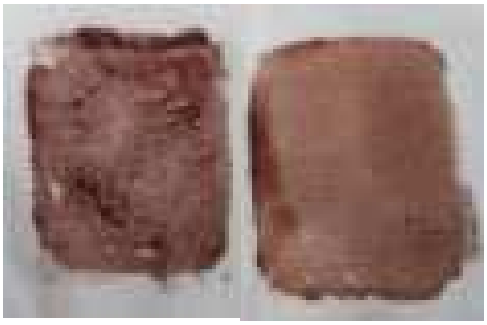


Figure 3. Soga tingi dye paste using CMC and sodium alginate as thickeners
Source: Research Team, 2024

Table 2. Printing results using wood MDF, lino rubber, and sponge plates
Source: Research Team, 2024

No	Materials	Plates	Stamp results
1	Sponge		
2	Lino Rubber		
3	MDF Wood		

After finding the optimal printing plate for applying the natural dye paste, the next step was exploring natural dye mordants or fixatives. Among the crucial stages in fabric dyeing is the mordanting stage. In addition, to enhancing the affinity of natural dyes to textile materials, mordanting also helps achieve even color distribution and sharp color intensity (Fadilah Ahmad & Hidayati, 2018). Three mordanting agents—potassium aluminum sulfate, quicklime, and iron—were used, each applied in a ratio of 5 g of mordant to 100 ml

Table 3. Fixation results using Aluminum Sulfate, Quicklime, and Iron Sulfate Mordants
Source: Research Team, 2024

No	Mordants	Results
1	Aluminum sulfate	
2	Quicklime	
3	Iron	

of water. The mordanting was carried out using the painting technique on the stamped areas only. The results showed that the alum mordant served as the most effective fixative for the Soga tingi natural dye paste. It effectively locked in the dye, produced a reddish-brown color, and left no residue during washing. The quicklime mordant produced a faded brown color and was ineffective in fixing the dye, with noticeable color bleeding in certain areas. Meanwhile, the iron mordant resulted in a black color and left residue during washing, causing the color to run and fade.

After determining the optimal mordant, the third step was to identify the best dye paste formula and determine the fixation material. The formulas were differentiated by varying the amount of thickener: Formula 1 contained 8 g of sodium alginate mixed with 100 ml of Soga tingi natural dye solution; Formula 2 contained 10 g; and Formula 3 contained 12 g of sodium alginate with the same dye volume. The viscosity of each formula was evaluated to

Table 4. Test result of the viscosity
Source: Research Team, 2024

Paste	Formula	Viscosity
1	8 g : 100 ml	17945 mPas
2	10 g : 100 ml	21135 mPas
3	12 g : 100 ml	56455 mPas

determine the appropriate consistency, using a viscosity test conducted at the Agro-industrial Technology Testing Services Laboratory, Padjadjaran University.

The toyobo cotton fabric must be scoured for 20 minutes in a TRO solution to remove dirt or oils, then rinsed and hung to dry. Once the fabric is dry, the dye paste is applied to the prepared wood stamp using a brush, and the wood printing plate is then pressed onto the dried fabric. After the paste had dried, mordanting was performed using an alum solution applied through a painting technique. The treatment was limited to the areas stamped with the natural dye, and the fabric was left to dry completely. A viscosity neither too thick nor too runny is considered the most optimal.

The overall results from the experiment showed that the modified extraction of tingi liquid dye produced a very intense and even color when applied at a concentrated level. The thickener used to create the Soga tingi dye paste in this study is sodium alginate, which produced a smooth, mucus-like consistency that mixes easily and does not leave any lumps. The optimal printing plate is wood, while toyobo cotton fabric was chosen as the printing medium due to its excellent ability

Table 5. Dye paste formula results
Source: Research Team, 2024

Formula	Picture	Explanation
1		The resulting dye paste had a smooth, mucus-like consistency. The color was evenly distributed and remained intact even after washing. The dye paste was slightly too liquid, making it difficult to adhere to the printing plate. As a result, the printed color was uneven.
2		The resulting dye paste had a smooth, mucus-like consistency. The color was evenly distributed and remained intact even after washing.
3		The dye paste was slightly clumpy, making it difficult to apply to the printing plate. The resulting color was uneven, and residual dye remained on the fabric after washing.

to absorb the dye. Alum mordant is the most effective fixative for binding the Soga tingi dye paste. Meanwhile, the most optimal dye paste formula, which achieves the ideal concentration and viscosity, is a ratio of 10 g of sodium alginate mixed with 100 ml of tingi liquid dye. This balanced viscosity allows the dye to flow smoothly during the printing process while still adhering well to the fabric, resulting in better definition and quality in the printed patterns.

Figure 4. Pattern board
Source: Research Team, 2024

Application

In the following application stage, a motif design concept was developed to be carved into the printing plate and applied to the fabric. The chosen motif was designed to complement the natural Soga tingi dye paste. This design incorporates the beauty of traditional Betawi house ornaments, whose color palette aligns harmoniously with the natural hues produced by the dye.

The color palette is dominated by rich reddish brown tones, reflecting the warmth of Betawi culture and the natural materials of traditional wooden houses. Soga tingi dye, which is closely associated with Indonesia's coastal region (Paryanto et al., 2021), also symbolizes the cultural connection of coastal Betawi communities such as those in Marunda and Luar Batang. The ornaments of the Betawi house vary in their overall forms, but the main characteristics of their shape configurations are easily recognizable from their physical appearance (Setiawan & Laswandi, 2020). The decorative patterns on Betawi houses have a

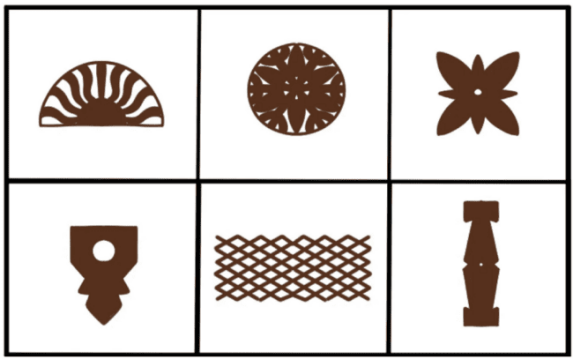


Figure 5. Stylization of Betawi traditional house ornaments
Source: Research Team, 2024

simple form with geometric motifs such as dots, squares, diamonds, triangles, curves, semi-circles, circles, etc. (Sudarwani et al., 2021). In addition to geometric motifs, many Betawi house ornaments are adaptations of floral decorative elements (Nabila et al., 2020). Traditional Betawi house ornaments' floral and geometric motifs have been adapted into fabric designs that blend tradition with modernity. This mood board celebrates the harmony between cultural heritage, nature, and sustainable textile beauty (Hudaidah et al., 2023).

The following exploration stage involves creating stylized patterns based on a pattern board filled with traditional Betawi house ornaments. Betawi traditional houses feature a wide range of decorative elements that can be transformed into motifs. The selected ornaments for stylization include the sun, Cempaka flower, Jasmine flower, Gigi Balang, Tapak Jalak, and Ginggang.

The next stage is designing the motif composition by duplicating and stylizing several ornaments from Betawi traditional houses. These motifs will be applied using the block printing technique, utilizing wood printing plates and tingi natural dye paste on Toyobo cotton fabric as the printing medium. The focus will be on creating symmetrical and asymmetrical compositions to explore visual balances and design aesthetics.

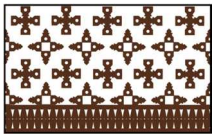
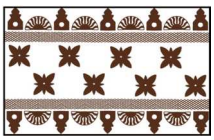
One of the five compositions will be finalized on the fabric sheet. The chosen composition will be applied using the block printing technique, ensuring that the design aligns with the project's aesthetic and functional goals while preserving the essence of Betawi traditional motifs.

The selected composition consists of stylizations of the sun, jasmine flower, *gigi balang*, and *tapak jalak*. These four stylizations will be carved into wood printing plates using a laser-cut technique. Each plate was designed with specific dimensions: Gigi Balang (24 × 12 cm), Jasmine Flower (24 × 24 cm), Sun (30 × 15 cm), and Tapak Jalak (30 × 6 cm). The wood printing plates will be used with Soga tingi natural dye paste on toyobo cotton fabric measuring 200 x 150 cm. The resulting block-printed fabric can be utilized for fashion products.

The evaluation of this research indicates potential for further development. In particular, the size and design of the printing plate can be explored in more depth to assess how the spacing between lines and the thickness of the motifs affect print quality. The block printing technique using tingi natural dyes has the potential to produce textile works that are not only visually appealing but also demonstrate strong technical performance.

This research aligns with current fashion movements focusing on sustainability by

Table 6. Motif composition
Sources: Research Team, 2024

No	Composition Design	Description
1		The motif composition follows the principle of asymmetrical balance, where the motifs are arranged in a repetitive pattern. This deliberate asymmetry creates a dynamic and visually engaging design that maintains overall balance.
2		The motif composition follows the principle of symmetrical balance, where the motifs are arranged in a repetitive pattern. This structured repetition creates a harmonious and visually balanced design.
3		The motif composition follows the principle of symmetrical balance, where the motifs are arranged in a repetitive pattern. This structured repetition creates a harmonious and visually balanced design.
4		The motif composition follows the principle of asymmetrical balance, where the motifs are arranged in a repetitive pattern. This deliberate asymmetry creates a dynamic and visually engaging design that maintains overall balance.
5		The motif composition follows the principles of symmetrical balance and opposition, with motifs arranged in such a way that they face each other. This structured arrangement creates a harmonious and visually balanced design.

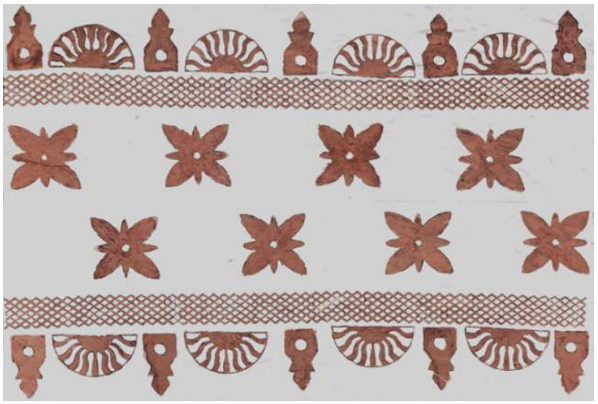


Figure 6. Composition of selected motif
Source: Research Team, 2024

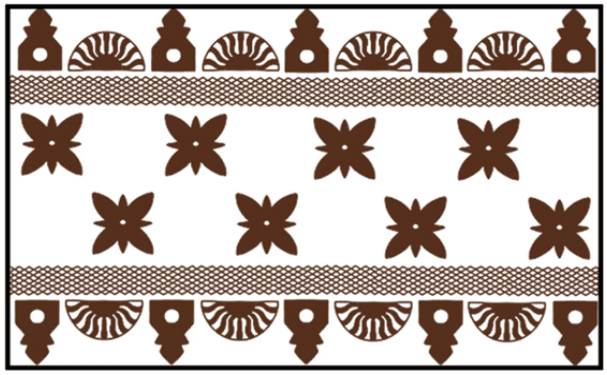


Figure 7. Printing Results on Fabric
Source: Research Team, 2024

utilizing natural materials and eco-friendly processes (Rohaeni & Perangin-Angin, 2024). The block printing technique with natural dye paste made from tingi provides an alternative that promotes environmental preservation while maintaining aesthetic and cultural significance. Brands like SukkhaCitta exemplify how sustainability can be integrated through natural dyes, responsible production practices, and the fusion of traditional motifs

with a modern perspective. This highlights that block printing with tingi natural dye is highly relevant in today's fashion industry, which values authenticity, artisanal craftsmanship, and the cultural heritage embedded in each piece.

CONCLUSION

Based on the research conducted, focusing on the development of block printing using Soga tingi natural dye paste as colorants, it can be concluded that Soga tingi is highly suitable for use in the block printing technique. The research found that this technique's most effective thickening agent is sodium alginate, a food-grade thickener used in a precise ratio of 10 g to 100 ml of liquid natural dye. This composition resulted in a smooth, mucus-like consistency, making it easier to apply to fabric and ensuring an even distribution of color.

The wood-based printing plates were found to be the most effective choice for printing materials. Compared to other materials such as linoleum rubber or sponge, wood plates produced the most precise and well-defined prints, ensuring that the intricate details of the motifs were accurately transferred onto the fabric. Additionally, toyobo cotton fabric was selected as the printing medium due to its natural fiber composition, allowing for better natural dye absorption.

The mordant application was also studied to ensure optimal color depth and permanence. Among the different mordants tested, aluminum sulfate proved to be the most effective when applied using the painting technique. This mordant helped the dye bind strongly to the fabric, producing a rich reddish-brown color while maintaining color fastness after washing. Future research is needed to measure color fastness through laboratory testing.

Furthermore, the design motifs used in this research were inspired by traditional Betawi house ornaments, incorporating elements such as the sun, jasmine flowers, *gigi balang*, and *tapak jalak*. These motifs were carefully selected and stylized to align with the characteristics of tingi natural dye, resulting in a harmonious blend of cultural heritage and sustainable textile innovation.

To conclude, the research shows that Soga tingi natural dye paste, when applied with block printing technique into fabric, presents a viable and sustainable alternative for textile design. This method preserves traditional craftsmanship and aligns with the global movement toward eco-friendly and sustainable fashion.

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