

Applying 'Salt Dyeing' in the Art Creation with Paper Mulberry Fibers

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ABSTRACT

Through innovative salt dyeing techniques, the study aimed to rediscover the inherent characteristics and charm of paper mulberry fibers, explore unique regional features specific to Taiwan, and bridge craftsmanship with emotional connections to life. Additionally, it sought to engage in a dialogue on sustainable awareness towards the natural environment.

With the application of research methods such as action research, empirical research, and literature review, accumulated experiences and wisdom were gradually deconstructed and re-encoded. Salt dyeing techniques play significant roles in societal relations and environmental contexts, influencing the resources that warrant further study.

The study proposes relevant research directions and methodologies to deepen understanding of natural dyeing, commercialization and consumption.

Keywords : Sustainability, Traditional handicraft, Paper mulberry, Salt dyeing

INTRODUCTION

This study focuses on the innovative application of dyeing techniques that utilize the cultural significance of *Broussonetia papyrifera* (paper mulberry) within Austronesian traditions. By merging modern craftsmanship with traditional materials and dyeing methods, the research aims to enhance public appreciation and accessibility of traditional culture.

RESEARCH OBJECTIVES

Reduce Water Consumption: The study seeks to minimize water usage during the cleaning process in plant dyeing, aiming to extend the lifespan of plant-based dyes.

Minimize Carbon Footprint: The goal is to transform the dyeing process from a single-use model into a circular process, thereby reducing the carbon footprint associated with water usage.

Explore Cultural Significance: The research intends to reinterpret the cultural significance of paper mulberry within Austronesian traditions through various artistic techniques, highlighting its historical and contemporary relevance.

RESEARCH METHODS

1. Salt Dyeing Observational Study

This component employs action research to compare two experimental approaches:

Method A: Daily washing, drying, and re-soaking of dyed fabrics.

Method B: Continuous immersion of dyed fabrics.

Both methods will be repeated 100 times, with observations focused on:

- **Colorfastness:** Evaluating how well the dye adheres to the fabric over time.
- **Uniformity of Dyeing:** Assessing the consistency of color across the fabric.
- **Volume of Water Used:** Measuring the amount of water consumed during the washing process.

2. Historical and Documentary Analysis

- **Comparative Analysis:** Examining the differences between plant dyeing and salt dyeing techniques.
- **Literature Review:** Investigating the historical and modern uses of paper mulberry fibers through existing literature and historical documentation, providing context to its cultural significance in Austronesian societies.
- **By integrating these methodologies,** the study aims to contribute to the understanding of traditional dyeing practices while promoting sustainable techniques that honor cultural heritage.

LITERATURE REVIEW

Broussonetia papyrifera (paper mulberry) is a monoecious and highly adaptable plant from the Moraceae family, classified as a pioneer species. It thrives in disturbed environments, contributing to the restoration of ecosystems. The plant is capable of rapid growth within a short period and can easily colonize various landscapes, including plains, agricultural fields, rural pathways, and roadside areas.

The bark of paper mulberry is rich in fiber and nutritional value, playing a significant role in the cultural traditions of Taiwan's Indigenous peoples. It has been utilized in cultural

celebrations and rituals and historically served practical purposes such as producing fibers for currency and crafting clothing. These uses reflect not only the vitality and sustainability of Indigenous cultures but also their deep connections to material culture, cultural identity, and social structures.

Cultural Transition and Applications of Paper Mulberry Fibers: A Chronological Division at the Year 2000
The year 2000 marks a pivotal moment in the promotion of bark culture, when the broader public began to recognize this traditional Indigenous heritage. Below is a comparison of the uses, techniques, and transformations of paper mulberry fiber across two time periods.(Tables 1)

Table 1: Cultural Transition and Applications of Paper Mulberry Fibers

Category	5000 BCE – 2000 CE	2001 CE – 2024 CE
Applications	Currency, clothing, daily necessities	Daily necessities, lighting designs, art installations, accessories
Techniques	Beating, pounding, steaming	Beating, pounding, steaming, soaking
Size	Small-scale	Scalable: small to large
Processing Methods	Sewing, printing patterns	Sewing, printing patterns, dyeing

Source: Compiled by researchers themselves

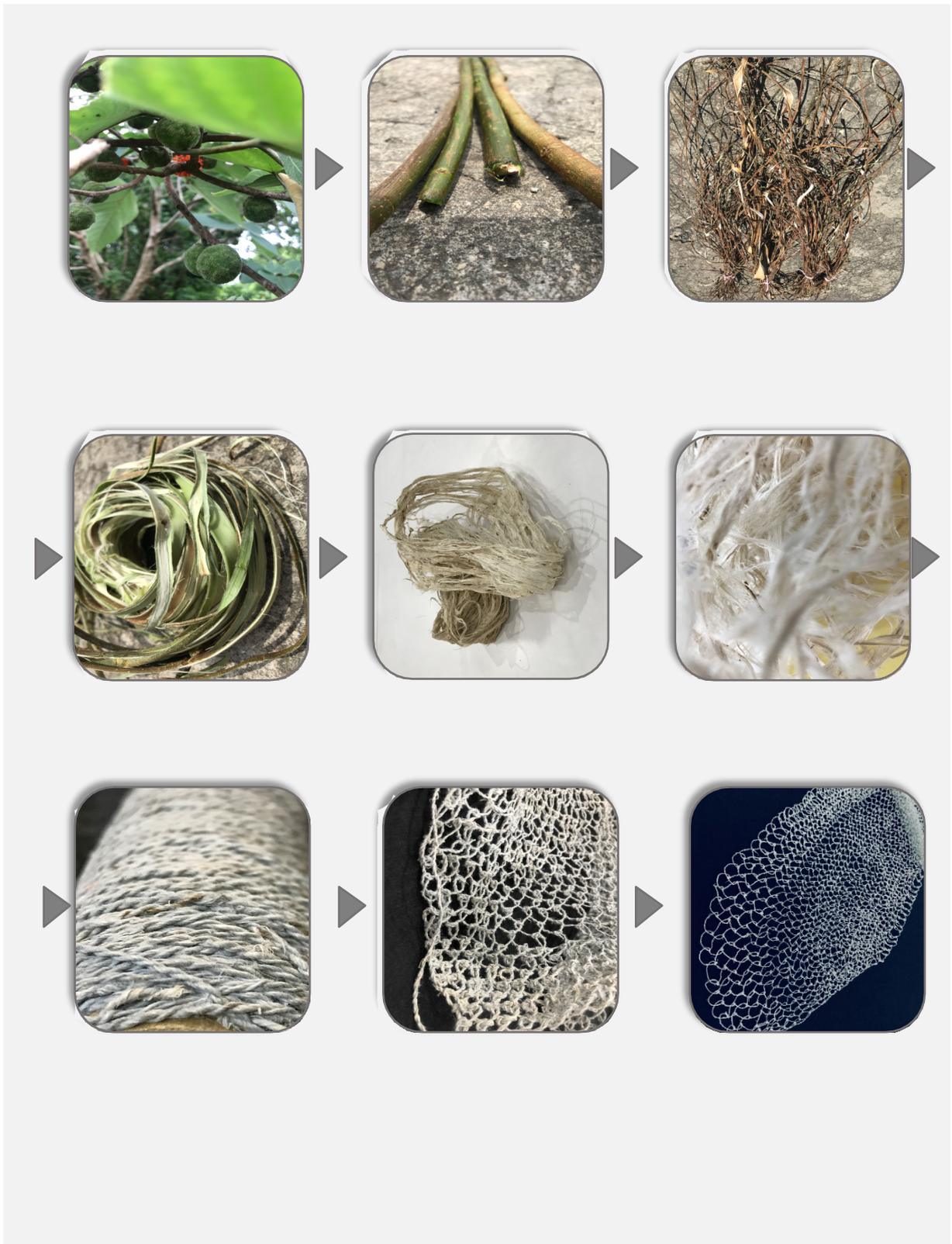
Paper Mulberry Fiber Collection and Processing

In this study, paper mulberry trees were collected near the geographic coordinates of latitude - 25.033493 and longitude -121.564101. It was observed that fibers from trees in flatlands are thicker compared to those from mountainous regions. As a result, the processing, designing, and creation of these fibers require more time. However, this also reduces transportation time and carbon emissions, contributing to sustainability.

A visual representation of the process is provided in the accompanying illustration. (Figures1) The complete fiber processing workflow involves the following steps:

1. Collecting branches.
2. Stripping the bark.
3. Soaking the bark.
4. Beating the bark.
5. Thinning the fibers.
6. Twisting the fibers into threads.
7. Weaving the threads into nets.

Paper mulberry collection process
Figures 1: Material collection process



Source: Photographs by the researcher

Indigo Salt Dyeing

Indigo dyeing is a traditional technique that produces a rich, deep blue color. This method is environmentally friendly as it utilizes plant-based dyes.

Source of Indigo Dye

Indigo dye is primarily derived from plants such as *Indigofera tinctoria*. The leaves of these plants undergo fermentation and processing to extract the dye. As a natural dye, indigo is known for its excellent colorfastness and eco-friendly properties.

Role of Salt

In indigo dyeing, salt functions as a mordant, assisting in the adhesion of dye molecules to fibers. It facilitates the dissolution of the dye and enhances the uniformity and intensity of the coloration.

This study integrates traditional food preservation techniques, specifically salting methods, into the dyeing process. Inspired by the concept of using salt to prolong the shelf life of food, the approach leverages salt's ability to alter water activity in food. By creating osmotic pressure during dissolution, salt balances internal and external salinity levels, which aligns with the principles of natural fiber dyeing. The high osmotic pressure of salt not only inhibits the proliferation of microorganisms but also extends the lifespan of the dye.

Indigo salt dyeing is a traditional dyeing technique primarily used for applying indigo dye onto fibers. This method not only produces a rich, deep blue color but also possesses environmentally friendly characteristics, as the dye is derived from plant sources.

Source of Indigo Dye Figures 2: Methods



Source: Photographs by the researcher

The difference between plant dyeing and salt dyeing

Indigo dye is primarily obtained from indigo plants, such as *Indigofera tinctoria*. The leaves of these plants undergo fermentation and processing to extract the indigo dye. As a natural dye, indigo has excellent color fastness and environmentally sustainable properties.

Role of Salt

In indigo salt dyeing, salt functions as a mordant, assisting in the adherence of the dye to the fibers. Salt facilitates the dissolution of the dye and enhances the uniformity and depth of the coloration, thereby improving the overall dyeing process.

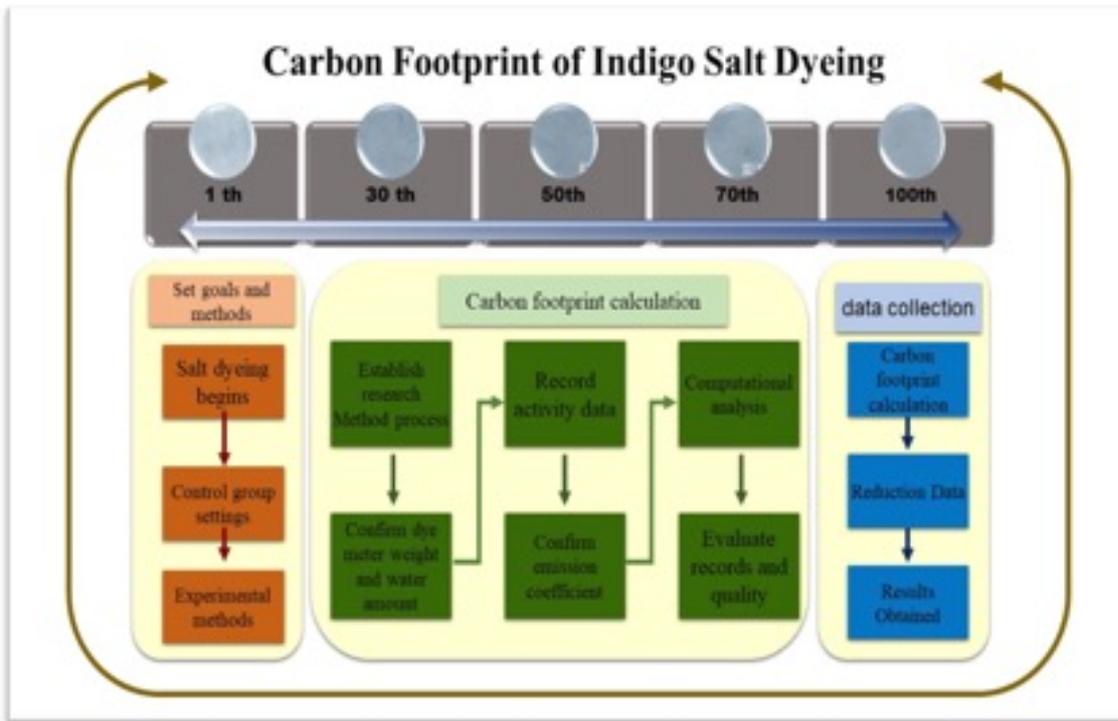
Indigo salt dyeing is not only capable of producing distinctive deep blue hues but also avoids the use of harmful chemicals, making it a relatively eco-friendly dyeing method. (Table 2)

Tables 2: The difference between plant dyeing and salt dyeing

Category	Plant Dyeing	Salt Dyeing
Source	Natural plants	Natural plants
Pre-Dyeing Preparation	Requires cleaning and pre-treatment to remove any oils or dirt	Requires cleaning and pre-treatment to remove any oils or dirt.
Detergent	Soap water, soybean milk	Soap water, soybean milk
Dye Shelf Life	1 to 3 days	Can be reused
Dye Activation Method	Requires heating	Can be used directly
Dye Bath Ratio	50% to 100% of the fabric weight	70% to 100% of the fabric weight
Water Ratio	20 to 60 times the fabric weight	30 times the fabric weight
Washing Water Volume	(20 to 60 times the fabric weight) x 3 times	30 times the fabric weight
Post-Washing Water	Disposed of	Reused for irrigation
Process	Suitable for large-scale dyeing	Suitable for small-scale dyeing
Uniformity	High uniformity	May exhibit unevenness with excessive quantities
Color Fastness (Undyed)	High	High

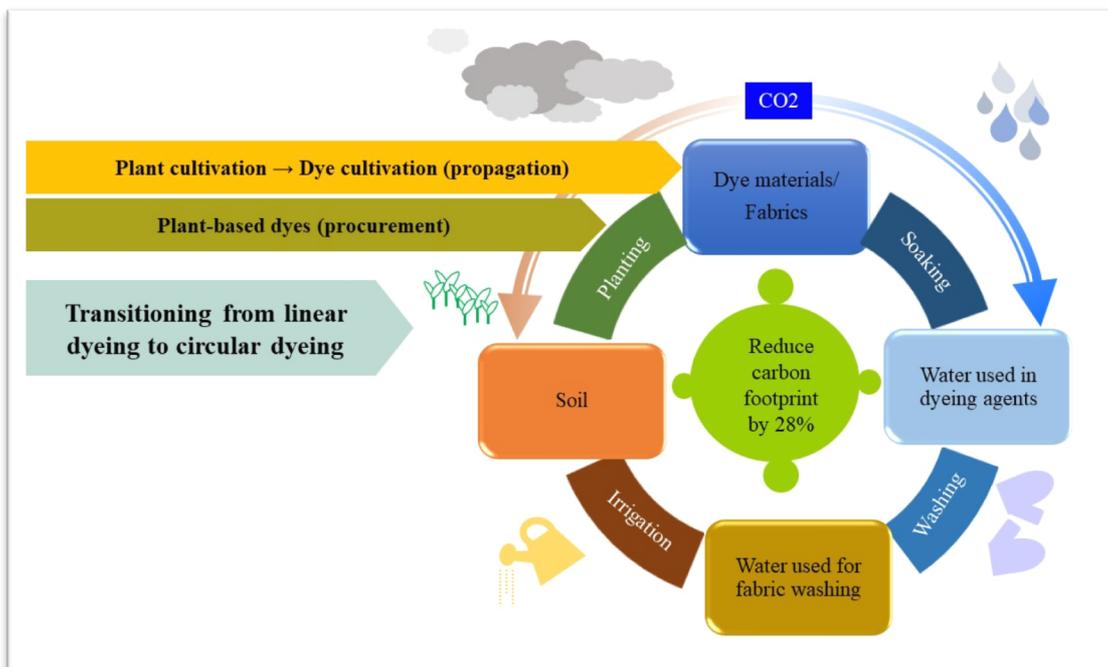
Source: Compiled by researchers themselves

Figure 3: Indigo salt dyeing research flow chart



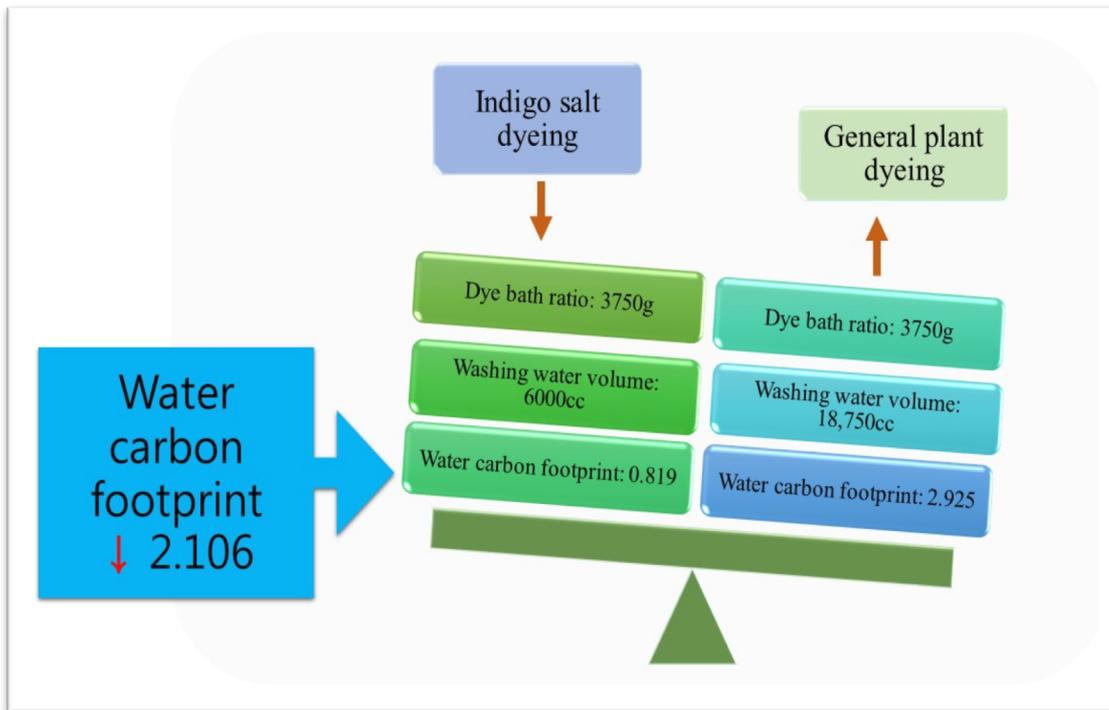
Source: Drawn by researchers

Figures 4: Indigo Salt Dyeing Research Dyeing Reuse Cycle Diagram



Source: Drawn by researchers

Figure 5: The difference between indigo salt dyeing and plant dyeing



Source: Drawn by researchers

Salt Dyeing Research: Experimental Comparison and Results

This study utilized an action observation methodology to explore the effects of salt dyeing, conducting two distinct experimental approaches repeated over 100 cycles. The investigation focused on evaluating **colorfastness**, **dye uniformity**, and **water consumption** during the washing process. (Tables 30

Experimental Design

Group A: Fabrics were subjected to daily washing, air-drying, and re-soaking until all sample pieces were completed (Figures 6)

Group B: Fabrics were directly removed from the dye bath, washed, and air-dried without intermediate steps. (Figures 7)

Table 3: Comparative Results Between Group A and Group B

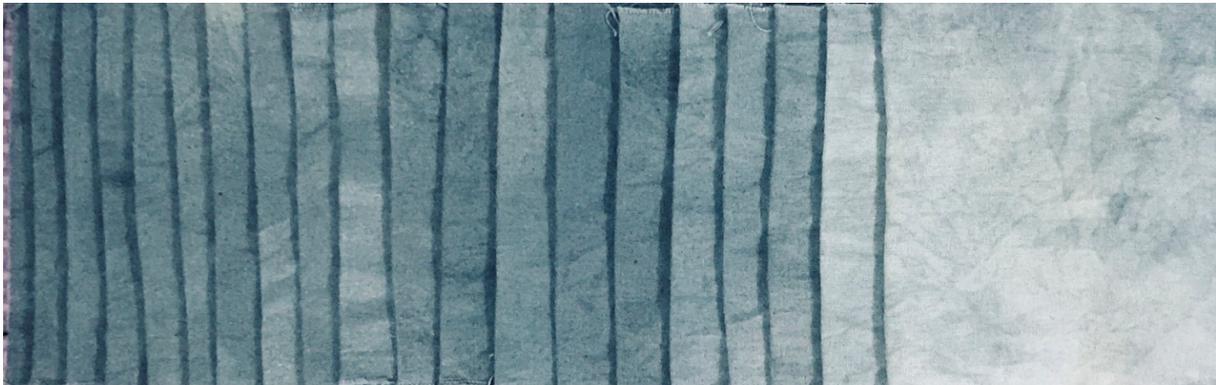
Aspect	Group A	Group B
Methodology	Daily washing, air-drying, and re-soaking	Direct extraction from the dye bath
Colorfastness	Superior	Inferior
Dye Uniformity	High	Low
Texture	Thick and robust	Fine and delicate
Color Intensity	Deepens with increased cycles	Light and less saturated

The findings indicate that **Group A** is the more effective approach and has been selected for subsequent creative dyeing applications. This method allows for precise control over color depth by modulating the number of dyeing cycles according to design requirements. (Figure 8)

From an environmental perspective, the carbon footprint analysis for salt dyeing also prioritizes **Group A**. Compared to conventional plant dyeing techniques, this method demonstrated a **2.106-fold reduction in water usage** during the washing process. Furthermore, the dye solution exhibited reusability across multiple cycles, contributing to a significant reduction in environmental pollution. (Figures 3.4.5)

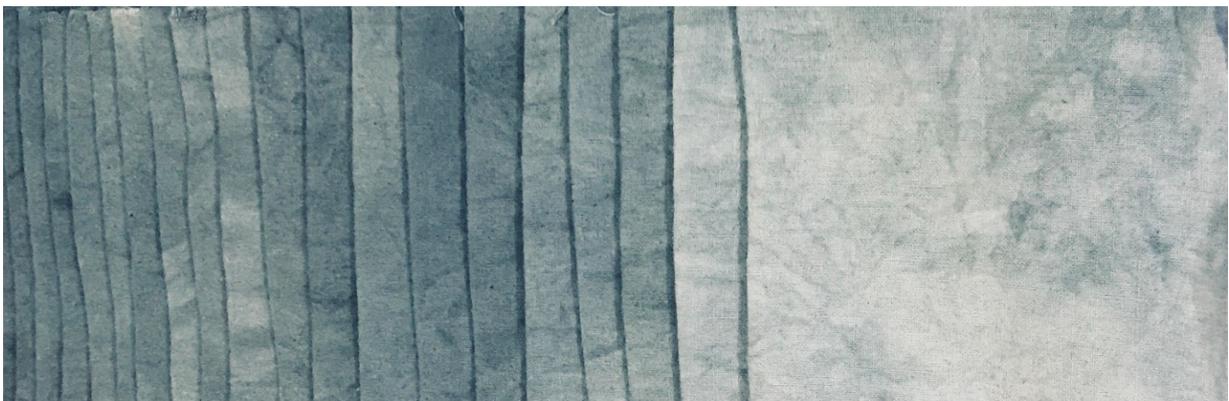
RESULTS

Figures 6: Salt dyeing (Daily washing) 100-number of times experimental process



Source: Photographs by the researcher

Figures 7: Salt dyeing (soaking) 100-number of times experimental process



Source: Photographs by the researcher

Figures 8: Salt dyeing (soaking/ Daily washing) 100-number of times experimental process



Source: Photographs by the researcher

Source of creative inspiration:

The paper mulberry, with its resilience and deep cultural significance, has been a symbol of survival and renewal for generations. This remarkable tree thrives in harsh environments, offering hope where nature has been damaged or neglected. In the mythology of the Austronesian peoples, the paper mulberry is often considered a gift from the gods, planted to heal the Earth after times of destruction. A touching story from one such community speaks of a young woman whose village was devastated by a fierce storm. As she wandered through the ruins, she stumbled upon a paper mulberry tree standing tall amidst the wreckage. The tree's bark provided her with fibers strong enough to weave into clothing, keeping her warm during the harsh nights. Its fruit gave her nourishment, allowing her to survive and return home. When she shared her story, her people saw the tree as a divine gift—an embodiment of hope and survival.

The fibers of the paper mulberry, known for their strength and versatility, have been central to the lives of many Indigenous peoples. They were used not only for clothing but also for ceremonial textiles, baskets, and tools. The process of weaving the fibers into fabric was more than just a craft—it was a spiritual act, connecting the people to the land, to their ancestors, and to the cycles of life. Each piece of woven cloth carried a story, a prayer, or a blessing. It was as if every thread was a connection between the past and the future, between the human and the natural world.

In the quiet moments of weaving, the people could feel the presence of their ancestors, guiding their hands, teaching them to survive, to adapt, and to grow. The paper mulberry was not just a resource—it was a teacher, a protector, and a constant companion in times of hardship. Even when the tree faced the harshest conditions, it would continue to thrive, just as the people did. The paper mulberry's story is one of survival, connection, and resilience,

showing us that, like the tree and the woven fibers, we too can create something beautiful and enduring from life's challenges. Through its legacy, we are reminded that we are all part of a larger, interconnected story of renewal, strength, and hope.

Creative approach

The creative process begins with the meticulous decomposition and reorganization of paper mulberry fibers. These fibers are carefully separated, softened, and restructured, much like the intricate art of twisting threads. Each strand is thoughtfully intertwined, forming a robust yet pliable bundle that serves as the foundational material for weaving. This process not only respects the rhythms of traditional craftsmanship but also integrates modern versatility, ensuring a harmonious blend of heritage and innovation.

The weaving stage artfully combines time-honored methods with contemporary innovations. Dynamic textures are achieved by varying the weave density: loosely woven sections offer a softer, breathable feel, while tightly woven areas provide structural integrity. Patterns emerge directly within the weave, utilizing fibers of different thicknesses and natural tones to create geometric or organic designs. This interplay between density and texture infuses the fabric with a rich tactile and visual depth, enhancing its overall aesthetic appeal.

The dyeing stage transforms into an artistic endeavor that elevates the fabric's character. A combination of salt-dye brushing and resist-dyeing techniques is employed to craft intricate patterns. Salt-dye brushing involves layering dye, with each stroke building subtle gradients of color. Resist-dyeing incorporates natural materials like leaves or bark to mask certain areas, leaving delicate imprints that echo organic forms found in nature.

Colors are applied with a deliberate strategy: cool hues emphasize flowing, dynamic sections, while warm tones highlight focal points, enhancing the fabric's movement and rhythm. The result is a harmonious design where patterns naturally guide the viewer's gaze across the piece.

For the skirt, the creative process begins with the selection of long, thick paper mulberry branches. These branches are softened through steaming and then layered. Each layer is sculpted into forms reminiscent of petals or waves, lending the skirt a three-dimensional quality. Dye is applied using a brush in successive layers, with each application deepening the shade. This cascading gradient effect creates a sense of movement and vitality, adding a dynamic flair to the design.

To unify the various elements, advanced layering techniques are employed. Paper mulberry fibers are twisted into cords or ropes to form decorative details such as braided trims or tassels. Additional woven layers are overlaid or combined with translucent

materials, creating a captivating interplay of light and shadow that adds dimensionality to the design.

The final creation embodies a seamless fusion of cultural heritage and contemporary design. The inherent strength and elasticity of paper mulberry fibers, combined with meticulous craftsmanship, transcend the boundaries of traditional functionality. This approach transforms the material into a medium for artistic expression, celebrating the legacy of ancient techniques while showcasing their relevance in modern creative practices. Through this synthesis, the design honors tradition and reimagines it for the future, bridging generations with an enduring narrative of innovation and cultural identity.

Figure 9: research works



Source: Photographs by the researcher

Figures 10: research works



Source: Photographs by the researcher

Figures 11: research works



Source: Photographs by the researcher

Figure 12: research works



Source: Photographs by the researcher

RESEARCH SUMMARY

This study explores innovative dyeing technology aimed at extending the usability and sustainability of natural dyes. Over a four-month period, the dye demonstrated remarkable stability, showing no significant deterioration despite repeated use. Swatches dyed during this process exhibit gradual deepening of color with repeated applications, though the changes are subtler compared to traditional vegetable dyes.

The research highlights a substantial reduction in water's carbon footprint, estimated to be approximately 28% lower than that of conventional dyeing methods. This achievement opens avenues for further exploration into eco-friendly dyeing practices and their broader applications.

In the creative process, the integration of Taiwan's indigenous plants, particularly paper mulberry fibers, plays a crucial role. This approach not only enhances the functional aspects of the research but also serves as a medium to promote understanding of South Island culture and its rich spiritual heritage. By connecting traditional materials with contemporary applications, the study bridges cultural knowledge and innovation.

Currently, the application of this technique is limited to small-batch dyeing and smaller fabric samples. Scaling up for large-batch production and commercial manufacturing will require additional testing and refinement. However, the potential for broader industrial application remains promising, with ongoing research paving the way for more sustainable and culturally significant dyeing methods.

REFERENCES

Taiwan International Studies Quarterly, Vol. 3, No. 3, pp. 161-86, Autumn 2007

Chi-Shan Chang (2011) *Clothes Made of Trees: The tapa culture and the phylogeographic study of the Pacific paper mulberry (Broussonetia papyrifera)*. National Museum of Taiwan Prehistory. Taitung City

Chang, Hsuan Chung, Kuo-Fang Biodiversity Research Center, Academia Sinica The Great Paper Mulberry Environmentally friendly and sustainable bark cloth for garment applications: evaluation of fabric properties and apparel development. P.D. Venkatraman^{1*}, K. Scott² and C.M. Liauw

Cai Renjie, Xu Xiufeng, Lin Zihao, Chen Jianzhang, and Zheng Xiangyuan (2019). Technical Guidelines for Industrial Water Optimization and Water Saving in the Textile Industry P1-61. Bureau of Industry, Ministry of Economic Affairs, Taiwan

Ye Ruorun, Xu Jianguo (2018) Fiber plants×papermaking. Journal of Forestry Research. Issue 1, Issue 25, Issue 2, P25-30 Forestry Laboratory Wood Fiber Group

Jung-Yi Lin (2019) Backtracking and Remake — Lin Jung Yi/ Halomei's Podac no Kilang (Bark) Art. National Dong Hwa University. Department of Art and Creative Industries

Y. D. Lin (2021) The Research and Production of Regenerated Ramie Fiber. P15-20. Volume 31 Issue 4. Dept. of Raw materials and Fibers, Taiwan Textile Research Institute, New Taipei City, Taiwan, R.O.C.

Zhang Zhishan (2014) Discussed the possibility of the selection and domestication of paper mulberry by the Austronesian language group in the bark cloth culture based on the characteristics of bark fiber P1-26.103 World Austronesian Academic Research Project - Results Report

Chen Jiaqi. Xu Jianguo (2021) Research and development of new handmade paper products-using Taiwan's local fibers as materials P62-65. Forestry Research News Vol. No. 28 No. 2

Huang, Yun-Ru (2023) The Application of "Natural Dyeing" for Taiwan Hakka Cultural Symbol on Bags. National Taiwan Normal University

Min-HuaChiang (2014) Study on Soil Desalination of Derelict Salt Field with Open Channel. National Cheng Kung University. Department of Civil Engineering

Pin-Hao Wu (2006) The effects of leached characteristics of nutrients in several typical agricultural soils by using different fertilizers and rainfall pH. National Cheng Kung University. Department of Environmental Engineering

HSU, HSIN-TZU (2021) Research of Chinese Leek Plant Dyeing. Ajou University. Department of Creative Product Design

Yu-Kang Peng (2017) An Action Research of Teaching Straw-Stained Painting Integrated with Environmental Issue for Upper Graders of Elementary School. Department of Visual Arts, National Chiayi University.

Yu-Yung Chang (2015) The production of indigo blue and the maketing of indigo-dyed textiles in Hualien and its future development. Donghua University. Department of Art and Creative Industries

Yi-Ru Chen(2017) Green dyeing process of natural indigo dyes. National Taipei University of Technology. Institute of Organic Polymers

金田, 弘; 田村, 健. 1999. 木材加工教育の実践に関する研究(第 18 報) : 樹皮,薄板を編む試みについて . 北海道教育大学紀要. 自然科学編, 50(1): 63-72

松永 篤知.2000. 環状樹皮製品とその用途について金大考古: 10-12

五 関 美 里 . 河野コレクションからみる文様 およびその特徴 —樹皮衣・木綿衣を中心に— 昭和女子大学文化史研究第 21 号_p089-p104

名久井 文明. 1993 . 東日本における樹皮利用の文化 : 加工技術の体系 と伝統. 221-301

Cheng, H. W. (2023). *Spiritual Plants: Native Plant Wisdom*. Macaw Press.

Zhang, Z. S. (2017). *Bark cloth culture and phylogeography of Pacific paper mulberry*. National Dong Hwa University.

Zhong, M. Z., and Yang, Z. K. (2012). *Atlas of Taiwanese Ethnobotany*. Morningstar Publishing.

Chen Qinglin and Ma Yuxiu (2022). *The Glory of the Earth: A Compendium of Taiwan's Natural Dyes, Revised Edition (Volume 1 and 2)*. Taichung Fiber Craft Museum.

Michiko Matsumoto (2023). *Happy plant dyeing [Anniversary Edition]*. Jigsaw culture.

Robin Wall Kimmerer (2023), translated by Lai Yanru. *Braiding Sweetgrass: Native Wisdom, Scientific Knowledge, and the Teachings of Plants*. Wanderer culture.

Lin, Yixiang, and Lu, Zonghan (2020). *New Fiber Story: Local craft innovation with paper mulberry and areca nut*. National Taiwan Institute of Technology Research and Development.

Zhang, F. Chi (2021). *Research on Taiwan fiber plant weaving process (paperback)*. Taichung Fiber Craft Museum.

Xu Qiuyi et al. (2014). *Weaving nature: Taiwan's plant fiber craft culture*. National Taiwan Institute of Technology Research and Development.

Kang Yazhu (2015). *Fabric Pictures: A Fiber Artist's Journey into Textile Dyeing*. Garden City Press.

Kang Yazhu (2016). *Fabric Map 2: Wool, spinning, and fiber craftsmanship of ancient civilizations in Peru*. Garden City Press.