MERAKI: ***Journal of Creative Industries***
Vol. 03, No. 01, November 2025, pp. 34-45
https://journal.ubaya.ac.id/index.php/meraki/index
DOI: https://doi.org/10.24123/meraki.v3i01.7751

Optimization of Pandan Leaf Processing (*Pandanus Tectorius*) as Craft Material: A Comparative Study of Drying and Natural Dyeing Methods

Hani Siti Nurjaihan [1,*], Afifah Mu'minah[2], Andri Pahrulroji[3]
[1]Universitas Pendidikan Indonesia, Indonesia
[2]Universitas Pendidikan Indonesia, Indonesia
[3]Universitas Pendidikan Indonesia, Indonesia
Email: hanisitinurjaihan@mail.com*
*afifahmmnh@upi.edu
*andri.pahrulroji@upi.edu

ABSTRACT

This research aims to optimize the processing of pandan leaves as craft material through comprehensive analysis of various drying and natural dyeing methods. Nine pandan leaf specimens with different initial treatments were tested using two main drying methods: natural sun-drying and oven drying. The research results show that pandan leaves with dimensions of 4-6 cm width and 40-100 cm length provide an optimal yield rate of approximately 60-70% for high-quality craft material production. The boiling process as initial treatment followed by sun-drying produces the best balance between drying time efficiency, color quality, and material structural integrity. Oven drying for 20 minutes proved equivalent to conventional sun-drying in terms of dryness level, but resulted in brittle material and loss of color absorption capability. Dyeing exploration using turmeric extract, suji leaves, and teak leaves showed that the use of lime water as solvent produces superior color intensity compared to regular water. This research provides significant contribution to the development of standard specifications for sustainable and environmentally friendly pandan leaf craft industry by utilizing experimental methods.

Keywords: pandan leaves, drying, natural dyeing, craft material, process optimization

Article history

Received:	*Revised:*	*Accepted:*	*Published:*
16 July 2025	*4 October 2025*	*21 October 2025*	*30 November 2025*

Citation (IEEE Style): H.S. Nurjaihan, A. Mu'minah, A. Pahrulroji, "Optimization of Pandan Leaf Processing (Pandanus Tectorius) as Craft Material: A Comparative Study of Drying and Natural Dyeing Methods", *MERAKI: Journal of Creative Industries*, vol. 03, no. 01, pp. 26-33, November 2025..

INTRODUCTION

In the global era that increasingly emphasizes environmental sustainability issues, the use of natural materials in various industries has experienced significant growth. This trend is driven by international community awareness of the negative impacts caused by the use of environmentally unfriendly synthetic materials [1]. The handicraft industry, as an integral part of the global creative economy, has also felt the impact of this paradigm shift. Modern consumers increasingly demand products that not only have high aesthetic value but are also produced with consideration for sustainability and environmental conservation aspects [2].

Natural material-based crafts have proven to provide positive contributions not only from environmental aspects but also from social and economic perspectives. This industry is capable of creating sustainable employment opportunities, especially for rural communities that have access to natural resources. Additionally, natural material crafts also play a role in preserving traditional knowledge and local wisdom that has been passed down through generations by ancestors [3]. Research on batik crafts and natural dyeing shows that the utilization of natural materials in traditional crafts not only has economic value but also functions as a medium for cultural preservation and local knowledge.

Indonesia, as an archipelagic country with extremely high biodiversity, has tremendous potential in developing natural material-based crafts. Indonesia's flora wealth includes thousands of plant species that can be utilized for various purposes, including as raw materials for handicrafts. However, optimal utilization of this natural wealth still requires a more systematic and scientific approach to produce products with higher added value. Based on recent data, the natural material-based craft product market has experienced growth of 15.2% per year in the last five years, indicating very promising business opportunities in this sector [4].

The Pandanus genus is a highly diverse group of tropical plants with approximately 578 taxonomically accepted species. This species diversity shows wide morphological variation, ranging from small shrubs less than one meter in size to medium-sized trees that can reach heights of 20 meters. Each species has unique characteristics that allow them to adapt to various environmental conditions in tropical and subtropical regions. Among the various existing Pandanus species, Pandanus tectorius (Screw Pine) is one of the most widely distributed species and shows the best potential for use as handicraft material [5].

Pandanus tectorius has morphological characteristics that are highly supportive for use in handicrafts. This species is a small tree that can grow up to 10 meters in height with sword-shaped leaves arranged spirally at the end of the stem [6]. Its leaves have ideal thickness and strength for weaving, strong enough yet flexible, allowing craftsmen to shape them into various craft products without easily breaking or tearing. The leaf size, which can reach lengths of over one meter, provides sufficient material to make various sizes of craft products [7].

The advantages of Pandanus tectorius as craft material are also supported by its sustainability aspects. This species has wide distribution and can grow in various environmental conditions, especially in coastal areas with high salt tolerance and the ability to grow in areas exposed to seawater spray. Its high adaptability to sandy, poor, or saline soils makes it easy to cultivate and harvest sustainably, thus providing sustainability of raw material supply needed for the craft industry. The physical properties of Pandanus tectorius leaves are highly suitable for handicraft processing. Its leaves have strong and durable fibers and can be processed through various stages such as drying, dyeing, and forming without losing their structural strength [8]. The smooth yet non-slippery surface texture facilitates the weaving process and provides aesthetic final results. Research on natural fiber characteristics shows that Pandanus tectorius has superior tensile strength compared to other similar materials [9].

However, despite pandan leaves having been traditionally utilized in crafts in various regions of Indonesia, the processing methods and product designs produced are still tend to be conventional and have not experienced significant innovation. This condition differs from other Southeast Asian countries such as the Philippines, Thailand, and Malaysia, where pandan leaf processing innovations have produced high economic value products capable of penetrating international markets. This disparity indicates a gap that needs to be filled through more intensive research and development of pandan leaf processing techniques in Indonesia [10].

The development of contemporary technology and design methods opens great opportunities for exploring pandan leaf materials with a more systematic and scientific approach. The material experimentation method is an approach proven effective for identifying and optimizing the potential of a material, including in terms of transforming physical, textural, and aesthetic characteristics. In the context of design and crafts, this approach enables innovation in utilizing traditional materials to produce products with much higher added value compared to conventional processing methods [11].

The urgency of research on pandan leaf exploration as handicraft material through material experimentation methods is supported by several important factors. First, there is a global trend toward green economy and sustainable creative industries that creates high demand for environmentally friendly material-based products. Second, the enormous yet unoptimized economic potential of Indonesia's natural materials, particularly pandan leaves, which requires scientific research to produce innovative breakthroughs in processing and product design. Third, the importance of preserving and revitalizing traditional knowledge about plant utilization in the era of globalization and modernization that threatens the preservation of local wisdom.

This research also has high relevance to local community economic empowerment efforts, especially in rural areas that have access to pandan leaf raw materials. Through the development of innovative processing techniques and products with more attractive designs, it is hoped that new economic opportunities can be created that can improve the welfare of craftsmen communities. Additionally, this research also contributes to achieving sustainable development goals (Sustainable Development Goals), particularly in terms of industrial innovation, responsible consumption and production, and poverty alleviation through creating sustainable employment opportunities.

Based on the above description, research on exploring the use of pandan leaves, particularly Pandanus tectorius, as handicraft material with material experimentation methods has very high significance from various perspectives: academic, economic, environmental, social, and cultural. This research is expected to produce findings and innovations that benefit the development of natural material-based craft industries in Indonesia, while providing real contributions to environmental conservation efforts, community economic empowerment, and preservation of local wisdom in natural resource utilization.

METHOD

Experimental Method

The experimental method is a systematic approach used to investigate and understand the physical, mechanical, and chemical characteristics of a material. According to Berger et.al [12], the material experimental method involves a series of controlled tests to evaluate material performance under various varying conditions, with the aim of producing quantitative data that can be analyzed statistically.

Experimental design approach

In pandan leaf material research, experimental design plays a crucial role in ensuring the validity and reliability of results. Based on studies by Aristizábal-Alzate et al. [13], there are several experimental design approaches commonly used:

- Factorial Design: This method allows researchers to investigate the effects of various factors simultaneously. For pandan leaf materials, factorial design is often applied to analyze interactions between factors such as drying methods, dye concentration, and initial treatment methods.
- Response Surface Methodology (RSM): This approach offers mathematical modeling that can predict material response based on process variable combinations. Successfully applied RSM is shown to optimize pandan leaf dyeing parameters by considering responses such as color intensity, flexibility, and material strength.
- Taguchi Design: This method utilizes orthogonal matrices to reduce the number of experiments without losing essential information. Taguchi design is used to optimize heat treatment processes on pandan leaves by considering temperature, time, and pressure parameters.

Among these three approaches, the approach that was used in this research is the factorial design approach, which allows researchers to determine the effects of various factors simultaneously.

Experimental sample preparation

The sample preparation stage is a critical step that affects the overall experimental results. According to Rattanamato et al. [14], the sample preparation procedure for pandan leaf material testing includes:

1. Harvesting: Identification and selection of leaves based on criteria such as age (ideally 4-5 months), color (evenly dark green), and physical condition (free from disease and damage).
2. Cleaning: Removing dirt and dust present on the leaf surface.
3. Cutting: Standardization of specimen size according to testing requirements, generally with a width of 1-2 cm and length of 30-50 cm for tensile testing.
4. Initial Treatment: Application of treatments such as soaking in water, alkaline solution, or heat treatment according to experimental design.
5. Drying: Strict control over drying methods, temperature, and humidity to ensure consistency of final water content in samples (ideally 8-12%).
6. Storage: Controlled storage conditions at 20-25°C with 50-65% relative humidity to prevent changes in material characteristics before testing.

RESULTS AND DISCUSSION

Harvesting

Pandan leaves have diverse size variations with widths ranging from 0-2 cm for young leaves up to 6 cm or more for mature leaves, while their height ranges from 0-40 cm for young leaves up to 100 cm or more for fully mature and developed leaves. This size variation in pandan leaves shows different growth stages, where smaller leaves typically grow in the center of the plant as new shoots, while larger and longer leaves are positioned on the outer parts as mature leaves that have reached their maximum size. These size differences can also be influenced by environmental factors such as water availability, soil nutrients, and sunlight intensity received by the pandan plant during its growth period. In terms of quality, young pandan leaves have a fragile texture and tear easily, making them unsuitable for handicraft materials as they will easily break during the shaping process, while older leaves have high thickness and hardened fibers.

Based on the analysis conducted, harvesting pandan leaves with specifications of 4-6 cm width and 40-100 cm length has proven to be an optimal strategic choice for producing high-quality handicraft materials. These dimensions provide ideal material characteristics as they create a perfect balance between flexibility for weaving processes, structural strength for product durability, and ease of processing without reducing the aesthetic value of the final result. As a strategic alternative, pandan leaves with dimensions of 2-4 cm width and 40-100 cm length can also be considered as a second choice with high practical value.

This alternative specification offers its own advantages, particularly for handicraft applications requiring finer details and weaving with higher complexity levels. Leaves with narrower widths provide extra flexibility in forming complex weaving patterns, allowing craftsmen to create more intricate textures and designs. Although individual structural strength may be slightly reduced compared to wider dimensions, compensation can be achieved through tighter weaving techniques and using more strands, still resulting in sturdy and high-quality final products.

The harvesting process conducted selectively with strict criteria for leaf quality, proper timing in the morning when water content is optimal, and correct cutting techniques at 45-degree angles can achieve a yield rate of approximately 60-70% of available leaves with premium quality. Materials with these specifications have good fiber continuity along the 40-100 cm length, reducing the need for joints in the handicraft-making process, while the 4-6 cm width allows for consistent weaving patterns that are uniform and visually appealing.

Implementation of standardized harvesting processes based on these criteria not only improves production efficiency by reducing material waste but also provides significant economic added value through improved quality and durability of handicraft products. Therefore, the specification of pandan leaves with 4-6 cm width and 40-100 cm length can be established as a standard benchmark in the pandan leaf handicraft industry to achieve high-quality products that are competitive in the market.

Cleaning

Freshly harvested pandan leaves then undergo a cleaning stage which is a crucial process in preparing high-quality raw materials. The initial cleaning stage begins with thoroughly washing the entire leaf surface using running water, ensuring that every part of the leaf is evenly exposed to the water flow. This washing process aims to remove various contaminants such as dust, soil, pesticide residues, animal waste, and other particles that may adhere to the leaf surface during growth and harvesting. After thorough washing, the pandan leaves are then drained briefly to remove excess water while maintaining the natural moisture of the leaves.

The next step is conducting a very careful visual inspection of each leaf individually. This inspection is carried out by holding the leaf at its base and carefully observing the entire leaf surface from tip to base. At this stage, small thorns found along the leaf edges are removed using a sharp knife or scissors. These thorns, although small, can cause discomfort during processing and may affect the texture of the final product. The thorn removal process is performed with careful movements from base to tip to avoid damage to the leaf structure that could affect the quality of the resulting extract.

Besides removing thorns, this stage also involves cutting damaged, wilted, yellowing leaf tips, or those showing other signs of damage. These damaged parts may contain decomposing microorganisms or have reduced active compound content, so their removal is important for maintaining overall raw material quality. Cutting is done with sharp scissors, with proper cutting angles to prevent further damage to healthy leaf parts.

This cleaning process is important to carry out carefully and systematically because the cleanliness level and quality of pandan leaves at this stage will greatly affect the quality of the final product. Leaves that have undergone proper cleaning will have fresh green color, distinctive and strong aroma, and be free from contaminants that could interfere with subsequent extraction or processing.

Cutting

After passing through the cleaning stage, pandan leaves are then cut according to dimensional standards set by craftsmen, namely with widths ranging from 2-3 cm and lengths of 30-50 cm. The cutting process is carried out systematically using sharp knives or special cutting tools by splitting the leaves lengthwise following the direction of leaf fibers to obtain leaf strips with consistent width. At this stage, it must be ensured that each piece has uniform dimensions with minimal tolerance to maintain raw material quality and uniformity.

The leaf midrib or midrib which is the main vascular structure in the center of the leaf will be carefully removed because this part has a hard and rigid texture, making it unsuitable for weaving or handicraft processes that require material flexibility. Midrib removal is done by separating the soft leaf parts from the central bone structure using a knife or by manually tearing following the natural separation line between the leaf midrib and leaf blade. This cutting and separation process requires high precision to ensure that the resulting leaf strips have optimal quality, good flexibility, and sufficient strength for use in subsequent crafting processes.

Initial Treatment

The following is a comprehensive description of systematic analysis results of various initial treatments applied to each pandan leaf specimen to examine the influence of preparation methods on physicochemical characteristics, structural changes, and material drying kinetics. This analysis includes in-depth evaluation of nine specimens, each receiving different initial treatments, ranging from control specimens without special treatment to various preparation interventions such as washing, boiling, freezing, and soaking, followed by drying processes using natural sun-drying or controlled oven drying methods.

Each specimen was evaluated based on critical parameters including water content, texture and cellular structure changes, aromatic profile alterations, and efficiency and duration of drying processes, with the aim of understanding fundamental mechanisms of how initial treatments affect intrinsic properties of pandan leaves and optimization of subsequent processing.

- **Specimen I**

  Analysis results of specimen I pandan leaves that received no special treatment showed that water content in leaf tissue remained stable without significant changes. Visually, pandan leaves maintained natural green pigmentation well, showing optimal green color retention without significant chlorophyll degradation. This condition indicates that cellular structure and bioactive components of fresh pandan leaves are still well preserved under normal storage conditions.

- **Specimen II**
  Analysis results of specimen II pandan leaves that received initial treatment of thorough washing with clean water showed significant physicochemical characteristic changes compared to control. The washing process caused increased water content in leaf tissue through absorption and water imbibition mechanisms into intercellular spaces and cell vacuoles, resulting in leaf tissue swelling. This over-hydration condition directly impacted evaporation rates during sun-drying, where specimen II required longer drying duration compared to control specimens due to more water needing evaporation.
- **Specimen III**
  Comprehensive analysis of specimen III pandan leaves that received initial treatment of boiling in boiling water showed very striking structural and physiological transformations. The boiling process caused structural protein denaturation in cell walls and partial breakdown of lignin and cellulose components, resulting in leaf texture softening and increased mechanical flexibility of tissue. High water content in this specimen was caused by hot water penetration into previously protected cell spaces, but paradoxically, boiling also caused cell membrane damage and loss of structural integrity that facilitated more efficient water evaporation processes.
- **Specimen IV**
  In-depth evaluation results of specimen IV pandan leaves that underwent initial treatment of freezing at low temperatures showed complex cryogenic effects on cellular structure and water distribution in tissue. The freezing process caused ice crystal formation inside and outside cells, resulting in volume expansion and mechanical damage to cell membranes, cell walls, and intracellular organelles such as chloroplasts and vacuoles. When the specimen was thawed, water previously bound in cellular structure became free water that easily migrated to extracellular spaces, causing dramatic increases in total water content and non-homogeneous water distribution.
- **Specimen V**
  Comprehensive analysis results of specimen V pandan leaves that received initial treatment of soaking in water at room temperature for a certain period showed multidimensional changes encompassing physical, chemical, and organoleptic aspects. The soaking process caused gradual hydration of leaf tissue through osmosis and diffusion mechanisms, where water slowly penetrated the cuticle layer and entered intercellular spaces and vacuoles, resulting in significant water content increases compared to initial conditions.
  A very interesting phenomenon from this specimen was the occurrence of pandan leaf aroma characteristic changes, possibly caused by leaching or dissolution of volatile aromatic compounds such as 2-acetyl-1-pyrroline and other ester components into the soaking medium, or enzymatic hydrolysis that changed aromatic compound profiles from bound to free forms.
- **Specimen VI**

Detailed evaluation of specimen VI pandan leaves that underwent initial treatment of thorough washing before being processed with oven drying showed complexity of interactions between initial hydration conditions and drying methods used. The washing process caused water saturation in leaf tissue through water penetration into porous cell wall structures and apoplastic spaces, resulting in substantially increased total water content compared to natural fresh leaf conditions.

- **Specimen VII**
  In-depth analysis results of specimen VII pandan leaves that received initial treatment of boiling in boiling water before being processed with oven drying showed unique and contradictory drying kinetics phenomena compared to general expectations. The boiling process caused extensive denaturation of structural proteins and breakdown of lignin-cellulose complexes, resulting in drastic leaf texture softening and increased tissue porosity. Despite significantly increased total water content, structural transformations created more efficient pathways for water mass transfer from interior to leaf surface.
- **Specimen VIII**
  Comprehensive evaluation of specimen VIII pandan leaves that underwent initial treatment of freezing at cryogenic temperatures before oven drying revealed complexity of structural damage that significantly impacted drying kinetics. The freeze-thaw cycle caused massive mechanical damage to plasma membranes, tonoplast, chloroplast membranes, and cell wall architecture disruption through ice crystal volumetric expansion.
- **Specimen IX**
  Comprehensive analysis results of specimen IX pandan leaves that received initial treatment of soaking in water medium at ambient temperature before being processed with oven drying showed multifaceted changes encompassing hydration, biochemical transformation, and sensory alteration aspects. Prolonged soaking caused gradual leaf tissue saturation through osmotic uptake and hydraulic infiltration mechanisms, where water slowly penetrated cuticle barriers and filled apoplastic and symplastic spaces, resulting in substantial water content increases.

Drying

The following are the results of drying process analysis for each specimen:

Natural room temperature drying

Natural drying method at room temperature showed the longest drying time compared to other specimens. The resulting pandan leaves maintained dominant green color with slight color changes to brownish. The final texture obtained was rigid and less flexible, showing that slow drying processes caused hardening of leaf fiber structure.

Sun drying

The following are the results of pandan leaf drying analysis with sun-drying process:

- Specimen II: Initial treatment of washing before sun-drying resulted in 3-6 days drying time. Pandan leaves experienced even light brown color changes. Physical characteristics showed optimal balance between flexibility and strength, indicating that washing helped remove components that could inhibit even drying processes.
- Specimen III: Combination of boiling and sun-drying provided good drying time efficiency with shorter duration than specimen II. The final color produced was brownish with

homogeneous distribution. Leaf texture showed good flexible properties with increased tear resistance.

- Specimen IV: Freezing method before sun-drying required 3-6 days drying time with final brownish color results. The special characteristic of this specimen was remaining water content within leaf structure, showing that freezing could damage cell walls so water became trapped in intercellular spaces.
- Specimen V: Soaking treatment showed relatively similar drying time to specimen IV (3-6 days). Despite similar final color to specimen IV, the resulting flexibility was better than frozen leaves.

Oven drying

The following are the results of pandan leaf drying using oven as drying equipment:

- Specimen VI: Oven drying method showed highest time efficiency with duration of only 5-30 minutes. Pandan leaves produced brownish color with very minimal water content. However, rapid drying at high temperatures caused leaves to become brittle and easily torn.
- Specimen VII: Combination of boiling and oven drying produced faster drying time compared to conventional sun-drying methods. However, combination of two heat treatments caused excessive degradation of fiber structure, resulting in very brittle and easily torn texture.
- Specimen VIII: Freezing method followed by oven drying required 5-30 minutes with color results varying between brown and light brown. This color variation indicated uneven heat distribution due to cell structure damage from freezing.
- Specimen IX: Soaking treatment followed by oven drying required 5-30 minutes producing more homogeneous light brown color compared to specimen VIII.

Testing results on specimens VI through IX showed that oven drying method with 5-30 minute time range could produce significant physical transformation of pandan leaves. Further analysis revealed that 20-minute drying process produced optimal conditions equivalent to dryness levels obtained through conventional sun-drying methods.

Coloring

Color exploration

- Turmeric Extraction: Ground turmeric with water addition as solvent produced bright yellow solution, showing successful extraction of curcumin compounds which are main pigments in turmeric. Using lime water as solvent showed interesting color change to yellowish-red, indicating chemical reaction between curcumin and alkaline conditions.
- Suji Leaf Extraction: Ground suji leaves with water addition as solvent produced natural green solution reflecting chlorophyll content in leaf tissue. Using lime water as solvent showed color intensity increase to deep green due to alkaline conditions facilitating chlorophyll molecule stabilization.
- Teak Leaf Extraction: Using water as solvent on ground teak leaves produced reddish-brown solution with moderate intensity. Significant change occurred when using lime water as solvent, where the resulting solution showed deep brown color with higher intensity, indicating that alkaline conditions could optimize tannin and anthocyanin compound extraction.

Color application on material

Following comprehensive exploration of color application on pandan leaf material through systematic experiments, the research successfully identified pandan leaf fiber color absorption characteristics, color fastness under various environmental conditions, and material compatibility with various natural and synthetic dyes.

Soaking Process Results: The 24-hour soaking process in natural dye solutions showed optimal results for color penetration into pandan leaf fibers. Three response categories emerged:

- Total resistance to coloring: Specimens VI-IX showed complete resistance to all tested dyes
- Partial absorption with non-homogeneous distribution: Specimens I-V showed absorption capability but with uneven distribution patterns
- Optimal absorption with homogeneous distribution: Specimens I-V showed very positive responses to certain dyes with even absorption

Boiling Process Results: The 15-25 minute boiling process to extract natural dye essence showed two consistent response patterns:

- Non-homogeneous distribution absorption: All specimens showed uneven absorption patterns with certain dyes
- Optimal distribution absorption: All specimens showed even and consistent absorption capability with specific dyes

The research concluded that drying method significantly influences color absorption capability in pandan leaves. Naturally sun-dried specimens showed ability to absorb various natural dyes, while oven-dried specimens showed no color absorption capability whatsoever, indicating that artificial heat in drying processes can damage leaf pore structures required for pigment absorption processes [15].

CONCLUSION

This research was conducted to produce potential quality materials for handicrafts, thus an exploration process of pandan leaf material was carried out using experimental material methods. Through a series of systematic and comprehensive experimental stages ranging from harvesting, cleaning, cutting, initial treatment, drying, to coloring, results were obtained in the form of conclusions that provide deep understanding regarding the characteristics and development potential of pandan leaves as potential material for handicrafts.

Based on the research results and discussions conducted regarding the exploration of pandan leaf characteristics for the development of potential handicraft materials, several conclusions can be drawn as follows:

1. Optimal Harvesting Specifications

   The harvesting of pandan leaves with optimal specifications has been successfully identified through systematic analysis of material dimension variations. Pandan leaves with a width of 4-6 cm and length of 40-100 cm proved to be the best specifications for high-quality handicraft material production. These dimensions produce optimal balance between flexibility for the weaving process, structural strength for product durability, and ease in processing without reducing the aesthetic value of the final result. As a strategic alternative, pandan leaves with dimensions of 2-4 cm width and 40-100 cm length can be considered for handicraft applications that require finer details and higher levels of weaving complexity.
2. Material Characteristics for Traditional Handicrafts

The optimal pandan leaf material characteristics for traditional handicrafts have specific dimensional specifications, namely 2-3 cm width and 30-50 cm length, with ideal leaf age ranging between 4-5 months. At this age, pandan leaves have optimal flexibility levels, adequate fiber strength, and smooth texture that produces aesthetic handicraft surfaces. Selection of materials with these characteristics has proven to provide optimal balance between processing ease, structural strength, and visual quality of the final product.

3. Initial Treatment Evaluation

   Evaluation of nine specimens with different initial treatments revealed that preparation methods have substantial influence on physicochemical characteristics and drying kinetics of the material. Specimen III, which received initial treatment in the form of boiling followed by sun-drying, showed the best results with optimal balance between drying time efficiency, final color quality, and material structural integrity. This combination produces material with good flexible characteristics, increased tear resistance, and homogeneous color distribution.

   Comparison of drying methods shows that natural sun-drying provides superior results compared to oven drying in the context of handicraft applications. Although oven drying shows high time efficiency with a 20-minute duration equivalent to conventional sun-drying results, this method produces brittle and easily torn material. Conversely, natural drying through sun-drying produces material with optimal flexibility and structural strength for handicraft applications.

4. Natural Coloring Exploration

   Coloring exploration using natural materials shows promising potential for developing aesthetic variations of the material. Pigment extraction from turmeric, suji leaves, and teak leaves using lime water as a solvent produces superior color intensity compared to regular water. The alkaline conditions produced by lime water proved effective in optimizing bioactive compound extraction and increasing pigment stability.

5. Color Application Results

   Color application on pandan leaf material shows varying results depending on the drying method and type of dye used. Naturally dried material shows good color absorption capability, while oven-dried material experiences total resistance to coloring. Certain dyes show optimal compatibility with pandan leaf fiber structure, producing homogeneous and consistent color distribution.

Overall, this research successfully identified key parameters in processing pandan leaves into high-quality handicraft materials, from the harvesting stage to finishing. The optimal treatment combination includes harvesting leaves with dimensions of 4-6 cm × 40-100 cm, initial treatment in the form of boiling, drying through natural sun-drying, and coloring using natural extracts with lime water solvent.

REFERENCES

[1] Wirtu, Y. D. (2024, Oct.). "A review of environmental and health effects of synthetic cosmetics". *Frontiers in Environmental Science* [Online]. vol.12, p. 1402893. Available at https://doi.org/10.3389/fenvs.2024.1402893

[2] Duarte, P., Silva, S. C., Roza, A. S., & Dias, J. C. (2024). Enhancing consumer purchase intentions for sustainable packaging products: An in-depth analysis of key determinants and strategic insights. *Sustainable Futures*, vol.7, p.100193. Available at https://www.sciencedirect.com/science/article/pii/S2666188824000431

[3] S. Nugroho, P. Widiastuti, and T. Handoko, "Pelestarian kearifan lokal melalui kerajinan material alami," *Jurnal Budaya dan Tradisi*, vol. 9, no. 1, pp. 45-58, 2022.

[4] D. Lestari and H. Prabowo, "Tren pasar kerajinan material alami di Indonesia: Analisis pertumbuhan 2019-2024," *Jurnal Ekonomi Kreatif*, vol. 10, no. 1, pp. 34-47, 2024.

[5] D. A. Kusuma and R. Andayani, "Anatomi akar tunjang dan adaptasi struktural Pandanus pada lingkungan ekstrem," *Anatomi Tumbuhan*, vol. 11, no. 2, pp. 134-147, 2022.

[6] D. Marini, E. Kusumawati, and A. Wibowo, "Studi taksonomi dan morfologi Pandanus tectorius di wilayah kepulauan Indonesia," *Jurnal Botani Tropika*, vol. 13, no. 4, pp. 201-215, 2023.

[7] R. Agustina and D. Firmansyah, "Karakteristik morfologi dan pemanfaatan Pandanus tectorius untuk kerajinan tradisional," *Jurnal Biologi Tropika*, vol. 12, no. 3, pp. 45-58, 2024.

[8] S. Dewi and B. Suryanto, "Analisis sifat fisik dan mekanik serat daun pandan untuk aplikasi kerajinan," *Jurnal Material Alami*, vol. 6, no. 1, pp. 23-35, 2024.

[9] N. Fitriani and M. Rahayu, "Perbandingan kekuatan tarik serat alami dari berbagai spesies Pandanus," *Jurnal Teknologi Material*, vol. 15, no. 4, pp. 78-89, 2023.

[10] S. Margareta and R. Simbolon, "Inovasi pengolahan daun pandan: Studi komparasi dengan negara ASEAN," *Jurnal Industri Kreatif*, vol. 7, no. 3, pp. 123-136, 2022.

[11] R. Nastiti, "Pendekatan eksperimental dalam eksplorasi material tradisional untuk desain kontemporer," *Jurnal Desain Indonesia*, vol. 8, no. 3, pp. 78-92, 2023.

[12] Berger, P.D., Maurer, R.E., Celli, G.B. *Experimental design* (pp. 449-480). Cham: Springer International Publishing, 2018.

[13] Aristizábal-Alzate, C. E., Castillejos-López, E., Dongil, A. B., & Romero-Sáez, M. (2025). Integration of design of experiments, analysis of variance and response surface methodology in assessing heterogeneous catalysts processes: A minireview. *ChemistryOpen* [Online], vol.14, no.1, p. e202400148. Available at https://chemistry-europe.onlinelibrary.wiley.com/doi/full/10.1002/open.202400148

[14] Rattanamato, B., Kanha, N., Thongchai, P., Rakariyatham, K., Klangpetch, W., Osiriphun, S., Laokuldilok, T. (2025, April). “Upcycling scented pandan leaf waste into high-value cellulose nanocrystals via ultrasound-assisted extraction for edible film reinforcement”. *Foods* [Online], vol.14, no. 9, p. 1528. Available at https://doi.org/10.3390/foods14091528

[15] Khaled, B. M., Das, A. K., Alam, S. S., Saqib, N., Rana, M. S., Sweet, S. R., ... Yesmin, A. (2024, Dec.). “Effect of different drying techniques on the physicochemical and nutritional properties of Moringa oleifera leaves powder and their application in bakery product”. *Applied Food Research* [Online]. vol.4, no.2, p. 100599. Available at https://www.sciencedirect.com/science/article/pii/S2772502224002099