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(IJIREV)**www.gaexcellence.com/ijirev**DESIGN-LED ENHANCEMENT OF NIPA PALM MIDRIB
STICKS FOR SUSTAINABLE CRAFT APPLICATIONS: AN
EXPERIMENTAL STUDY OF DYEING AND BLEACHING
TREATMENTS**Asrol Hasan^{1*}, Nur Irdina Alya Mohd Hasnor²¹Department of Industrial Design, Faculty of Art and Design, Universiti Teknologi MARA (UiTM) Cawangan Kedah, Merbok, Malaysia asrol726@uitm.edu.my <https://orcid.org/0009-0000-4756-7766>²Department of Industrial Design, Faculty of Art and Design, Universiti Teknologi MARA (UiTM) Cawangan Kedah, Merbok, Malaysia 2026318199@student.uitm.edu.my <https://orcid.org/0009-0008-0471-5851>

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Abstract:

Nipa palm midrib sticks are still an under-used lignocellulosic material in the production of crafts and there is little evidence on how they respond to simple surface and colour treatments. This practice-based comparative experiment investigated the influence of surface preparation, treatment type, and exposure time on visible colour development and apparent material integrity. Scraped and unscraped sticks were treated with synthetic dyes, turmeric, commercial food colourants, peroxide-based hair-bleaching products, and household hypochlorite. Photographic records and descriptive notes were used to compare colour depth, uniformity, surface coverage, penetration and visible fibre deterioration. Since there are no replicated colour measurements, and no mechanical tests to test the effectiveness of the plastic, the results are primarily based on visual observations. So, the appearance of integrity is only related to the condition of the material and not to strength. Scraping generally enhanced colour uptake and produced a more even appearance. Longer dyeing times increased the colour intensity. In comparison, turmeric seemed to have the most apparent golden yellow colour on scraped sticks after 60 minutes. Peroxide-based products clearly brightened the material but there was no clear correlation between the concentration and the degree of brightening. Under hypochlorite, fibre separation and deterioration occurred. These findings suggest that carefully prepared, low-tech surface preparation and colouring can broaden the visual quality of nipa palm midrib sticks while aggressive bleaching may impair their visual

quality. This easy-to-use, design-driven approach could encourage material innovation in the creative local economy, but further mechanical, performance and safety testing is needed.

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Keyword:

Creative Economy, Material Driven Design, Nipa Palm Midrib Sticks, Surface Treatment, Sustainable Craft



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Introduction

Nipa palm (*Nypa fruticans*) is a mangrove-associated palm found in tropical coastal regions. Nipa palm products can be used for fuel, food, handicrafts, household, thatching and roofing purposes. Therefore, the palm has implications for resource diversification and livelihoods in nipa-producing regions (Cheablam & Chanklap, 2020). Nipa plant materials have been found to be lignocellulosic. This means that they possess some of the same physical properties as other plant materials used in textiles and other products (Tamunaidu & Saka, 2011). Not all sections of the plant are used equitably. Midrib sticks are relatively easy to collect, are flexible for weaving, bundling and ornate construction but are frequently classified as secondary products even though they are not heavy, possess a linear shape and are relatively lightweight.

Biomass from agriculture or the coast is not always readily available for another application. Rather, consideration should be made toward the ability of a material to be perceived, manipulated, distinguished, and utilized in design without losing the knowledge associated with that material in the specific landscape. For example, in Thailand work on nipa-based craft has shown that community use includes not only transformation of the material, but also connected processes of extraction, transformation, trade, and innovation (Chanklap et al., 2025). In Malaysia, also, craft innovation has been situated as a means of intangible cultural heritage preservation where new designs incorporate visible knowledge and practices while also addressing contemporary design needs (Ariffin et al., 2023). Material exploration can thus be an initial step within a broader social process of craft revitalization.

Nipa palm midrib sticks are untreated and pose many practical challenges to craft and product development. Their natural surface is pale, but different tones and textures are common. An intact outer layer may also limit the colour absorption and make it hard for makers to achieve a wider colour range or a consistent colour over a batch. A methodical preparation of the surface and colour treatment can be a simple, low-tech way of altering the colour of the material. But

visual improvement isn't enough. A treatment that produces a darker or brighter colour may have limited practical value if it causes the fibres to weaken, split, or separate.

Previous research has studied the ecological and livelihood benefits to nipa palm, chemical composition of nipa palm, and their potential to be used in such engineered materials as fibre composites and particleboard (Cheablam & Chanklap, 2020; Hasan et al., 2022; Mohd Ghani et al., 2024; Tamunaidu & Saka, 2011). However, little is known about how intact nipa palm midrib sticks respond to manual scraping, colourants, and treatment durations when ready for small-scale craft applications. Plant-fibre dyeing and surface treatments are helpful sources of background; however, most studies are based on textile fibres or composite reinforcement rather than entire midrib sticks (de Queiroz et al., 2020; Sahu et al., 2023). Therefore, manufacturers have been left with limited information on how to select simple treatments to give visible colour without damaging the fibre.

The study revisits findings from an undergraduate industrial design thesis and puts them in the context of culture and design. Instead of changing colour as an outcome, the material trials are considered as part of a wider process of design-led valorisation. The study addresses the following question: How do manual surface preparation, dyeing duration, dye category, and bleaching exposure affect the visible qualities and apparent integrity of nipa palm midrib sticks, and what are the implications of these changes for sustainable craft development? Thus, the study compares treated and untreated samples, establishes treatment conditions which may be helpful or harmful and translates the findings into a cautious decision framework for further craft experimentation. Its contribution is to provide a low-tech and design-led comparative account and a preliminary framework for improving the material's visual quality. The results establish material directions and ideas for further testing rather than making statements about statistically verified performance.

Literature Review

Nipa Palm As An Underutilised Community Resource

Using nipa palm is an example of how a plant that is available locally can generate social and economic value. Cheablam and Chanklap (2020) provide a detailed description of its food and non-food applications and indicate that sustainable use should be based on nature and environment and community practices. More recent supply chain mapping has revealed that nipa products are passed through various collectors, processors, makers, traders, and consumers. This suggests that the value of the material is not only determined by the technology of production but also by the social relations of its production and use (Chanklap et al., 2025). While these studies do not provide a clear picture of a market for dyed nipa midrib sticks, they do suggest that the plant's underused parts can be exploited as a source of diversity for community-based products.

A scientific basis for this research is provided by Tamunaidu and Saka (2011) who found cellulose, hemicellulose and lignin in different parts of the nipa palm. This lignocellulosic composition might help to explain the material's response to scraping, moisture, heat and colourants and to harsh chemical treatments. Chemical composition alone does not tell you if a material is suitable for craft applications, but geometry, texture, colour, flexibility, joining potential and meanings developed through the act of making are also important considerations for designers.

New research continues to bring this discussion beyond individual products to a more ecosystem-sensitive approach to value creation. Rahman et al. (2024) found that land uses associated with Nypa provide provisioning, regulating and cultural ecosystem services. New material applications should not be developed in isolation from mangrove functions or local livelihood systems, he said. At the product level, Mohd Ghani et al. (2024) found that the underused nipah fronds can also be converted into clean particleboard, indicating that nipa biomass can have more valuable applications than we think of as household use. Particleboard production is technically different from using midrib sticks in craft products. Nevertheless, the study underlines the need to systematically characterise the missing parts of the nipa palm before introducing them to product development.

Sustainable Craft Innovation And Cultural Continuity

Craft innovation is more meaningful when new ideas are linked to cultural continuity. Ariffin et al. (2023) show that innovation in Malaysian handicrafts can contribute to the preservation of intangible cultural heritage when designers and manufacturers purposefully adapt materials, motifs, techniques, and product functions. This must go beyond the use of heritage elements as surface decoration. This is especially true for nipa palm materials. The option of extending the colour range may open new markets for contemporary craft products, but the intervention has social value only if local makers adopt and adapt the process. The method also needs to be safe, affordable, and build on rather than replace existing craft knowledge.

Small craft businesses operate in entrepreneurial ecosystems that are determined by skills, professional networks, institutional support, market access, and opportunities for continuous learning. Malaysian handicraft micro and small businesses were studied in detail, and these resources were found to affect both entrepreneurial activity and business resilience (Hussein et al., 2021). In this study we did not assess enterprise performance, market demand, or consumer preferences. Still, material diversification can be seen as a beneficial capability in this wider ecosystem. A wider variety of finishes would allow artisans, young professionals, and micro-enterprises to design and test new product prototypes.

Culture-sustainable innovation also requires that material culture, maker identity, and economic continuity are connected. Craft-based production, Brown and Vacca (2022) suggest, can contribute to sustainable development if cultural knowledge is used for design as a resource and not as a passive monument to heritage. Similarly, Walker et al. (2022) consider that decisions in craft enterprises should have to be made on local support opportunities, core values, sustainability principles, and clearly defined design possibilities. Liu et al. (2024) further observe that contemporary handicraft research is establishing design as a link between heritage preservation, product innovation, and sustainable development. Collectively, these studies suggest that a wider colour palette for nipa palm midrib sticks is a useful and culturally relevant option, provided that the treatment procedure is accessible for makers, is meaningful in their local context, and can be related to maker-led product development.

Material Driven Design and The Experience Of Plant Fibres

Material driven design starts with an exploration of a material's technical and experiential features. The process is carried out through material characterisation, meaning making, vision development, and product design (Karana et al., 2015). This approach is especially relevant for natural materials that are not well-characterised yet because it doesn't depend on an industrial specification or product specification for the material. Instead, making systematic ways helps designers to gain a first sense of the potential and limitation of the material. For nipa palm midrib sticks, colors are more than a theory and the midrib sticks are more than a piece of fabric. Together, they affect how the material may be perceived in terms of warmth, naturalness, refinement, and suitability for different craft narratives.

Research on other plant fibres gives a good technical basis for surface preparation. Cottonisation and related processes can enhance processability and dyeing behaviour of pineapple leaf fibres by changing their surfaces and making the fibres more accessible to colourants (de Queiroz et al., 2020). Rattan studies have also shown that surface treatments affect morphology, water absorption and mechanical behaviour, yet the type and intensity of treatment are different (Sahu et al., 2023). These results enable us to study manual scraping as a low-tech pretreatment for nipa palm midrib sticks. At the same time, it should be noted that the better surface appearance does not necessarily mean better mechanical performance.

Nypa fruticans engineering research also underscores the need to control such treatments. Hasan et al. (2022) found that chemical treatment altered the behaviour of *Nypa fruticans* fibres during composite processing. They found that surface modification may enhance some material interactions but affect others as well. From a design perspective, scraping, dyeing and bleaching should be considered as material interventions that should be evaluated for performance improvement as opposed to purely aesthetic finishing. Ferreira et al. (2023) also contend that biomaterial selection should consider technical performance, biodegradability, material flows, lifecycle impacts, and the designer's material knowledge. The colour response of nipa palm midrib sticks should therefore be assessed alongside fibre integrity, treatment safety, durability, and potentially end-of-life outcomes.

Colour Systems, Sustainability, And Performance Caution

Natural colourants have been more of a topic of interest recently because of concern about the environmental effects of synthetic dye production and discharge (Lellis et al., 2019; Yusuf et al., 2017). Turmeric is a popular plant-based source of yellow colour, and controlled textile studies have shown that its colouring can be improved by careful process design and biomordants (Rahman et al., 2023). Natural dye extracts have been applied to pineapple leaf fibres, with the choice of mordant being important for colour as well as fastness (Nitayaphat & Jintakosol, 2024). This research is a good basis for the incorporation of turmeric in nipa palm midrib sticks.

There are two clarifications to make when interpreting the treatments used in this study. The red, green, and yellow liquids in part of the original thesis protocol were commercial food colourants. They are not natural dyes and should not be considered as natural dyes just because they are for food products. Second, the origin of a colourant does not automatically mean it has low environmental impact, good colour fastness, or product safety. Colour stability depends on the substrate, extraction method, mordant, pH, temperature, treatment duration, light exposure, washing, and rubbing (Harsito et al., 2021; Yusuf et al., 2017). The present study thus uses

visual observations to suggest future directions for further research. In this respect the treatments make no claims of standardised durability, safety, or environmental superiority.

We believe that the literature reviewed here offers valuable knowledge regarding nipa resource systems, chemical structure, application of engineered materials, craft sustainability and treatment of other plant fibres in general. However, there is limited evidence of the extent to which intact nipa palm midrib sticks are affected by scraping with different colourants, different lengths of bleaching and on how long to prepare them for craft application. None of these studies consider visible colour development, surface uniformity, and visible fibre deterioration in combination with design-led treatment for this material. In this study we address this material-application gap by providing a comparative study comparing the positive and negative results of treatment and the results provided by this study can be used as a starting point to design and product development.

Methodology

Research Design

The study adopted a practice-based comparative material-experiment design in industrial design. The treatment categories and exposure duration were laid out as a structured experimental matrix, but the study was qualitative and did not aim to gain statistically valid results. Nipa palm midrib sticks from Kedah were prepared in two situations: manually scraped and unscraped, and the original outer surface was left. The source records did not specify a probabilistic sampling method, formal grading by size, random assignment, or the number of independent replicates. The material was treated as a non-probability exploration sample, not a statistically reproduced experimental sample.

The unit of analysis was the visible condition of the material after each treatment combination. Comparisons were made between photographic groups according to their surface condition, treatment type, stick segment and exposure duration. The researchers looked at the photographs and recorded descriptive notes to determine visible colour depth, uniformity of the surface, visible internal penetration, and signs of fibre damage. No independent number of replicate counts, standard lighting conditions, instrumental colour measurements, or statistics were performed, and no averaging or inference was made. Therefore, the observations are not average nor inferences made. Descriptions such as darker, brighter, more uniform, and damaged refer only to visual differences observed in the trials and should not be taken as measurements. Table 1 and Figures 1-4 show the experimental matrix and treatment procedures.

Experimental protocols

The synthetic-dye series tested the six Dylon colours on both scraped and unscraped nipa palm midrib sticks. The samples were boiled in dye baths for 20, 40 or 60 min. After boiling, they were left to cool in their respective baths for about 5 hours before being drained and air-dried. Table 1 shows the amount of salt used in each treatment. Since this information could not be reliably reconstructed, it is a methodological limitation.

The second series was to investigate turmeric along with red, green, and yellow commercial food colourants. Scraped and unscraped sticks were treated with the same 20-, 40-, and 60-

minute duration. The quantities prepared for each treatment bath are also reported in Table 1. Turmeric and the commercial food colourants were classified separately because products intended for food use cannot automatically be assumed to be natural dyes.

Table 1: Experimental Treatment Matrix

Series	Materials and levels	Process	Comparison
Synthetic dye	Six Dylon colours; scraped and unscraped sticks	1,000 mL water; dye and salt added (salt quantity not reported); boiled for 20, 40, or 60 min; cooled for 5 h; drained and dried	Surface preparation, colour category, and duration
Turmeric	Five teaspoons turmeric powder per 1,000 mL water; scraped and unscraped sticks	Heated and immersed for 20, 40, or 60 min; drained and dried	Surface preparation and duration
Commercial food colourants	Red, green, and yellow colourants; 25 mL per 1,000 mL water; scraped and unscraped sticks	Heated and immersed for 20, 40, or 60 min; drained and dried	Surface preparation, colour category, and duration
Peroxide-based hair-bleaching formulation	Commercial formulations labelled 3%, 6%, 9%, and 12%, prepared as separate treatment conditions	Applied separately and documented over exposure periods of up to 10 h	Concentration and exposure time
Household hypochlorite	A commercial sodium-hypochlorite household product, tested separately from peroxide	Visual documentation over exposure periods of up to 10 h	Brightening and visible fibre deterioration

The brightening experiment was carried out on commercial peroxide-based hair-bleaching formulations labelled 3%, 6%, 9%, and 12%. The different treatment conditions in the treated sticks were observed for periods longer than 10 hours. A household product containing sodium hypochlorite was examined in a different treatment series and was not mixed with any of the peroxide-based formulations. The two series were set up in such a way that each treatment is safe and not mixing household bleaching chemicals with other chemical products can cause hazardous reactions. The article refers only to the specific treatment conditions described in the thesis and does not call for any unsupervised chemical processing.



Figure 1: Experimental Procedure Using Synthetic Dye

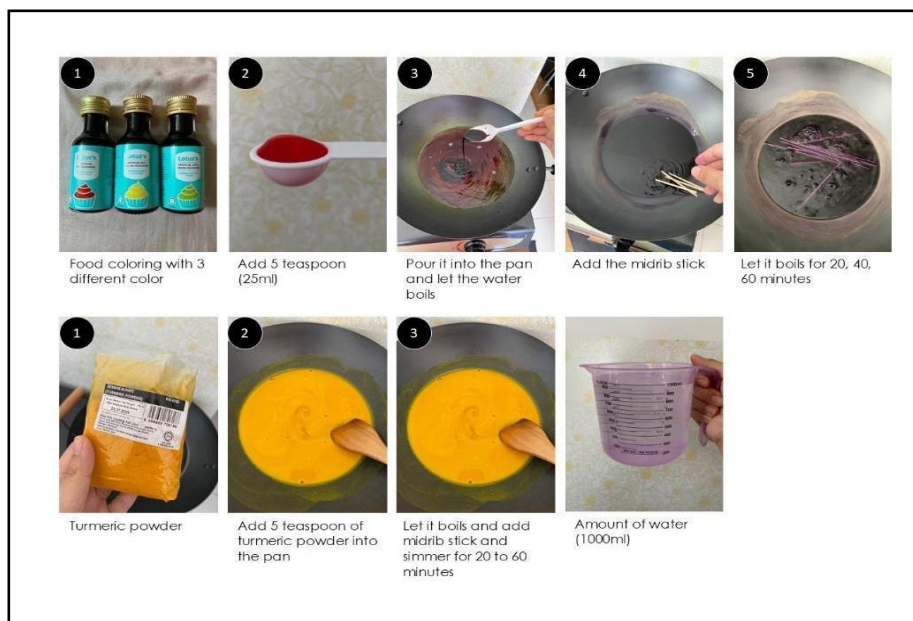


Figure 2: Experimental Procedure Using Turmeric And Commercial Food Colourants



Figure 3: Preparation Of Peroxide-Based Hair-Bleaching Formulations

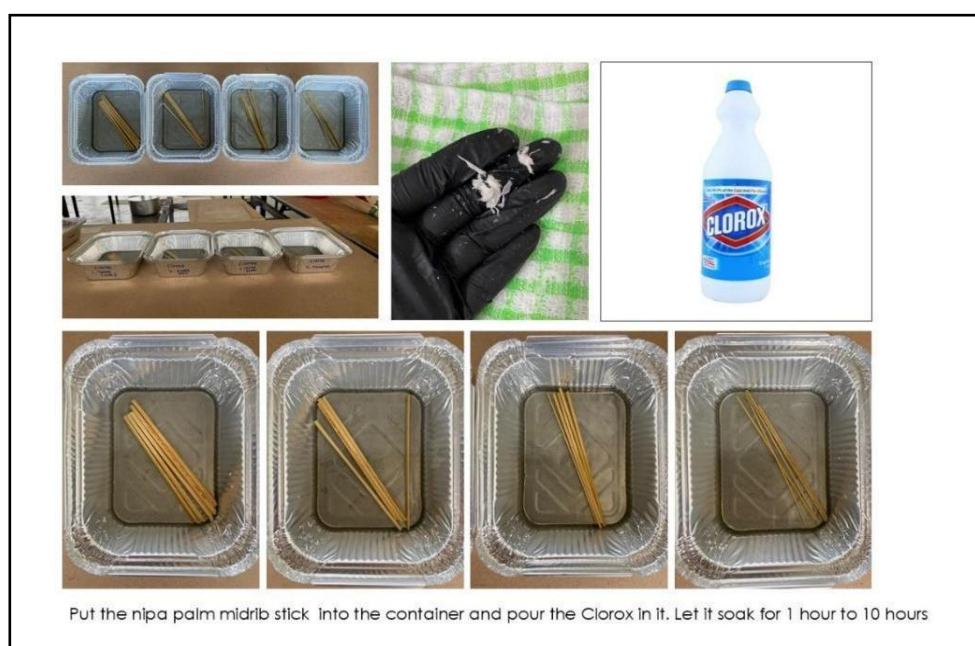


Figure 4: Experimental Procedure Using Household Sodium Hypochlorite

Analytical procedure

The analysis was conducted through detailed comparisons in each treatment series. The photographs were classified as being scraped or intact, treatment type, stick segment, and exposure duration. Then, they were compared to find common visual patterns. The comparison was based on the colour quality of the external surface over time, colour uniformity of the scraped and intact surfaces, colouring of the inner surface of the sticks, evidence of brightening after oxidising, and the separation of the fibres after exposure to hypochlorite. No numerical ratings, mean values, or statistical significance tests were used. The patterns were interpreted

as craft-design implications only when they were directly supported by the available photographs and descriptive records.

Ethical and safety considerations

The study was conducted with plant-material specimens and did not involve human or animal subjects. Human or animal research ethics approval was not necessary to do so. The chemical treatments reported here are only records of the original study and should not be considered instructions for using them at home. All future replications should be done under proper supervision and use of appropriate personal protective equipment, ventilation, clearly labelled containers, separate treatment baths, reference to manufacturers' safety information and controlled handling and disposal of chemical waste.

Results

Three of the findings from the treatment matrix were especially relevant for craft applications. Manual scraping increased the colour uptake, and it appeared even in colour, while longer dyeing times generally increased the colour intensity on the outer surface of the sticks. In contrast, exposure to household hypochlorite caused visible fibre damage. Table 2 summarizes the results and limitations of the available evidence.

Table 2: Summary Of Observations And Craft Implications

Treatment factor	Observed pattern	Craft implication	Evidence limit
Manual scraping	Stronger and even external colour in most documented comparisons	A low-technology preparation step can broaden colour options	Scraping force and removed thickness were not standardised
Longer dyeing	External colour generally deepened from 20 to 60 min	Duration can be adjusted for visible shade development	No instrumental colour or fastness values
Peroxide-based hair bleaching	Visible brightening, but no clear concentration-dependent effect under the tested conditions	Potential pre-lightening route requiring controlled optimisation	No instrumental colour measurement or optimum concentration established
Prolonged hypochlorite	Brightening accompanied by fibre separation and deterioration	Avoid prioritising whiteness over apparent fibre integrity	No mechanical-strength testing

Synthetic-Dye Response

Each of the synthetic dyes produced colour on the outer surface of the nipa palm midrib sticks. The scraped samples generally appeared darker and more evenly coloured than the original surface. Colour development was already visible after 20 minutes, and usually more noticeable after 40 and 60 minutes. In many of the reported comparisons, the 60-minute treatment produced the deepest external shade.

But the colour did not penetrate fully into the material. The underside and inner part of some sticks remained lighter than the exposed surface, so the treatment mainly affected those areas closest to the dye bath. Table 2 summarizes the main observations and Figures 5–8 show the differences associated with treatment duration, dye colour, and surface condition.

Experiment Procedure using Synthetic Dye product
Scraped

Midrib stick parts	Before	After 20 minutes	After 40 minutes	After 60 minutes	Facts
End					The midrib sticks of the nipa palm are boiled with Dylan blue color for 20 minutes, which fully colors the outside of the sticks. Even after scraping off the outer layer to improve dye absorption, the inside of the sticks remains uncolored. Extending the boiling time to 40 and 60 minutes also does not color the inside, suggesting that the outer surface absorbs the dye, but the interior resists color penetration. 
Second part					
Third part					
Base					

Figure 5: Colour Development In Scraped Midrib Sticks Across Synthetic-Dyeing Durations

Experiment Procedure using Synthetic Dye product
Scraped

Midrib stick parts	Before	After being dye with red Dylan	After being dye with yellow Dylan	After being dye with orange Dylan	After being dye with purple Dylan	After being dye with blue Dylan	After being dye with green Dylan
End							

Figure 6: Colour Variation In Scraped Midrib Sticks Treated With Six Synthetic Dyes

Experiment Procedure using Synthetic Dye product					Unscraped
Midrib stick parts	Before	After 20 minutes	After 40 minutes	After 60 minutes	Facts
End					The untreated midrib sticks of the nipa palm are boiled with Dylon blue dye for 20 minutes, fully coloring the outer surface of the sticks. However, the interior remains uncolored, even when the boiling time is extended to 40 or 60 minutes. This suggests that the dye is absorbed by the outer layer, while the interior resists color penetration. 
Second part					
Third part					
Base					

Figure 7: Colour Development In Unscraped Midrib Sticks Across Synthetic-Dyeing Durations

Experiment Procedure using Synthetic Dye product						Untreated	
Midrib stick parts	Before	After being dye with red Dylon	After being dye with yellow Dylon	After being dye with orange Dylon	After being dye with purple Dylon	After being dye with blue Dylon	After being dye with green Dylon
End							

Unscraped

Figure 8: Colour Variation In Unscraped Midrib Sticks Treated With Six Synthetic Dyes

Different colour levels were observed in individual stick segments, indicating that the density and surface condition or geometry of the sticks might have influenced colour uptake. This variation has practical implications for craft production. To make a visually consistent batch, the sticks must be sorted before treatment and scraped with the same pressure and placed within the dye bath. The colour fastness was not measured, so it is still not known whether the deeper shades would withstand light, rubbing, moisture, or washing.

Turmeric And Commercial Food-Colourant Response

Turmeric produced a golden-yellow surface, and the most pronounced visual result was recorded on scraped sticks after 60 minutes. Unscraped turmeric-treated samples were lighter and less even. The contrast underlines the role of manual surface opening and exposure time in visible uptake. Commercial red, green and yellow food colourants also coloured the external surface and scraped samples appeared to be richer and more consistent than their unscraped counterparts. These outcomes are visually versatile, but the food colourant results are not evidence for natural dyeing. Figures 9 and 10 compare the turmeric and commercial food-colourant responses, respectively.

Experiment Procedure
Turmeric Powder**Scraped**

Midrib stick parts	Before	After 20 minutes	After 40 minutes	After 60 minutes	Facts
End					The longer the midrib sticks of the nipa palm are boiled with turmeric powder, the darker their color becomes. The
Second part					

Experiment Procedure
Turmeric Powder**Unscraped**

Midrib stick parts	Before	After 20 minutes	After 40 minutes	After 60 minutes	Facts
End					The longer the untreated midrib sticks of the nipa palm are boiled with turmeric powder, the lighter their outer color
Second part					

Figure 9: Turmeric Response Of Scraped And Unscraped Midrib Sticks Across Dyeing Durations



Figure 10: Commercial Food-Colourant Response Of Scraped And Unscraped Midrib Sticks

Peroxide-Based Hair-Bleaching Response

The commercial peroxide-based hair-bleaching formulations clearly brightened the nipa midrib sticks. However, under the presented conditions there was no clear concentration-dependent brightening effect for 3%, 6%, 9%, and 12% formulations. Without the instrumental colour measurement and standardised illumination, the differences may have been masked. The conclusion is therefore not very clear: the formulations can brighten the surface, but there is no clear optimum concentration given. Figure 11 presents the documented time-based response of the 9% peroxide-based formulation.



Figure 11: Time-Based Response Of Nipa Palm Midrib Sticks To The 9% Peroxide-Based Formulation

Household-Hypochlorite Response

The household sodium-hypochlorite treatment also lightened the sticks, but prolonged exposure had corrosion-like surface change, fibre separation and reduced apparent integrity. These effects became more relevant as exposure continued. For craft applications where bending, weaving, or joining are required, this visible deterioration is a hazard: a lighter surface might be achieved at the expense of handling reliability. Figure 12 shows the development of brightening and visible fibre deterioration with prolonged exposure.

Experiment Procedure using Bleaching Clorox product											
Midrib Stick Parts	Before	After 1 hour	After 2 hours	After 3 hours	After 4 hours	After 5 hours	After 6 hours	After 7 hours	After 8 hours	After 9 hours	After 10 hours
End											

Figure 12: Time-Based Response Of Nipa Palm Midrib Sticks To Household Sodium Hypochlorite

Discussion

Surface Preparation as Material Capability

The most consistent cross-series observation was the advantage of manual scraping for external colour production. This observation is consistent with research showing that preparation can improve plant fibre surface accessibility and performance (de Queiroz et al., 2020; Sahu et al., 2023). The relevance in a craft context is in the modest technological hurdles that are to be reached. The process is not dependent on specialised machines and could be learned in a workshop or design studio. It thus operates as material knowledge that could be used to move from a natural palette to planned colour variation.

This capability should not be confused with industrial standardisation. Natural sticks are different and hand scraping introduces operator variation. For small-batch craft, some variation can contribute to material character, while for repeat orders it can become a quality-control problem. A future artisan-led protocol could define acceptable stick diameter, surface removal depth, bath loading, temperature, and colour reference samples while protecting the material's natural character.

Colour Differentiation, Experience, And Cultural Continuity

From a Material driven design standpoint, these experiments open both technical and experiential possibilities (Karana et al., 2015). Golden turmeric tones can reinforce associations with warmth, nature and local plant resources, and synthetic or commercial colourants can create stronger contemporary contrasts. No one is better in colour design. The design effort is

to tie colour choice to the product, to make process, cultural narrative, performance, and disposal visible and not have colour be seen as a stylized styling decision.

This perspective is consistent with research that locates innovation in the continuity of Malaysian handicraft knowledge (Ariffin et al., 2023). Dyed nipa midrib sticks could be used in decorative panels, woven objects, lighting details, small containers, model making or educational material libraries. These are not product results, but design opportunities. And to know if the new palette does indeed support existing techniques and meanings or just adds an external aesthetic, we would need to work with artisans. Figure 13 shows one conceptual furniture application of dyed nipa palm midrib sticks.



Figure 13: Conceptual Furniture Prototype Demonstrating the Decorative Application of Dyed Nipa Palm Midrib Sticks

Sustainability Requires Process-Specific Evidence

The turmeric result offers a credible plant-based direction, but the article does not tie its natural origin with proven sustainability. Natural dye systems can rely on water, heat, auxiliaries, mordants, and repeated processing; they can be highly stable (Harsito et al., 2021; Yusuf et al., 2017). Research on turmeric and other natural dyes has shown that process design can enhance uptake and fastness, but such results are substrate and method-determined (Nitayaphat & Jintakosol, 2024; Rahman et al., 2023). The turmeric observation has therefore been a natural reason for conducting controlled studies on mordant and fastness rather than just a general environmental claim.

The synthetic-dye and oxidiser series are also instructive. Synthetic colourants may provide a broader and more controllable palette, but textile dye systems can create health and environmental burdens when chemicals and effluents are poorly managed (Lellis et al., 2019). Peroxide-based hair-bleaching formulations may provide a brightening path, but without a visible concentration-response pattern as a result, stronger formulations cannot be justified by these records. Hypochlorite is the easiest one to see; surface lightness increases while material

integrity appears to be diluted. So sustainable material development must consider the whole treatment system and not a single visual trait.

Potential Implications for Local Creative-Economy Development

Nipa product value chains involve several participants and stages, from resource access to processing and sale (Chanklap et al., 2025; Cheablam & Chanklap, 2020). The experiments provide a potential upstream design resource: a visually differentiated stick material that can be carried into prototyping. If future safety, performance, cost, user and market testing are favourable, a documented colour protocol may support local creative-economy opportunities through material kits, workshop activities, craft components or small product collections. Such development may augment the skills and networks that underpin handicraft entrepreneurship (Hussein et al., 2021).

However, the study did not interview artisans, calculate production costs, evaluate consumer acceptance, or measure income. That would make livelihood impact claims premature. The next step is participatory validation: the makers should assess preparation time, safety, attainable colour consistency, joining behaviour, cultural fit, pricing, and waste management. And social value should be shown by these relationships, not imposed on material novelty. The design-decision sequence is illustrated in Table 3.

Table 3: Proposed Design-Led Valorisation Framework

Stage	Decision	Current evidence	Next validation
Material selection	Sort sticks by size, surface condition, and intended craft use	Segment and surface variation influenced visible outcomes	Define artisan-relevant grading criteria
Surface preparation	Use controlled manual scraping where stronger colour is required	Scraped sticks were usually darker and more even	Standardise removed thickness and record labour time
Colour development	Select turmeric, commercial colourants, or synthetic dyes according to product narrative and performance needs	All tested systems changed external appearance	Measure CIELAB/K/S values and light, rub, and moisture fastness
Brightening	Use the mildest effective separately tested process; avoid prolonged hypochlorite exposure	Peroxide-based hair bleaching brightened; prolonged hypochlorite damaged fibres	Measure tensile/flexural behaviour and optimise exposure
Craft and market validation	Co-design prototypes with local makers before scaling	Not tested in the research	Assess usability, cultural fit, cost, demand, and waste pathways

Study Limitations and Future Research

The study has several limitations. Independent replicate counts and randomised sample allocation were not reported. Surface removal, bath loading and the quantity of salt in the synthetic dye production were not standardised in the available record. There was no comparison of visual performance with calibrated lighting, spectrophotometry, CIELAB or K/S values, microscopy, or image analysis. Colour fastness to light, rubbing, moisture and washing were not tested. Peroxide-based hair-bleaching and hypochlorite trials did not involve instrumental colour or mechanical strength measurements. Finally, the study didn't analyze toxicity, effluent, lifecycle impact, production costs, artisan experience, consumer response, or market demand.

Future studies should do replicated factorial trials that control scraping depth, liquor ratio, bath temperature, pH, auxiliaries, and drying. Instrumental colour measurement should be combined with standardised light, rub, and moisture-fastness tests and tensile or flexural evaluation before treated sticks are recommended. For turmeric, biomordants and lower-impact fixation systems should be compared based on existing natural dye research (Rahman et al., 2023). In research with artisans and design students, we should also be able to evaluate process learnability, cultural meaning, prototype quality, safety, cost and willingness to adopt. Lifecycle and effluent assessment are important to make sure any treatment is environmentally preferable.

Conclusion

The study indicates that nipa palm midrib sticks are visually identifiable through easy to access surface and colour treatments and should be used as a starting point for further sustainable craft production. The results are clear: manual scraping has improved colour uptake and evenness, longer dyeing results in more visible colour, and household-hypochlorite exposure has damaged the fibres. Turmeric produced the most pronounced golden-yellow colour after 60 minutes on scraped sticks. Peroxide-based hair-bleaching formulations helped brighten the material up but didn't show any concentration-dependent effects.

The main lesson in design is that valorisation needs to be balanced. The appearance, process accessibility, material integrity, safety, cultural meaning, and environmental burden all must be considered. The experiments do not prove product durability, ecological superiority, or economic impact. In the exploratory context, the study offers an accessible and yet potentially low-cost design-based approach to improving the visual qualities of nipa palm midrib sticks for craft applications. This underutilised material can be used in a craft and creative-economy context through controlled performance testing, cost analysis, and participatory product development.

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