ISETC2025

UNIVERSITI TEKNOLOGI MARA

ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
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ISETC 2025 Proceedings Editors

PHYSICAL PROPERTIES OF PAPER MADE FROM PINEAPPLE LEAVES

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Abstract: Pineapple (*Ananas comosus*) is one of the most widely grown tropical fruits, and its production results in a large quantity of agricultural waste, mainly in the form of leaves. This study was conducted to produce biodegradable paper from pineapple leaves without the use of bleaching agents or starch. The pineapple leaves were used instantly without fiber separation. The starting of the processes began by soaking the leaves in a 5% sodium hydroxide (NaOH) solution to soften their structure. After that, the leaves were washed, blended with water and manually formed into paper sheets. The paper quality was observed based on physical appearance, weight, and estimated thickness. The findings showed that alkaline treatment helped soften the leaves and enabled the formation of paper with natural bonding. The resulting paper appeared fibrous, lightweight, and suitable for basic use. This study shows that pineapple leaves, usually thrown away, can be turned into eco-friendly paper using a simple and low-cost method. It is especially useful for small industries or countryside areas.

Keywords: *Pineapple leaves, biodegradable paper, alkaline treatment, agricultural waste, eco-friendly material*

INTRODUCTION

The global paper industry has traditionally relied on wood-based fibres, resulting in deforestation, high energy demand, and environmental degradation (Laftah et al., 2016). In recent years, attention has shifted towards alternative lignocellulosic sources, particularly agricultural residues, as sustainable raw materials for pulp and paper production. Among these residues, pineapple (*Ananas comosus*) leaves have gained interest due to their abundance, fibre strength, and underutilised potential (Asim et al., 2016; George et al., 2020).

Malaysia, being one of the major pineapple producers, generates significant amounts of agricultural waste in the form of discarded leaves. These residues are often left to decompose or are burned, contributing to environmental concerns (Babu et al., 2020). Converting such biomass into value-added products, such as biodegradable paper, supports the principles of waste valorisation and the circular economy (Teo et al., 2020; Zainuddin et al., 2019). Pineapple leaf fibres (PALF) are characterised by their high cellulose content and mechanical strength, making them suitable for papermaking applications (Sibaly et al., 2017; Yuniarto et al., 2021).

Earlier studies have demonstrated that PALF can be processed into composite materials and eco-friendly papers with promising strength and durability (Ahmed et al., 2020; Sharma et al., 2021). The use of alkaline treatment, such as sodium hydroxide (NaOH), has been shown to improve fibre softness and enhance inter-fibre bonding, contributing to better sheet formation (Ahmad et al., 2021). Unlike conventional papermaking processes that involve bleaching and chemical binders, the direct utilisation of whole pineapple leaves without harsh treatments offers a low-cost and environmentally sound approach suitable for small industries and rural communities.

This study aims to explore the feasibility of producing biodegradable paper directly from pineapple leaves using a simple alkaline treatment and hand-sheeting process. By examining the physical characteristics of the resulting paper, the work contributes to sustainable material development while offering a practical pathway for agricultural waste management in Malaysia and other pineapple-producing regions.

MATERIALS AND METHODS

Pineapple leaves (1 kg) were used as the main raw material, while a 5% sodium hydroxide (NaOH) solution was prepared by dissolving 30 g of NaOH in 600 mL of distilled water. The process began by washing and cutting the leaves into 2–3 cm pieces, then blending them into a fiber-rich slurry. The slurry was added to the NaOH solution and heated at 80–90 °C for 2 hours to soften the fibers and remove lignin. The pulp was then transferred to a basin

of water and stirred. A mould and deckle (A4 size) were dipped into the mixture to form sheets, which were then transferred onto muslin cloth. A sponge was used to press out excess water. The sheets were dried under direct sunlight for 1–2 days before being carefully removed for testing. Equipment used included a beaker, hot plate, blender, basin, mould and deckle, muslin cloth, sponge, stirring rod, and PPE.

RESULTS AND DISCUSSION

Table 1. Physical properties data of handmade pineapple leaves paper

Characteristic	Description / Measurement	Thin Paper	Medium Paper	Thick Paper
Drying Time	Time under sunlight until fully dry	6–8 hours	10–12 hours	18–24 hours
Sheet Thickness	Measured with a caliper	0.16 mm	0.17 mm	0.26 mm
Texture	Visual and tactile observation	Smooth	Smooth and slightly firm	Rough and stiff
Flexibility	Manual bending test	High- easily bendable	Moderate	Low
Tear Resistance	Manual tearing strength test	Low- tears easily	Moderate- resists small tears	High- strong and tear-resistant
Color	Visual observation	Light beige, slightly translucent	Light brown, more opaque	Dark brown, fully opaque
Weight	Measured using a digital scale (per sheet)	7.81 g	8.28 g	13.14 g
Density	Density=Mass/Volume	0.782 g/cm^3	0.781 g/cm^3	0.811 g/cm^3

Table 1 presents the physical characteristics of the handmade paper sheets derived from pineapple leaves. The results indicate clear correlations between sheet thickness, drying time, mechanical strength, and flexibility. Thicker sheets (0.26 mm) required up to 24 hours to dry compared to 6–8 hours for thinner sheets (0.16 mm). This difference is consistent with the higher fibre density and moisture retention in thicker samples, which slowed down evaporation under natural sunlight conditions. Similar observations were reported by Sibaly and Jeetah (2017), who found that fibre-rich sheets prolong drying due to limited airflow through compacted structures.

Mechanical testing through manual bending and tearing highlighted a trade-off between flexibility and strength. Thicker paper exhibited higher tear resistance but reduced flexibility, whereas thinner sheets were more pliable but tore easily. This relationship has also been observed in other non-wood fibre studies, where dense fibre networks enhance bonding but compromise foldability (Ahmed et al., 2020). The results suggest that intended application should guide sheet thickness: thinner sheets may be more appropriate for wrapping or writing purposes, while thicker sheets are better suited for packaging or craft materials.

The visual characteristics also varied with thickness. Thin sheets were light beige and semi-translucent, while thicker samples appeared darker and opaque. These colour variations were expected given the absence of bleaching and the higher concentration of lignin and hemicellulose in denser fibres (George et al., 2020). Although darker colours may limit commercial use for printing applications, they remain acceptable for eco-friendly packaging and craft uses. Future refinements could explore natural bleaching or additives to improve aesthetics without compromising biodegradability.

In terms of weight, thicker sheets were almost twice as heavy as thinner ones, reflecting higher fibre loading. Correspondingly, density values increased slightly with sheet thickness, ranging between 0.781–0.811 g/cm³. This confirms the formation of compact structures with better fibre bonding, which is essential for durability (Sharma et al., 2021). The findings are in line with previous work highlighting that alkaline-treated agro-fibres form stronger, denser structures compared to untreated ones (Ahmad et al., 2021). Overall, the results demonstrate that pineapple leaf waste is a viable raw material for producing biodegradable paper with varying qualities suitable for different end-use applications.



Figure 1. Paper from Pineapple Leaves

CONCLUSIONS

This study successfully demonstrated the production of biodegradable paper from pineapple leaves using a simple, low-cost alkaline treatment and hand-sheeting method. The process yielded fibrous, lightweight, and durable sheets without the need for chemical bleaching or starch binders. Physical characterisation showed that sheet thickness significantly influenced drying time, strength, flexibility, colour, and density. While thinner sheets offered greater pliability, thicker sheets provided superior tear resistance and durability.

The results confirm that pineapple leaves, often discarded as agricultural waste, can be repurposed into eco-friendly paper, supporting waste valorisation and sustainable practices in small-scale or rural contexts. These findings align with global efforts to reduce reliance on wood-based pulp and promote renewable alternatives (Teo et al., 2020; Yuniarto et al., 2021).

Future work should investigate mechanical properties in greater detail, including tensile and bursting strength, as well as water resistance. The incorporation of natural binders or surface treatments could further enhance durability and broaden potential applications. By advancing such research, pineapple leaf fibre-based paper may contribute meaningfully to sustainable materials development and circular economy initiatives in Malaysia and other pineapple producing agents.

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