

PRODUCT DEVELOPMENT OF PINEAPPLE PAPER FROM PINEAPPLE (ANANAS COMOSUS) WASTE MATERIALS FOR SUSTAINABILITY OF PINEAPPLE FARMER COMMUNITY

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ABSTRACT

This research aimed to develop pineapple paper product from agricultural waste in pineapple farm to assess the efficiency of design towards consumer needs and to create management guidelines for the pineapple farmer community. The pineapple papers were prepared from waste pineapple leaves. The chemical composition of pineapple paper was investigated. The color was measured and the CIELab (L*, a*, b*) was used to evaluate the color of the pineapple papers. From the results, it was found that the pineapple leaves contained cellulose, hemicellulose and lignin 57.78%, 27.75% and 5.59%, respectively. The pineapple paper had white color and smooth surface with high L* value. The consumer survey was conducted. The population for this study consisted of 50 participants. The questionnaires consisted of three parts which are: a) General information, b) Attitudes of consumer towards the product, c) consumer acceptance in pineapple paper characteristics such as outer appearance, paper quality, texture, color and eco-friendly image. The results indicated that satisfaction with outer appearance, paper quality, color, texture and eco-friendly image was all at the highest level. Papers produced from Pineapple leaves will be an innovative product of the community and can promote a sustainable bio-based economy of pineapple farmer community.

Keywords: Pineapple, Paper Production, Pulp, Waste, Sustainable management

INTRODUCTION

Currently, Thai fruits are valued as economic crops that bring in at least 45,613 million baht [1]. Rayong province is located in the Eastern Economic Corridor (EEC). The main economic crops are durian, pineapple, and mangosteen, with pineapple having the largest output volume. The issue of declining pineapple prices has long plagued pineapple production in the eastern region. This is a result of the constant high pricing for pineapples in 2015 and 2016. Large-scale pineapple cultivation has become popular. Pineapple farmers in Rayong Province therefore are consequently faced with declining pricing and an excess of supply in the market.

Pineapple (*Ananas comosus*) is a tropical fruit tree. Classified in the *Bromeliaceae* family, it is native to the tropics of South America. The plant can grow up to a height of 75-150 cm with a spread of 90-120 cm. It is short, having a stout stump with narrow, fibrous and spiny leaves. The plant develops to a cone-shaped juicy and fleshy fruit with crown at the top. Pineapple fruit can also be processed into a range of products including pineapple juice, canned pineapple, pineapple stir, and etc. Thailand, Brazil and Philippines are the main producers of pineapple include which supplying nearly 50 % of the total output in the world [2]. Pineapple consists of high variety of almost 70 cultivars, and their classification is divided into five groups based on their spininess, fruit shape and flower colors. This includes Spanish, Queen, Cayenne, Pernambuco and Perolera [3].

Thailand is known as a leader in global pineapple production with mainly two widely planted cultivars, Cayenne (specifically ‘Smooth Cayenne’), and Queen. Sriracha Pineapple (Fig.1 (a)) is a Pattavia variety, in the group of smooth Cayenne. The size is about 1.8 to 4.5 kilograms. The shape is in cylindrical form, shallow eyes, orange rind and yellow flesh. it is one of the most popular types of pineapple for the processing and canning industry. Rayong Golden Pineapple (Fig.1 (b)) is a Queen variety pineapple locally grown in Rayong. It is in cylinder shape with shallow skin groove, big eyes, and thin skin. The flesh is deep yellow, firm, sweet and fragrant.

Nowadays, non-wood fiber plays important roles in papermaking as substitutes or complements to wood. Examples of non-wood fiber resources available for paper production are rice-straw, reeds, bamboo, bagasse, kenaf, palm oil, and jute. Coconut husk, waste material from coconut milk production, was also successfully exploited as the main raw material for papermaking [4]. For this purpose, a participatory research project has been conducted with the community on the management of waste materials from the production of pineapple. By developing technology for producing paper made from waste pineapple leaves. This will result in new innovations occurring in the community. Create careers and income for pineapple farmers.

Figure 1
Appearance of (a) Sriracha and (b) Rayong Golden pineapple

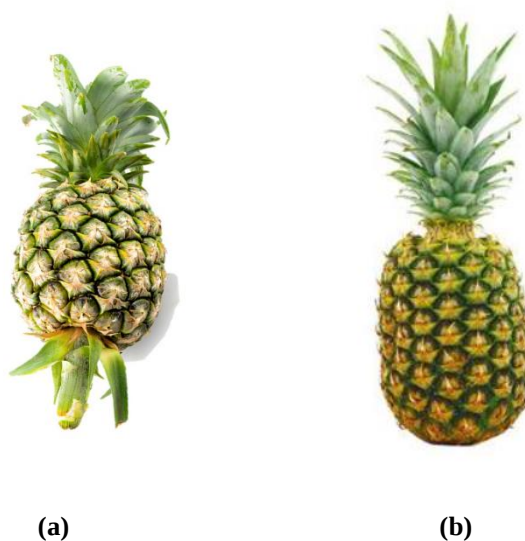


Figure 2

Waste pineapple leaves in pineapple farm at Rayong province



METHODOLOGY

1. Paper production

1.1. Pulping

After harvest of fruit, pineapple leaves were washed with tap water several times to remove contaminants and chipped into smaller pieces and boiled using 1M NaOH solution until soft. Then the boiled leaves were poured in a stainless steel bowl and rinsed with tap water carefully and filtered using a cloth of very fine pore size to obtain retained pulp. Bleaching was done with Hydrogen peroxide (H_2O_2) in the Liquor: substrate ratio of 10:1 for 30 minutes.

1.2. Paper preparation

The paper making process was adopted and modified from Chumee *et al.*, 2016 [5]. Bleached fibres were poured into a blender in which filled of water and blended for 1 hour or until it reached a pulpy consistency, with no addition of starch or another dispersing agent. Paper sheets were made using handmade paper mould. The blended pulp was stirred and poured on the mould screen to produce a uniform sheet. Moulds were placed horizontally allow water to drain. After completely dried, the paper was peeled off from the mould.

Figure 3

The process of pineapple paper production by pineapple farmer community



1.3 Characterization

The chemical composition of pineapple paper was investigated compared with that of bagasse. The color was measured by light reflectance technique using a Hunter Lab spectrophotometer Color Quest XE. The CIELab (L^* , a^* , b^*) was used to evaluate the color of the pineapple papers. L^* , a^* and b^* represent lightness, redness-greenness of color, yellowness-blueness of color, respectively [6].

2. Consumer survey

50 questionnaires were distributed to participants. The questionnaires consisted of three parts which are: a) General information, b) Attitudes of consumer towards the product, c) consumer acceptance in pineapple paper characteristics such as outer appearance, paper quality, texture and color. The data collection was carried out from January to March, 2024.

Conducting a knowledge transfer of paper production technology from waste materials to the pineapple farmer community in Phana Nikhom Subdistrict, Nikhom Phatthana District, Rayong Province

RESULTS

From table 1, it was found that the pineapple leaves contained cellulose, hemicellulose and lignin 57.78%, 27.75% and 5.59%, respectively. The bagasse contained cellulose, hemicellulose, and lignin at 45.24%, 31.19%, and 17.02%, respectively. It can be seen that the pineapple leaves had higher content of cellulose and lignin than bagasse. Lignin has been believed to cause paper degradation, however, the study of Małachowska *et al.*, (2020) showed that the lignin content in pulp has no significant impact on the ageing rate of paper. Furthermore, the high lignin content can increase paper strength and simplifies the process of paper production due to the unuse of dispersing agent [7].

Table 1
Chemical composition of pineapple leaves and bagasse

Composition (%)	Pineapple Leaves	Bagasse
Cellulose	57.78	45.24
Hemicellulose	27.75	31.19
Lignin	5.59	17.02
Ash	2.51	0.17

Figure 4 showed that the resulting paper had white color and smooth surface. The high lignin content allows pineapple fibers to weave together without adding other fibers or binders (Figure 4, right). The color values of the pineapple paper are shown in Table 2. High value of L* denotes the whiteness of paper product, which is corresponds to the appearance shown in Figure 4.

Figure 4
Appearance of (left) pineapple paper and (right) pineapple fiber when viewed with a 10x magnification



Table 2
The colorimetric data of pineapple paper

Sample	Color coordinates		
	L*	a*	b*
Pineapple paper	90.69 (± 0.32)	0.13 (± 0.05)	12.91 (± 0.75)

The consumer survey was conducted in Bangkok, Thailand. After gathering information from the survey, it was found that the majority respondents, 70% of the participants were female, and 55% were females. 50% of the participants were at the range of age 36-45 years old, 30% of participants were at the range of age 26-35 years old, 10% of the participants were at the range of 16-25 and 46 – 55 respectively.

80% of the participants were officers, 10% of the participants were teachers and students, respectively. 80% of the participants had experience using craft paper. Factors that influencing consumer decision-making while choosing craft paper products are mainly price (50%) and straight (50%) followed by appearance (20%), color (20%) and texture (20%).

Participants tested the pineapple paper and rated the likelihood in some specific characteristics (outer appearance, paper quality, color, texture and eco-friendly image). The value of each rate was 5 excellent, 4 good, 3 average, 2 poor, 1 very poor.

Table 3
The satisfaction level of pineapple paper

Satisfaction level of pineapple paper:	$\bar{X}$	S.D.	Level
1. Outer appearance	4.90	0.32	Highest
2. Paper quality	4.60	0.52	Highest
3. Color	4.60	0.70	Highest
4. Texture	4.70	0.48	Highest
5. Eco-friendly image	4.90	0.32	Highest

The survey scores were interpreted based on the following criteria:

- An average score ranging from 4.51 to 5.00 indicates the highest level of satisfaction,
- an average score ranging from 3.51 to 4.50 indicates a high level of satisfaction,
- \ an average score ranging from 2.51 to 3.50 indicates a moderate level of satisfaction,
- an average score ranging from 1.51 to 2.50 indicates a low level of satisfaction, and
- an average score ranging from 1.00 to 1.50 indicates the lowest level of satisfaction.

The results from table 3 indicated that satisfaction with outer appearance, paper quality, color, texture and eco-friendly image was all at the highest level. The participants satisfied most in outer appearance and eco-friendly image of the paper product.

CONCLUSION

It was found that it is possible to make paper using waste materials derived from the production of pineapples. The paper products satisfied customer needs with efficiency. Moreover, it can serve as a remedy for low-income issues that arise during the period of pineapple oversupply.

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REFERENCES

- [1] Information and Communication Technology Center, Department of Agricultural Extension (2020), —<http://www.agriinfo.doae.go.th/year63/plant/rortor/agronomy/สำเนาจรด.pdf>
- [2] Dittakan,K., Theera-Ampornpunt, N. & Boodliam, P. (2018), —Non-destructive Grading of Pattavia Pineapple using Texture Analysis. *21st International Symposium on Wireless Personal Multimedia Communications (WPMC), Chiang Rai, Thailand*, pp. 144-149.
- [3] Hassan, A., Othman, Z., & Siriphanich, J. (2011), 10 —Pineapple (*Ananas comosus* L. Merr.). In *Postharvest Biology and Technology of Tropical and Subtropical Fruits*. Yahia, E. M., Ed., Woodhead Publishing, pp. 194-218e.
- [4] Dey, S. K., Bhattacharyya, G. K., & Bhattacharyya, S. K. (2005), —Magic yarns from ramie and pineapple—a new dimension in 21st century. *Proceedings of the 20th Indian Engineering Congress*, pp. 69.
- [5] Bussaban, K., Chumee, J. (2019). —From Coconut Husk Waste to Community Business. *Advances in Human Factors, Business Management and Society*. pp.229-238.
- [6] Ohama, P., (2014). Eco-friendly dyeing of cotton fabric using ultrasonic energy with natural colorants extracted from mulberry leaves. *Advanced Materials Research*, 979, pp. 382-385.
- [7] Małachowska, E., Dubowik, M., Boruszewski, P. (2020), —Influence of lignin content in cellulose pulp on paper durability. *Sci Rep* 10, 19998.
- [8] Nkeudem, A. G., Metuge, S., Mabel, K. F., Ning, T. R., Ngole, S. I. U. (2023), Hand-made paper produced from pineapple leaves (*Ananas comosus*) as a potential material for food packaging. *Journal of Tertiary and Industrial Sciences*, Vol. 3, No. 1, pp. 65-79.