

MAKING PAPER FROM WATER HYACINTH FOR PRODUCTS AND HOME DECORATIONS

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Abstract

The study conducted fieldwork to examine the community identity and investigate the application of water hyacinth from San Bua Bok to product design and home decoration, which is a community enterprise in Phayao province. Fiber pulp from the plant is used to produce paper, out of which five product and home decoration prototypes were developed. Satisfaction with such products was then evaluated. The results illustrated that the optimal proportion of materials for paper making is 70% water hyacinth to 30% hemp fiber. Finally, the product that obtained the highest level of satisfaction is the notebook prototype at 4.63.

Keywords: Water hyacinth, home decorations, community enterprise.

INTRODUCTION

Water hyacinth [*Eichhornia crassipes* (Mart.) Solms], which is also known as lilac devil, is a free-floating aquatic weed (Gopal 1987). It is durable and can tolerate drought but displays low tolerance for saline waters. Although water hyacinth can survive severe environmental conditions and propagate quickly, it can cause agricultural and irrigational problems, thus affecting health and creating propagation control difficulty (Abral et al., 2014).

Water hyacinth is classified as an invasive alien plant that severely damages ecosystems and freshwater biodiversity because it can live in any water condition (i.e., dirty and clean water) and extremely propagate in still water. Moreover, it hinders sunlight from penetrating underwater, which obstructs the growth of underwater plants (e.g., algae) or other surrounding plants. Moreover, water hyacinth has a long-term impact on water quality by covering the deposition of dead plants under water and polluting water, which consequently harms underwater animals and causes massive losses in biodiversity. Furthermore, water hyacinth poses

problems for water transportation systems, such as difficulty in navigation (Wang 2012).

Similarly, Phayao province confronts problems related to the overgrowth of water hyacinth. Although eradicated yearly, water hyacinth propagation in this area is considered uncontrolled, particularly in Phayao Lake. Water hyacinth covers an area of more than 5,000 rai (8,000,000 m²), obscures the beautiful scenery of the lake, and pollutes the water, which leads to a foul odor emanating from the lake. Importantly, its overpropagation is detrimental to the ecosystem. Accordingly, the government and private sectors in Phayao province established a solution for problems related to the overgrowth of water hyacinth by promoting its utilization in different types of products, such as organic fertilizers or wickerwork, to generate community income.

The aforementioned problems have prompted startups and One Tambon One Product (OTOP) community enterprises in Phayao province to turn a crisis into an opportunity by transforming water hyacinth into fiber pulp to develop products and home decorations. The project

aims to (1) be a part of the solution, (2) introduce various products made of water hyacinth to create an alternative for commercial products and packaging development of community enterprises, (3) generate family and community income from the said products based on the less is more concept, and (4) provide an opportunity for the exchange between local wisdom and modern academic knowledge for integration into the development of new innovations for the community.

LITERATURE REVIEW

Green design

The development of science and technology and rapid progress of the human society may have an environmental impact as natural resources become increasingly restricted because of the overload consumption of the human civilization. Therefore, the concept of environmentally friendly or green design, which promotes sustainable consumption and production, is currently emphasized at a large scale because the scheme can become a solution to the aforementioned problems. Green design highlights limiting waste, maximizing sustainable materials, and using renewable energy during production. Additionally, green design reduces not only production cost but also negative impacts on the environment. Therefore, if green design is employed, then design work can be harmonious with the living environment (Zhou 2014).

Papermaking process

Paper refers to sheet materials used for writing, packaging, and other special purposes. Paper is developed by filtering a network of fibers over water and forming a sheet of fiber on a screen. The fibers adhere to one another in the dry state through hydrogen bonding. Additives and fillers are frequently added to paper (T Suropan 2019). Papermaking involves three primary processes as follows:

1. Stock preparation

Stock preparation is the most important process for papermaking as the paper quality is adjusted to suit the purpose of the paper. The process comprises spreading the fibers, adjusting concentrations, beating/refining, blending, and contaminating or removing entrained air. The order of this process can be adjusted according to various conditions (Mishra 2019).

2. Sheet forming

Handicraft sheet forming primarily pertains to placing the prepared fiber pulp onto a screen with the dimensions of 55×79 cm² in a washing basin or container filled with a suitable level of water. The pulp is refined and spread evenly by hand over the screen before lifting the screen out of the container.

3. Paper properties and testing

3.1 Structural properties can indicate the overall characteristics of the paper sheet, such as basis weight and thickness. Basis weight refers to the weight of the paper per unit stored under controlled temperature and humidity conditions. The most commonly used unit is grams per square meter. Moreover, thickness refers to the perpendicular distance between the top surface and underside of the paper based on specific test conditions. The measuring unit is micrometer; however, millimeter is a widely used unit.

3.2 Mechanical properties denote physical properties related to paper strength. The most commonly used mechanical properties are tensile, burst, and tear strength.

3.3 Optical properties can be simply explained as follows: the paper must produce reflection, scattering, and absorption when struck by light. Such phenomena and their effects compose the optical properties of paper, such as gloss, brightness, or opacity. Moreover, optical properties include whiteness and color (Gullichsen 2000).

Conceptual framework

The conceptual framework of the study is based on the less is more concept, as shown in Figure 1.

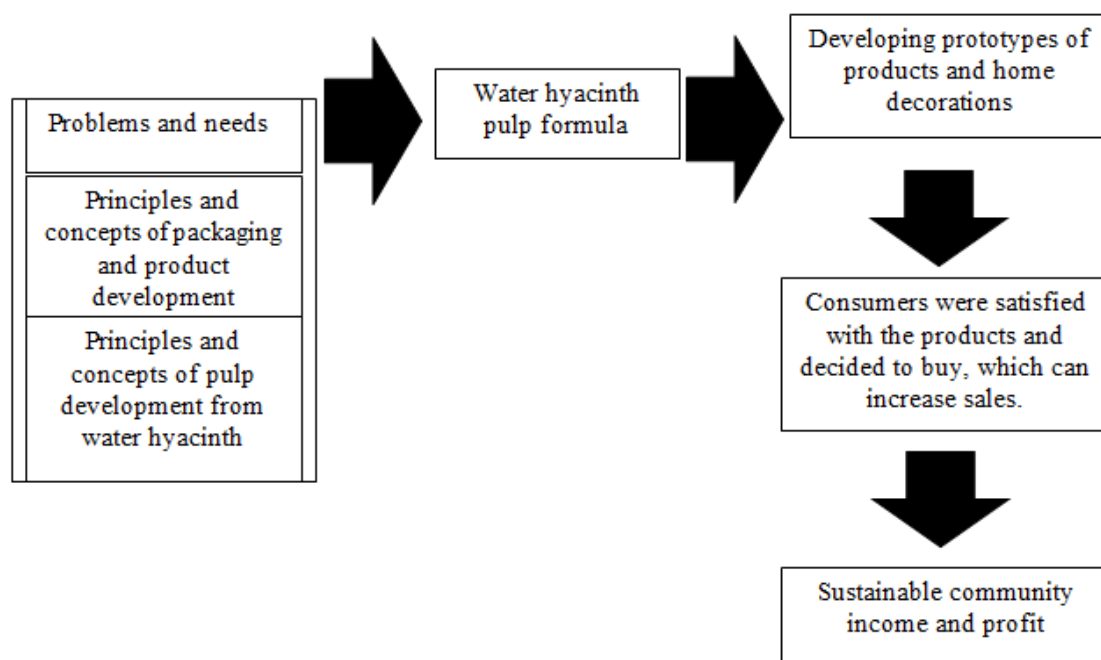


Figure 1 *Conceptual framework*

Objectives of the study

1. Produce paper from water hyacinth to develop products and home decorations.
2. Evaluate satisfaction toward the developed products and home decorations.

Experiment

The experiment is divided into two primary sections, namely, papermaking and developing prototypes of products and home decorations.

Papermaking

The study involved the following processes for papermaking:

1. Preparing the materials

The pulp is composed of 500 g of water hyacinth per 4,000 ml of water in a pot with a width of 30–32 cm.

2. Boiling the pulp

For the additive, 100 g of sodium hydroxide (diluted in 100 ml of water) was added to 500 g of water hyacinth and 6,000 ml of water. It was stirred well with pulp and boiled for 45 min.

3. Bleaching the pulp

This component includes 2,000 g of boiled water hyacinth per 400 ml of hydrogen peroxide and 4,000 ml of water. It was stirred well into the

pulp and marinated for approximately 45 min to bleach.

4. Dyeing the pulp

This step requires 10 g of any chemical color of choice for hot dyeing (the color was diluted in 100 ml of warm water). The mixture was then stirred well into the pulp. The bleached water hyacinth and hemp fiber pulp were boiled for approximately 5–15 min to ensure the absorption of the dye, which may vary according to the fiber pulp.

5. Beating the pulp

The proportion included 70% of water hyacinth fiber pulp and 30% hemp fiber pulp per 50 ml of tapioca starch. Beat the fiber pulp for 2 min using a beating machine.

6. Forming the paper sheets

The sheet of fiber pulp was dried in the sun by tilting the frame by 45°, and the fiber pulp was dried, which then transformed into paper in 1–2 days (Figure 2).

7. The structural properties of water hyacinth paper were tested in terms of weight and thickness.



Figure 2 *Forming paper sheets*

Developing prototypes of products and home decorations

The section provides the following processes for the development of prototypes of products and home decorations:

1. Fieldwork was conducted to gather data and analyze the problems and needs requirements of the samples by visiting production and distribution areas and conducting in-depth interviews with 20 stakeholders, such as producers and consumers, involved in the project.
2. The data were analyzed and summarized by examining documents, observing related works, and conducting fieldwork to interview experts, designers, and consumers for establishing the conceptual framework for developing prototypes of products and home decorations.
3. The conceptual framework was used to develop products for startups and community enterprises in Phayao and utilize the

aforementioned process using the hyacinth pulp formula.

4. The developed prototypes were evaluated through focus group discussions with stakeholders and three product and packaging experts. A questionnaire was used with items rated using a five-point Likert-type scale.

5. The prototypes were improved based on the recommendations and suggestions from stakeholders and experts, and consumer satisfaction toward the prototypes was evaluated. A questionnaire was then used with items rated using a five-point Likert-type scale with their average scores (5 = highest [4.51–5.00]; 4 = high [3.51–4.50], 3 = moderate [2.51–3.50], 2 = low [1.51–2.50], and 1 = lowest [1.00–1.50] levels of consumer satisfaction; Best, 1970).

6. Data were analyzed using descriptive statistics, such as mean (\bar{x}) and standard deviation (S.D.), and the result were summarized.

RESULTS

The study provided two sets of results as follows:

1. Papermaking from water hyacinth

Papermaking from water hyacinth elucidated that developing products and home decorations are a feasible San Bua Bok community enterprise. In addition, testing the structural properties of 10 sheets of paper indicated a mean weight of 150 g and mean thickness of 0.70 mm.

2. Product development of San Bua Bok water hyacinth community enterprise

Table 1 *Analysis of problems and requirements of products and home decorations*

Community and Products	Problems and Needs	Solutions
San Bua Bok Water Hyacinth Community Enterprise, Ban Sang Subdistrict, Mueang District, Phayao Province	— Products and home decorations from water hyacinth	— Design and develop products and home decorations made of paper from water hyacinth to respond to community needs.

Table 1 indicates that the communities need products and home decorations using paper made of water hyacinth pulp. The solution was

designing and developing products and home decorations from water hyacinth to respond to community requirements.

Accordingly, the products and home decorations from paper made of water hyacinth were designed and developed based on the need and identity of the San Bua Bok water hyacinth community enterprise in Ban Sang, Mueang district, Phayao province. Three experts

evaluated five product prototypes, namely, a lamp, tablet case, mobile phone pouch, umbrella, and notebook. The results revealed a high level of satisfaction ($\bar{x} = 4.59$; S.D. = 0.50; Table 2).



Figure 3 Prototypes of mobile phone pouch, umbrella, and notebook

Table 2 Satisfaction with notebook produced from water hyacinth

Aspects	Mean	Standard Deviation	Level
1. Creativity	4.67	0.58	Highest
2. Combination of composition, color, and image	4.67	0.58	Highest
3. Representativeness	5	0	Highest
4. Esthetics	4.33	0.58	High
5. Suitability of materials used	4.67	0.58	Highest
6. Convenience of use	4.33	0.58	High
7. Uniqueness	5	0	Highest
8. Information communicability to consumers	4.33	0.58	High
9. On-shelf remarkability and attractiveness	4.67	0.58	Highest
Total	4.63	0.45	Highest

CONCLUSION AND DISCUSSION

1. The six-process papermaking could be used to develop products and home decorations to generate income for the San Bua Bok water hyacinth community enterprise in Prayao province. (Chotithammaporn et al., 2020) examined the production of paper using water hyacinth and mulberry pulp for dried fragrant flower packaging. By contrast, (Kongtad et al., 2007) investigated the mechanical properties of paper using a combination of water hyacinth and hemp fiber pulp at a ratio of 70:30. The paper was manufactured by hand, which is of good quality and can be used for handicraft instead of mulberry paper. Furthermore, the result of the current study is consistent with that of (Kumaravel et al., 2015) who combined several materials to ensure tensile strength support.

2. Using paper from water hyacinth to develop products and home decorations promoted the utilization and added value to residual and environmentally friendly materials, which is in accordance with the finding of (Wang 2014), who applied a packaging design that displayed the features and basic principles of design and green design methods.

3. The level of satisfaction with the products and home decorations of the San Bua Bok water hyacinth community enterprise was high ($\bar{x} = 4.47$, S.D.= 0.13). Satisfaction with each product is ranked highest to lowest as follows: notebook → lamp → tablet case → umbrella → mobile bag.

4. Accordingly, satisfaction with the products and home decorations of the community enterprise in Prayao pointed to the relationship between community identity and

products and home decorations. This result is consistent with that of (Daoduean 2018), who proposed that such products could be developed at the industrial level to gain knowledge related to the prosperity belief of the Thai, which led to the conservation and dissemination of Thai intellectual values and beliefs. This scheme could consequently induce the process of designing and developing home and office products and decorations systematically to contribute to the research on product design and provide guidelines for developing arts and handicrafts using natural materials. This aspect is relevant to the Thai belief on prosperity and corresponds to consumer satisfaction.

RECOMMENDATIONS AND SUGGESTIONS

Further studies should investigate the properties of products and home decorations in the community to inform the development of modern products suitable to the gender, age, and income of target consumers.

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