

CHARACTERISTICS AND PROPERTIES OF *HIBISCUS TILIACEUS* YARN

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Abstract

The objective of this study was to study the characteristics and properties of *Hibiscus tiliaceus* fiber of different ages, the production process of *Hibiscus tiliaceus* yarn with fibers of different ages, and the characteristics and physical properties of *Hibiscus tiliaceus* yarn of different ages.

The Completely Randomized Design (CRD) was employed for the experiment planning of the characteristics and properties of the 2-month, 3-month and 4-month *Hibiscus tiliaceus* fiber and yarn. The test was in accordance with the American Society for Testing and Materials (ASTM). Then the average properties of the fibers and yarn of different ages were analyzed by the Analysis of Variance with One-Way ANOVA and compared with the average pair LSD (Least Significant Difference).

The result indicated that the longitudinal characteristics of the 4-month yarn had the best arrangement of fiber and rough surface all along the length. Its cross section looked like a polygon shape and its burning was quick, giving the smell of burning paper and gray ash. In addition, the fiber was dissolved in sulfuric acid. Concerning the physical properties test, it was found that the 4-month *Hibiscus tiliaceus* fiber had the highest strength and the longest length with an average strength of 16.34 N. and the average length of 5.61 cm. Concerning the moisture absorption, it was found that the average moisture absorption of the 2-month *Hibiscus tiliaceus* fiber was the highest of 12.29 per cent. The experiment on the production and properties of *Hibiscus tiliaceus* yarn showed that the 4-month *Hibiscus tiliaceus* fiber could produce the smallest and longest yarn of 45 meters while the 3-month yarn had the highest average strength of 111.39 N. The different physical properties of the fiber and the yarn of different ages were statistically significant at the level of 0.5

Key words: Fiber, Yarn, *Hibiscus tiliaceus*, Physical Properties

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1. Introduction

Currently the textile and garment industry of Thailand is facing high competition, especially with ASEAN countries such as China, Vietnam and India, etc. To keep its status in such a competitive market, it is necessary for the Thai textile and garment industry to increase its competitive potential with focuses on the following two key aspects: development of new materials and creation of added-value products. While innovation is one key factor in restructuring the Thai economy for sustainable development of creative and green economy, the entire Thai textile and garment industry should also put its emphasis on developing innovative products with a transition from upstream to downstream and the development must be geared towards a creative and green economy. In addition, to comply with the requirements of the global markets, its product development should result in quality products with innovative new materials that make a difference. In other words, the outcome should meet the consumer demand and consequently generate additional value to the Thai creative economy. To achieve this, there needs to be a combination of local wisdom with appropriate technology to develop a product with outstanding quality and a difference that meet the needs of consumers. [1]

Hibiscus tiliaceus (*Hibiscus tiliaceus* L *malvaceae*) is a small tree of 3 – 10 meters high with spreading top, smooth or grooved and gray or brown bark. Its pink with scattered white inner layer is tough and can be easily peeled off. The single leaves are heart-shaped with wide base; the flowers are in bunches while the fruits with short nibs are circular oval covered with thick hair and are inside loop cloves. The tree grows well along the seaside, brackish-watered rivers or canals like mangrove forests and it flowers almost all year round. [1]. In terms of use, the tree is ornamental while the trunk is used for fire or canoe making and in fishery and the bark is used for making rope. [2]



Figure. 1 *Hibiscus tiliaceus*

The researcher was interested in studying the characteristics and properties of *Hibiscus-tiliaceus* fiber of different ages, and the production of yarn from the fiber by combining the local wisdom with current technology. The characteristics and physical properties of *Hibiscus tiliaceus* yarn were also studied. This can lead to the maximum use and added-value of the tree, and the farmers' additional income as well. The study result can also be used as guidelines for further development of new natural fibers and yarn, as well as products of unique quality in the Thai textile and garment industry.

2. Materials and Methods

The research materials were the 2-month, 3-month and 4-month *Hibiscus tiliaceus* inner layers collected from Tambon Taklob, Chaiya District, Surat Thani Province. The research was undertaken in the following four steps.

2.1 Preparation for the comparison of the characteristics and properties of *Hibiscus tiliaceus* fibers of different ages

The experimental procedure of this step was as follows.

2.1.1 Studying the age of the natural *Hibiscus tiliaceus* found along the river at Tambon Takrob, Chaiya District, Suratthani Province and then cutting and keeping some branches of the 2-month, 3-month and 4-month *Hibiscus tiliaceus* to be the experimental materials.

2.1.2 Removing the outer bark of those branches.

2.1.3 From the fresh bark, peeling off the outer cover, keeping only the inner layer i.e. the fiber. Then combing the fiber.

2.1.4 Washing the fiber and then sundrying it.

2.2 The study of the characteristics and properties of *Hibiscus tiliaceus* fiber

The study at this step included the following aspects of the fiber: the longitudinal and cross sectional characteristics, the chemical and the physical properties. The chemical properties in terms of burning and dissolving in chemicals were tested by standardized tests AATCC Test Method 20-2005 while the physical properties in terms of single fiber strength, fiber length and moisture content were tested by standardized tests ASTM D 3822-2001 Standard Test Method for Tensile Properties of Single Textile Fiber, ASTM D 5103-01 Standard Test Method Length and Length Distribution of Manufactured Stable Fiber, and ASTM D2654-89a Standard Test Methods for Moisture in Textiles, respectively.

2.3 The production process of *Hibiscus tiliaceus* yarn with fibers of different ages

The Completely Randomized Design (CRD) was employed for the experiment planning. The yarn production process was as follows.

2.3.1 Preparing 3 kilograms of the 2-month, 3-month and 4-month *Hibiscus tiliaceus* fibers.

2.3.2 Arranging the fibers and fastening them in bunches of 2 inches each.

2.3.3 Spining the fibers with the traditional hand yarn spinning, the local wisdom of Prachin Buri Province.

2.4 The study of the characteristics and properties of *Hibiscus tiliaceus* yarn

The characteristics of *Hibiscus tiliaceus* yarn were studied from the lengthwise aspect by means of the Scanning Electron Microscope. The study of the physical properties in four aspects was undertaken by means of different tests as follows: the Yarn Numbers, by standardized tests ASTM D 1059 - 2001 Standard Test Method for Yarn Number Based Short-Length Specimens; the Single Yarn Strength, by standardized tests ASTM D 2256-2002 Standard Test Method for Tensile Properties of Yarn by the Single-Strand Method; the Yarn Twist, by standardized tests ASTM D1 4 2 3 - 1999 Standard Test Method for Twist in Yarn by Direct-Counting; and the Unevenness, by standardized tests ASTM D 2255 - 02 Standard Test Method for Grading Spun Yarns for Appearance.

3. Results and Discussion

The research results responding to the objective of the study were presented in three parts as follows:

3.1 The characteristics and properties of *Hibiscus tiliaceus* fiber of different ages

3.1.1 The study result of the longitudinal and cross sectional characteristics of *Hibiscus tiliaceus* fibers of different ages

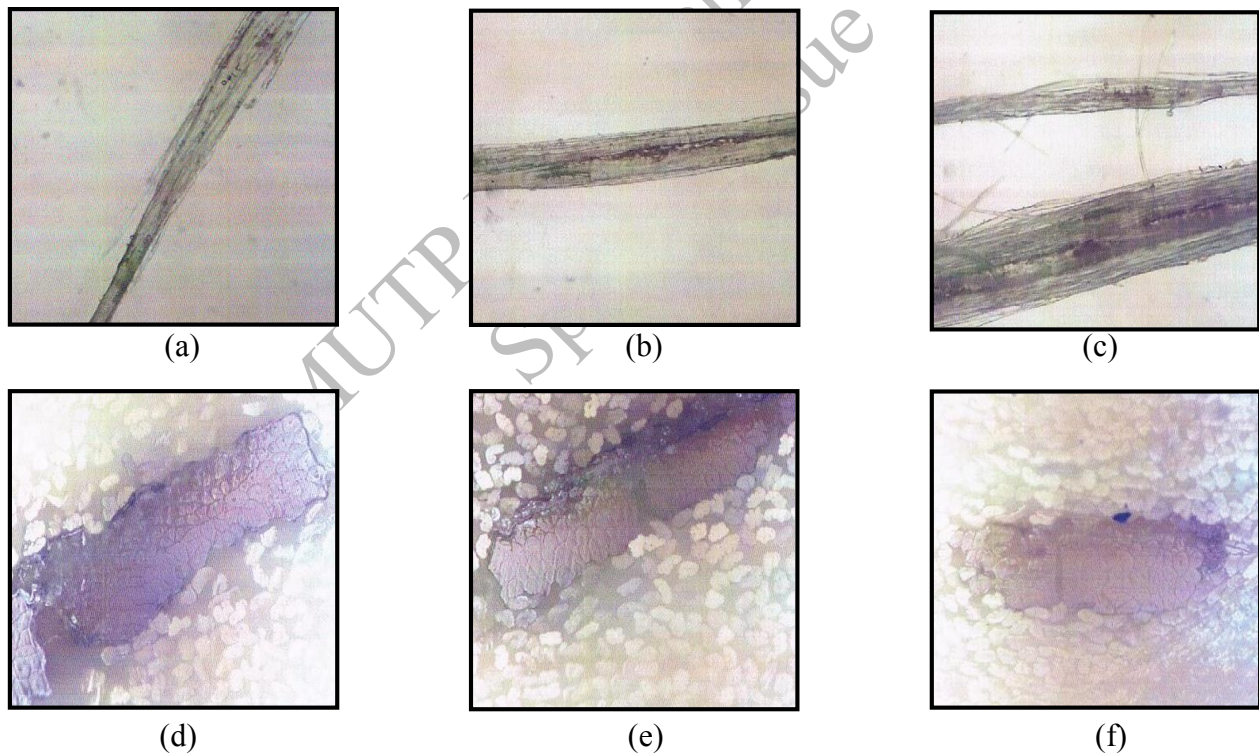


Figure 2. The longitudinal characteristics and cross section of *Hibiscus tiliaceus* fiber

- (a) the longitudinal characteristics of the 2-month fiber (Magnification 40X)
- (b) the longitudinal characteristics of the 3-month fiber (Magnification 40X)
- (c) the longitudinal characteristics of the 4-month fiber (Magnification 40X)
- (d) the cross sectional characteristics of the 2-month fiber (Magnification 200X)
- (e) the cross sectional characteristics of the 3-month fiber (Magnification 200X)

(f) the cross sectional characteristics of the 4-month fiber (Magnification 200X)

The result indicated that the longitudinal characteristics of the fibers of different ages were uneven. Considering the arrangement of the fibers, the 2-month *Hibiscus tiliaceus* fiber displayed fewer fibers than the other two. Concerning the cross sectional characteristics of *Hibiscus tiliaceus* fiber, the cross-sectioned fiber looked like a polygon and there appeared the black shadow of the lumen and smaller size of cells in the 2-month *Hibiscus tiliaceus* fiber while the cells of the 3-month and 4-month fibers were bigger, without any black shadow – just like the Flax fiber of which the longitudinal characteristic was of an oval or elliptical shape while the cross sectional characteristic was uneven similar to the bamboo.

3.1.2 The result of the chemical properties tests

The result showed that the fibers of all ages burned quickly, giving the smell of burning paper and gray ash. Concerning the chemical solubility, the fiber was dissolved in sulfuric acid and sodium hyper chloride. [5] It was mentioned that the cellulose fibers had resistance properties against alkali solutions as well as dilute acids, but not against concentrate acid or dilute acid at high temperature.

3.1.3 The test result of the physical properties of *Hibiscus tiliaceus* fiber of different ages.

Table 1 The result of physical properties tests of *Hibiscus tiliaceus* fiber of different ages.

<i>Hibiscus tiliaceus</i> fiber	Single Fiber Strength (Newton)	Fiber Length (cm)	Moisture Content fiber (%)
2-month	13.46	3.12	12.29
3-month	14.37	3.89	11.94
4-month	16.34	5.61	11.14

Form Table 1, the result indicated that the 4-month *Hibiscus tiliaceus* fiber had the highest strength and the longest length with an average strength of 16.34 N. and the average length of 5.61 cm. while the average strength and the average length of the 3-month *Hibiscus tiliaceus* fiber were 14.37 N. and 3.89 cm., and the average strength and average length of the 2-month *Hibiscus tiliaceus* fiber were the smallest of 13.46 N. and 3.12 cm., respectively. However, the average moisture absorption of the 2-month *Hibiscus tiliaceus* fiber was the highest of 12.29 per cent which was similar to the moisture absorption of the flax fiber. This high moisture absorption indicated the good moisture absorption property that helped enhance the fiber flexibility. [6]

3.2 The production process of *Hibiscus tiliaceus* yarn with fibers of different ages

Through the production process, the fibers of different ages were separated, washed and hand spun to produce the unique *Hibiscus tiliaceus* yarn. From the comparison, it was found that the 4-month fiber could produce the highest weight of 90 g. and the longest length of 45 m. yarn while the 3-month fiber could produce yarn of 710 g. and 25.20 m., and the 2-month fiber could produce yarn of 630 g. and 14.20 m.



(a)



(b)



(c)

Figure 3. *Hibiscus tiliaceus* yarn

(a) 2-month *Hibiscus tiliaceus* yarn

(b) 3-month *Hibiscus tiliaceus* yarn

(c) 4-month *Hibiscus tiliaceus* yarn

3.3 The Characteristics and Properties of *Hibiscus tiliaceus* Yarn of different ages

3.3.1 The study result of longitudinal characteristics of *Hibiscus tiliaceus* Yarn of different ages.



(a)



(b)



(c)

Figure 4. The longitudinal characteristics of *Hibiscus tiliaceus* yarn

(a) longitudinal characteristics of the 2-month yarn (Magnification 40X)

(b) longitudinal characteristics of the 3-month yarn (Magnification 40X)

(c) longitudinal characteristics of the 4-month yarn (Magnification 40X)

Concerning the longitudinal characteristics of the yarn, it was found that the yarn was in good twisting and alignment.

3.3.2 Concerning the physical properties tests on four aspects: Yarn Numbers, Single Thread Strength, Yarn Twist and Unevenness, the findings were as follows.

Table 2 The result of physical tests of *Hibiscus tiliaceus* yarn of different ages.

<i>Hibiscus tiliaceus</i> Yarn	Yarn Numbers (Tex)	Single Thread Strength (Newton)	Yarn Twist (Inch)	Unevenness (Grades)
2-month	1,045.6	97.58	3.2 Twist / S	C
3-month	1,000.1	111.39	3.2 Twist / S	B
4-month	903.9	108.64	4.7 Twist /Z	A

Form Table 2, the result indicated that the 2-month yarn had the biggest Yarn Number of 1,045.6 Tex while the 3-month yarn had the highest average Single Thread Strength of 111.39 Newton and the 4-month yarn had the highest Yarn Twist of 4.7 Twist per inch and its unevenness was at A level. The thread had good fiber alignment with rough surface all along the thread.

4. Conclusions

The result of the longitudinal and cross sectional characteristics study indicated the *Hibiscus tiliaceus* yarn displayed good arrangement of fibers and had rough surface all along the length. Its cross section looked like a polygon shape and its burning was quick, giving the smell of burning paper and gray ash. In addition, the fiber was dissolved in sulfuric acid. Concerning the physical properties test, the 4-month *Hibiscus tiliaceus* fiber had the highest strength and the longest length and the average moisture absorption of the 2-month *Hibiscus tiliaceus* fiber was the highest. The experiment on the production and properties of *Hibiscus tiliaceus* yarn showed that the 4-month *Hibiscus tiliaceus* fiber could produce the smallest and longest yarn while the 3-month fiber produced the yarn of the highest average strength which could be used as special yarn or strong home textiles products. Obviously these products are of unique quality as they are made from a new type of natural fiber and they could also be an additional option for the Thai textile industry

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