

## **The Study on Physical Characteristics of Water Hyacinth Fibers by Scanning Electron Microscopy**

**Apichote Urantinon**

School Civil Engineering, Faculty of Engineering and Architecture, Rajamangala University of  
Technology Suvarnabhumi, Thailand.

Email : apichote.u@rmutsb.ac.th

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### **Abstract**

This study investigated the physical properties of water hyacinth fibers. The sources of samples in this study are 3 areas: (1) Klong-Rangsit Pathumthani Province, (2) Klong-Phasicharoen Bangkok and (3) Khlong Leb-Khlong-Papa, Nonthaburi Province. The steps of study are carving water hyacinth by mechanical methods and investigate the physical properties of water hyacinth fibers by scanning electron microscopy (SEM). For a primary study, the water hyacinth fiber extraction was done using the mechanical method. It combined with the preliminary method using the semi-automatic mechanical extraction machine. The sizes of water hyacinth fibers in three sources are similar since this method using mechanical force was roller grinding; this allowed successful production. Next, the water hyacinth fiber was examined by microscopy at 150x, 500x, 750x and 1,000x. The mechanical extraction method is a group of fibers that are clustered together. The surfaces of fiber were uneven distribution and fiber-like tubular pipe several thousand units per single fiber. In addition, a hollow porous massively complex and the surface of the fiber is similar to a group of tubes with a cluster on a single fiber unit. Furthermore, the surface of the fiber by the similar pipes arranged in an orderly manner. When viewing the image in single transverse fibers, visual appearance across the single fiber is hollow, porous, high density complex. This is a great feature of the fibers in which can retain air better. From the above results gave a clearly visual.

**Keywords :** Water hyacinth Fibers; Scanning Electron Microscopy; Mechanical extraction Method; Tubular Pipe

## Introduction

Water hyacinth is one of the fastest growing plants which commonly spread within streams and water areas. It is the native plant of South America Continent that was brought for cultivating in various places in North America, Australia, Africa, and Europe on an occasion of ornamental plants and flowers exhibition. In 1901, it was brought from Indonesia to Thailand since it has beautiful flowers Papaiwong and Ruanteetep (1995) as shown in Figure 1. Later, it has been drastically spread in rivers and all water bodies around the country. Due to its ability in adaptation and reproduction, it causes various problems to the waterway, both the hydraulics and water quality issues (Saknimit, 1976).

Several researchers have investigated the effects of the aquatic plant on the flow, such as Urantinon et al. (2014) studied effect of water hyacinth density on flow velocity and suspended solid transport in open channel. Urantinon et al. (2015) studied effect of Water Hyacinth on Open-Channel Water Flow Behavior. Ghisalberti and Nepf (1997) investigated the effect of circular wooden submerged cylinders on the flow velocity. Urantinon (2019) studied ability of water hyacinth to absorb heavy metals. But, presently, the natural plant is likely to develop for green production by the technology of natural fibers for economic development. Natural fibers also have attracted attention as promising for use in

many fields as Chaichana (2012) studied effects of fiber types and weaving structures on the puncture resistance, Chand, N. and M. Fahim (2008) studied tribology of natural fiber polymer composites, Chonsakorn et al. (2018) investigated effects of different extraction methods on some properties of water hyacinth fiber, (Techapermphol, 2007) examined polymer composites with treated natural fibers from coconut Siengchin et al. (2017) applied Green Composites Use for Automotive Applications at KMUTNB. Sundari (2012) examined isolation and characterization of cellulose nano-fibers from the aquatic weed water hyacinth - Eichhornia Crassipes. From the above, all research is focusing on the natural fiber, from agricultural production, but aquatic plant as water hyacinth have not been studied widely since it seems not received attention. The development of natural fibers will add value to the waste material, and create products that are environmentally friendly. Thus, the objective of this study is to study physical characteristics of water hyacinth fibers by scanning electron microscopy (SEM).

## Materials and Methodology

The materials is water hyacinth, the material resources were carried in 3 sources as (1) Khlong Rangsit, Pathum Thani Province (2) khlong Phasi-Charoen, Bangkok and (3) khlong Leb-Khlong-Papa,

Nonthaburi Province. The primary method was to remove water hyacinth from the sources, selected maturity materials, as shown in Figure 1, separated the roots and the leaves, and then cutting off the stems about 50 centimeter in length. The remaining part is the stem in which are separated the fibers by the semi-automatic mechanical extraction machine, as shown in Figure 2 and the mechanically extracted water hyacinth fiber bundles, as shown in Figure 3, were air dried at room temperature for 24 hours, as shown in Figure 4. The extraction mechanical method involves five-step process, as follows: (1) placing the stems in the machine, (2) fiber collection, (3) fiber tightening, (4) fiber scouring, and (5) fiber drying. One positive way of using mechanical force was roller grinding, in which produced fast and efficient results with low cost. Next, the physical properties were studied by scanning electron microscopy (SEM), as shown in Figure 5. The sample preparation for the SEM analysis was performed by coating the fiber with 10 mm of gold-colored sputtering coater using an Edward Sputter Coater apparatus for 5 minutes. The SEM image of fiber sample was recorded using a JEOL (Model 6390) electron micro-scope, with an accelerating voltage of 20 kv and a working distance of 15 mm. Next, the process of this microscope is studying and testing materials by sweeping the

electron beam on the surface and taking the signal to create an image. The images from the camera on SEM is high magnification and be able to distinguish the details examined microscopy at 150x, 500x, 750x and 1,000x in which is similar to virtual 3-dimensional depth-high. According to this process, it is possible to identify the characteristic of the surface clearly.



(a)



(b)

**Figure 1** Preparation of fresh water hyacinth stems; (a) fresh water hyacinth from material sources, (b) the fresh water hyacinth stems.



Figure 2 The semi-automatic mechanical extraction machine.



Figure 5 Scanning Electron Microscopy (SEM).



Figure 3 The mechanically extracted water hyacinth fiber bundles.



Figure 4 The fresh water hyacinth fiber bundles, dried at room temperature for 24 hours.

## Results

### 3.1 The primary results for the water hyacinth fiber extraction using the mechanical method

The primary results for the water hyacinth fiber extraction using the mechanical method, combined with the preliminary method using the semi-automatic mechanical extraction machine, the fiber size was reduced. Ordinarily, the fibers from 3 sources as, (1) Khlong Rangsit, Pathum Thani Province is about 0.74 mm, (2) Khlong Phasi-Charoen, Bangkok is about 0.68 mm and (3) Khlong Leb-Khlong-Papa, Nonthaburi Province is about 0.91 mm, respectively. The sizes of water hyacinth fibers in three sources are similar since this method using mechanical force was roller grinding; this allowed successful production, with the benefit of low cost. The water hyacinth fibers produced parallel fiber bundles, as shown in Figure 6a, 6b and 6c, respectively.



(a)



(b)



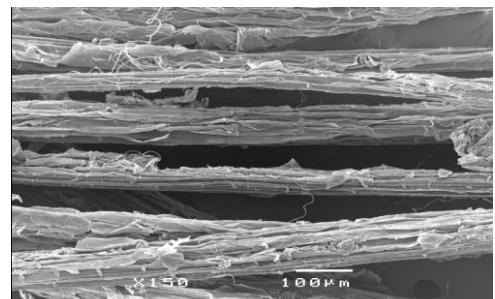
(c)

**Figure 6** The dried water hyacinth fiber bundles, (a) The samples from Khlong Rangsit, Pathum Thani Province, (b) from Khlong Phasi-Charoen, Bangkok and (c) from Khlong Leb-Khlong-Papa, Nonthaburi Province.

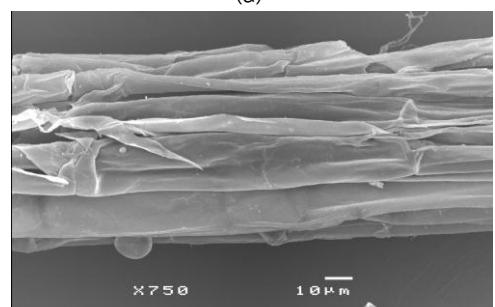
### 3.2 The secondary results for the physical characteristics of water hyacinth fibers by scanning electron microscopy (SEM)

The secondary results were studied the physical characteristics of water hyacinth fibers by scanning electron microscopy (SEM) at 150x, 500x, 750x and 1,000x. Next, ordinarily, the physical characteristics fibers from 3 sources are examined, as detail.

(1) Khlong Rangsit, Pathum Thani Province is shown in Figure 7a, 7b, 8a and 8b.

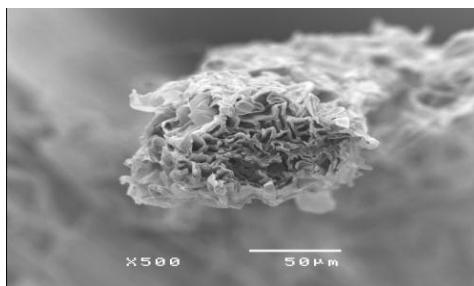


(a)

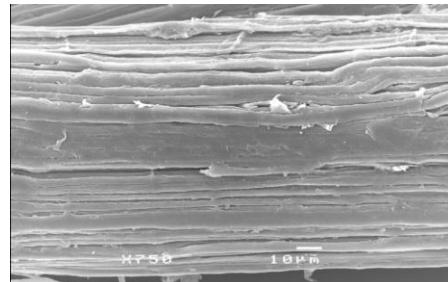


(b)

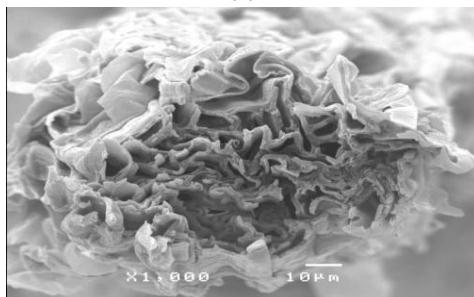
**Figure 7** The physical characteristics of the water hyacinth fibers through extraction with the mechanical method characteristics of the image SEM (a) images of the length of the fiber (150X) and (b) image of the length of a single fiber (750X).



(a)



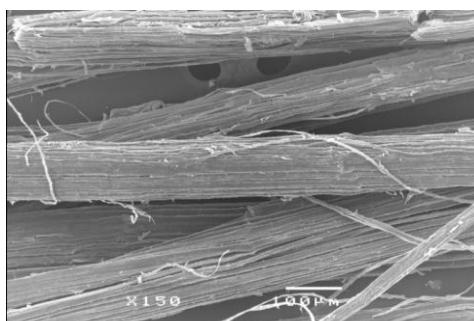
(b)



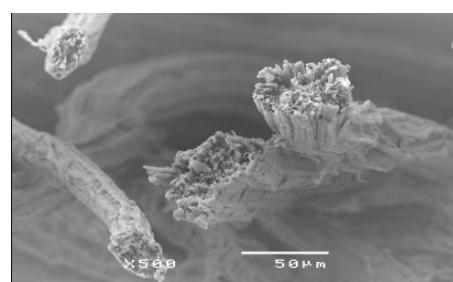
(b)

**Figure 8** The physical characteristics of the water hyacinth fibers through extraction with the mechanical method characteristics of the image SEM (a) Cross section of fiber (500X) and (b) a cross section of the fiber (1,000X).

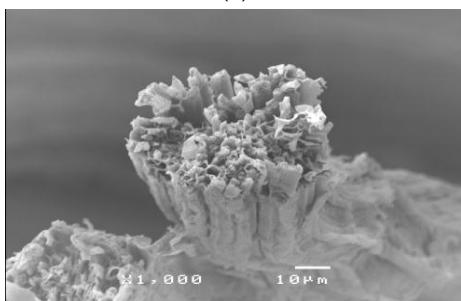
(2) Khlong Phasi-Charoen, Bangkok is shown in Figure 9a, 9b, 10a and 10b.



(a)



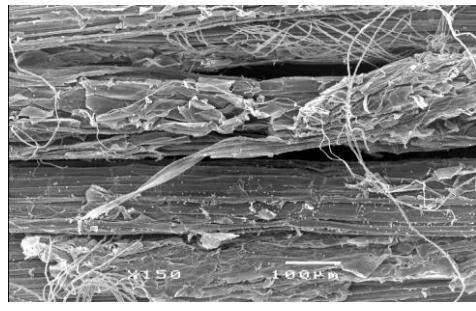
(a)



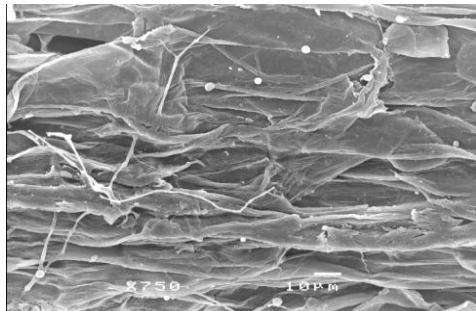
(b)

**Figure 10** The physical characteristics of the water hyacinth fibers through extraction with the mechanical method characteristics of the image SEM (a) Cross section of fiber (500X) and (b) a cross section of the fiber (1,000X).

(3) Khlong Leb-Khlong-Papa, Nonthaburi Province is shown in Figure 11a, 11b, 12a and 12b, respectively.

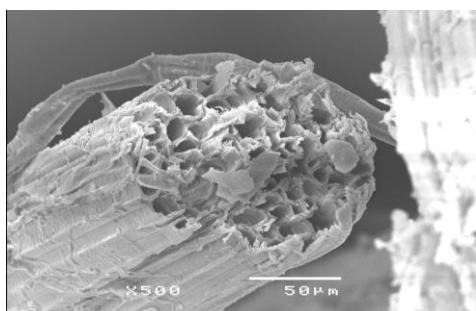


(a)

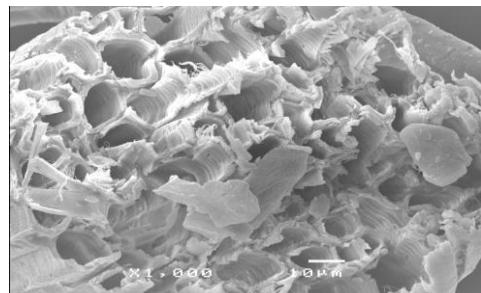


(b)

**Figure 11** The physical characteristics of the water hyacinth fibers through extraction with the mechanical method characteristics of the image SEM (a) images of the length of the fiber (150X) and (b) image of the length of a single fiber (750X).



(a)



(b)

**Figure 12** The physical characteristics of the water hyacinth fibers through extraction with the mechanical method characteristics of the image SEM (a) Cross section of fiber (500X) and (b) a cross section of the fiber (1,000X).

## Discussions

The primary results for the water hyacinth fiber extraction using the mechanical method, combined with the preliminary method using the semi-automatic mechanical extraction machine, the fiber size was reduced. Ordinarily, the fibers from 3 sources as, (1) Khlong Rangsit, Pathum Thani Province, (2) khlong Phasi-Charoen, Bangkok and (3) khlong Leb-Khlong-Papa, Nonthaburi Province. The sizes of water hyacinth fibers in three sources are similar since this method using mechanical force was roller grinding; this allowed successful production, with the benefit of low cost.

The secondary results were studied the physical characteristics of water hyacinth fibers by scanning electron microscopy (SEM) at 150x, 500x, 750x and 1,000x. Next, ordinarily, the physical

characteristics fibers from 3 sources are examined.

The samples from Khlong Rangsit, Pathum Thani Province, shown in Figure 7 and Figure 8, the water hyacinth fibers through mechanical extraction methods were as showing the size of the fibers that are very detailed and very small and a group of fibers that are cluster in Figure 7 (a) fiber surface uneven distribution of natural fibers from plants and image of a single fiber in Figure 7 (b) the surface of the fiber by a clear tube that resembles a tangle of pipes per unit single fiber, as shown in Figure 8 (a). The image feature of a single fiber crosswise in Figure 8 (b) is a cavernous porous high-density complex. This is a great feature of the fibers can retain air better. The characteristics of water hyacinth fibers were large lumens representing air holes (Chonsakorn S et al., 2018).

The samples from Khlong Phasi-Charoen, Bangkok, shown in Figure 9 and Figure 10, the water hyacinth fibers were as a group of fibers that are clustered together in image 9 (a), the fiber surface is relatively smooth fibers with a beautiful arrangement of fibers in the same direction as possible and a single strand of a longitudinal image in Figure 9 (b), the surface of the fiber by the similar pipes arranged in an orderly manner. When viewing the image in single transverse fibers, as shown in Figure 10 (a) and 10 (b), a hollow porous massively complex.

The surface of the fiber is similar to a group of tubes with a cluster on a single fiber unit.

The sample from Khlong Leb-Khlong-Papa, Nonthaburi Province, shown in Figure 11 and Figure 12. The water hyacinth fibers were as a group of fibers that are clustered, as shown in Figure 11 (a), and similar together in image 7 (a) and 9 (a). The surface fibers are not smooth and quite rough. A longitudinal image of monofilaments in Figure 11 (b). The surface of the fiber as a pipe with a mess of overlapping units per single fiber, as shown in Figure 12 (a), is disorderly. When viewing the image across the monofilaments in Figure 12 (b) is a cavernous hole that is quite large and complexity.

## Conclusions

The water hyacinth fiber extraction using the mechanical method, combined with the preliminary method using the semi-automatic mechanical extraction machine. The sizes of water hyacinth fibers are similar since this method using mechanical force was roller grinding; this allowed successful production, with the benefit of low cost.

The study of the physical properties of water hyacinth fibers, shows a result that 3 sources as, (1) Khlong Rangsit, Pathum Thani Province, (2) khlong Phasi-Charoen, Bangkok and (3) khlong Leb-Khlong-Papa, Nonthaburi Province. The

mechanical extraction method is a group of fibers that are clustered together. The surfaces of fiber were uneven distribution and fiber-like tubular pipe several thousand units per single fiber. In addition, a hollow porous massively complex and the surface of the fiber is similar to a group of tubes with a cluster on a single fiber unit. The surface of the fiber by the similar pipes arranged in an orderly manner. When viewing the image in single transverse fibers, visual appearance across the single fiber is hollow, porous, high density complex. This is a great feature of the fibers in which can retain air better. The fibers skin gave relatively smooth fibers with a beautiful arrangement of fibers in the same direction as possible and were uneven and quite rough with large hole. From the above results gave a clearly visual.

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