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Research Article

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The characteristics of vascular and fiber in plectocomia himalayana

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ABSTRACT

Rattan cane is a kind of plant resource with multipurpose utilization in the tropics and South Asian tropical forests. It is an important forest product second only to wood and bamboo, and with important economic values. Plectocomia himalayana is a special species that has great value for industrialized exploitation. The objective of this paper is to investigate the characteristics of vascular and fiber in Plectocomia himalayana. The microscopic observations and analysis are made to investigate the morphological characteristics of its vascular bundles and fiber. The results show that the vascular bundles as well as the vessels of Plectocomia himalayana increase from external to internal, the areas are 0.126 ㎜^{2} and 0.154 ㎜^{2} on average, and the variation is 0.059 respectively; the area of vessels is 0.015 ㎜^{2} and 0.042 ㎜^{2}，and the variation is 0.013; the length and width of the fiber are 1.216mm, 0.025mm respectively, the longest is 1.99mm, the ratio (length/width) is 50.87, the diameter and cavity are 15.99μm、10.33μm, respectively, the double wall thickness is 6.113μm, the lumen-diameter and wall thickness-lumen ratio are 0.646 and 0.592.

Key words: Plectocomia himalayana, Vascular bundle, Vessel, Fiber

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INTRODUCTION

Rattan, as a palmae, is an important non-timber forest product. Of the 600 species found throughout the world, about 106 species in 8 genera can be found [1-2]. However, only about 20 species are widely used commercially. Rattan cane (climbing palms) have the longest stems of any vascular plant, with some reported to be well over 100m long [3]. These climbing species also have the widest xylem vessels among palms [4] and thus follow the widespread trend of climbers in having wider vessels than do related non-climbing species [5-6]. In addition, all vascular tissues are primary and thus must function for the entire life of the stem.

The utilization of rattan is dependant on its basic characteristics such as anatomical features, physical properties and chemical compositions [7-8]. Vascular features and details of vascular structure are described for the first time by Tomlinson and Fisher [9] and Tomlinson [10] et al and then with research on structural variability of vascular bundles and cell wall [11]. There is also some research about rattan cane on the anatomical characteristics. The fiber morphological characteristics of Daemonorops margaritae has been studied already[12], thus there also about anatomical and physical properties of rattan species, some researches on anatomical and physical properties showed that there are variation in the stems of rattan cane[13], less research about the vascular distribution are reported.

Since the available information on such properties is lacking and many rattan species remain unutilized, research is needed to determine the properties of those species and develop their appropriate utilization technology. To better relate and understand these unique structures and properties, we must determine the size and structure of the vessels in a variety of rattan palms growing under natural conditions. Plectocomia himalayana is used in this experiment,

and it will provide the basis for the future use.

EXPERIMENTAL SECTION

Fiber preparation

Plectocomia himalayana were collected from about 50 plants in Yingjiang, Yunnan Province, China, with a size of about 36cm in length on average, and a diameter of 2.2cm. The material was cut into strips (20 mm longitudinally), then the strips were immersed in a chemical solution (one part H_2O_2 and one parts HAc) and kept at 85□ for 8h to separate. All the fibers were washed to neutrality for measurement.

SEM samples preparation

The materials were kept in open air for several weeks, then about 30 samples were selected from the middle section of the rattan cane, which were then immersed in water for a week to soften. A flat cross-section was obtained by a slicer, then a SEM scanning electron microscope was used to obtain a morphology to research the distribution characteristics of vascular bundles and so on.

RESULTS AND DISCUSSION

2.1 Microstructure

By using the SEM scanning electron microscope, in transverse section, the basic components of cuticle, cortex and vascular tissue(Fig.1). The vascular bundles are combined by xylem, phloem, parenchyma cell and fibrous sheath. The largest bundles usually have one wide metaxylem vessel element, several narrow metaxylem vessel elements and protoxylem vessel elements, sometimes interconnected irregularly and joined to the larger bundles. Phloem is usually divided into two separate areas in one bundle. There are also pits tissue on the cell wall, substances which could interpenetrate in transverse.

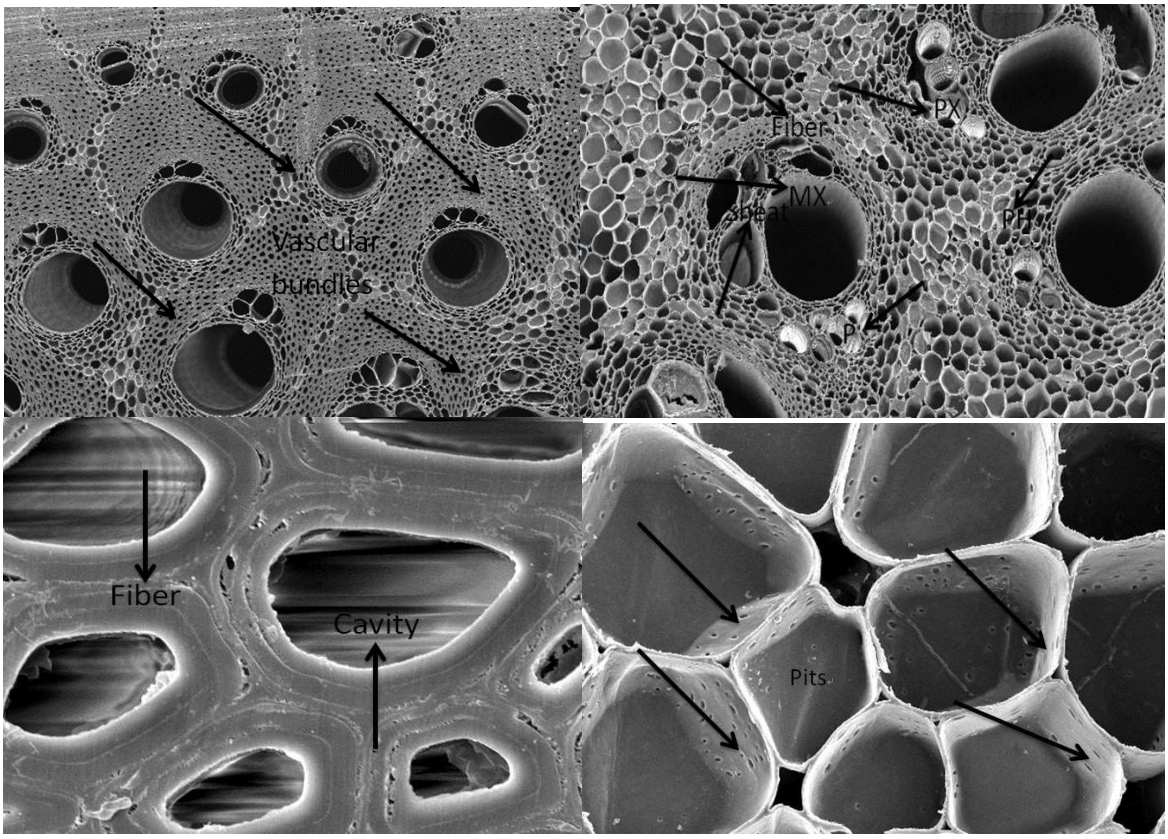

Fig. 1 Microstructure of rattan cane

2.2 Characteristics of vascular bundles

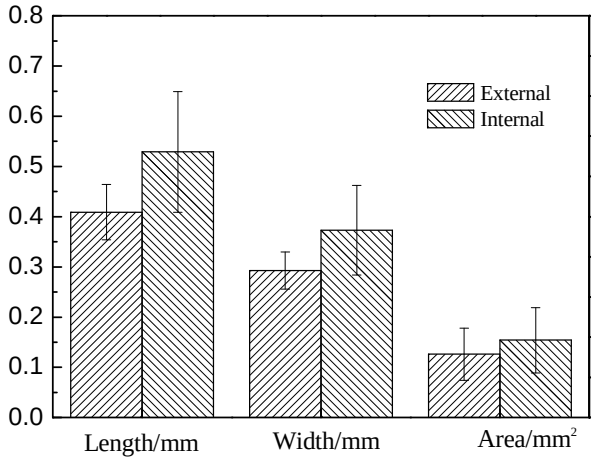

Fig.2 Distribution and area of vascular bundles

The distribution and area of rattan cane (Fig.2). The density distribution of vascular bundles has an important influence on the toughness of the stems[14]. The area of vascular bundles gradually increases from external to internal, the length (in radial) are 0.409mm and 0.529mm, respectively, the standard deviation is 0.087; the width (in tangential) are 0.293mm, 0.373mm, and the standard deviation is 0.063, the length-width ratio are 1.39 and 1.42, the area of vascular bundles are 0.126mm^2, 0.154mm^2, standard deviation is 0.059; and the number of the vascular in a unit are 2.89 and 1.85 respectively. There is a negative correlation between the size and density of vascular bundles, for example, when the area of vascular bundles is smaller, the density is greater, and the number of vascular bundles is more in unit area, so the external is tougher than internal.

2.3 Characteristics of vessel

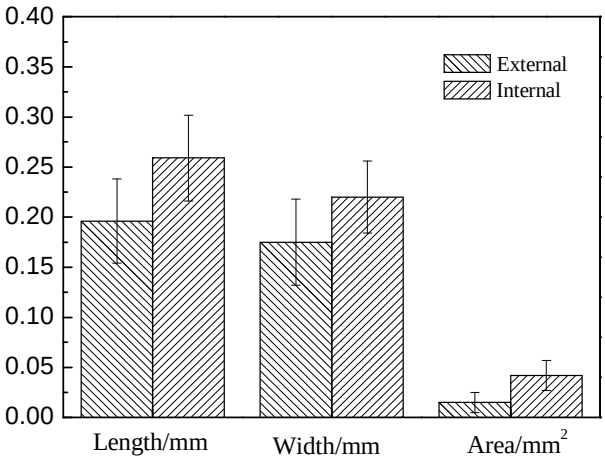

Fig.3 Distribution and area of vessel

The distribution of vessel elements can be seen above (Fig.3). Vessel elements are important components, the main function being transportation and some mechanical support. Studies have showed that the area of vessel elements are gradually increasing from external to internal, the size are 0.196mm and 0.257mm in length, 0.175mm and 0.22mm in width, the standard deviation are 0.042 and 0.036, respectively, the area are 0.015mm^2 and 0.042mm^2, the standard deviation is 0.013, the number of the vessel in one unit are 2.32 and 1.75. There is a negative correlation between the size and density of vessel elements. When the area is bigger the density is smaller, so the density is greater near the external, where the number of vessels is more per unit area.

2.4 Fiber characteristics

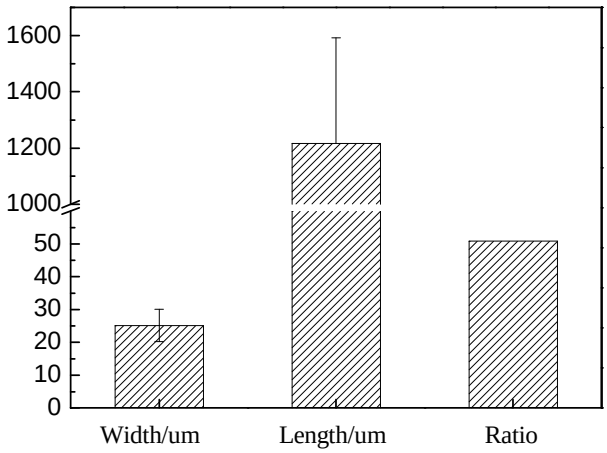

Fig.4 Characteristics of fiber

The characteristics of fiber are presented (Fig.4). Fiber length is one of the main factors in the paper and fiber industry, and has an important influence on the paper strength. Research has shown that there is a certain relationship between folding and bursting[15]. In this study, the length and width are 1.216mm, 0.025mm respectively, the longest is 1.99mm, and ratio (length/width) is 50.87. In addition, the diameter and cavity are 15.99μm 、 10.33μm, respectively, the double wall thickness is 6.113μm, the lumen-diameter and wall thickness-lumen ratio are 0.646 and 0.592. In general, the size has a great impact on the performance of the paper. When the ratio is gradually increasing, it is more suitable for paper making. The ratio of the fiber material should be greater than 30. When it is more than 100, the material will be excellent in paper making [16].

RESULTS

Structure determines performance. Anatomical characteristics and analysis of the anatomical features are useful for the better processing, and also increase the value of rattan cane materials. The results showed that there are some anatomical differences, for example, the area of vascular bundles and vessels gradually increase from external to internal, the standard deviation are 0.059 and 0.013, which has a negative correlation between the size and density. In the fiber studies, the length and width are 1.216mm, 0.025mm respectively, the longest is 1.99mm, and the ratio (length/width) is 50.87. In addition, the diameter and cavity are 15.99μm、10.33μm, respectively, the double wall thickness is 6.113μm, the lumen-diameter and wall thickness-lumen ratio are 0.646 and 0.592.

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