Fiber Properties of Kenaf *(Hibiscus cannabinus L.)* grown between Rubber Trees

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ABSTRACT

Kenaf plant (Hibiscus cannabinus L.) are becoming popular due the nature of fast growing and having unique properties which can be used as an alternative source for the manufacture of fiber-based products. Young kenaf plants aged between three to four months planted in the rubber plantation (clone RRIM 2024) were studied for the fiber properties such as fiber length, fiber diameter, cell wall thickness and lumen width. Variation of fiber properties was assessed for three different height levels namely top portion, middle portion and bottom portion (basal). Fiber length of kenaf tree showed significant variation for the three height levels with the longest fiber at the bottom portion of the tree (1.97 mm). Similar trend was exhibited by fiber diameter (86.9 μm). The vertical variation of cell wall thickness and lumen width followed the same trend with the thickest fiber wall (20.3 μm) and the largest lumen width (46.4 μm). Such findings revealed that fiber source from the bottom portion of kenaf plants has great potential in the hope to fulfill the need for alternative source of fibers much needed in the manufacture of composite materials including fiber-based products.

Keywords: *Kenaf, fiber length, fiber diameter, cell wall thickness, lumen width*

Introduction

Kenaf plant *(Hibiscus cannabinus* L.*)* belongs to the Malvaceae family and was introduced into Malaysia at Bukit Redan Pahang from its native countries such as Africa, India and America. The advantage of kenaf today makes it as one of the choices in plantation sector, and was reported to have the potential as raw material in the wood based industries in our country (Akhir, n.d.). It is the intention of the Malaysian Government to find alternative resources for bio-composite materials in lieu to the depleting wood resources from natural forest.

Kenaf has many advantages; these include fast growing as well as multiple uses from different parts of the plant. The bark can produce fibre, top leafy portion for animal forage; flowers for seed and core fibre for paper products (Mahieu et al., 1970). Besides, kenaf has been found to be suitable to be grown in the tropical country due to its high water requirement. To improve the yield of kenaf fibre, Malaysian Agriculutre Research and Development Institute (MARDI) has published various articles such as Manual Teknologi Pengeluaran Kenaf Di Malaysia and Agromedia and provides' 'Kenaf Defibring Machine' to facilitate working process. One of kenaf plantation about 50 hectare at Pekan, was planted as fibers material for future as a biocomposite material (Akhir, n.d.).

Although kenaf has been reported to have a great potential for future bio-composite products, there is current a gap of information regarding the anatomical features of the plants. Nowadays, kenaf becomes popular among the other resources in wood industry because of the characteristic that suitable as a future composite product (Ramaswamy et al., 2002). However, the characteristics of kenaf such as fiber properties are not well known. Therefore, the objective of this paper is to study the fiber properties of kenaf plants grown between rubber trees in a rubber plantation.

Materials and Methods

The plant samples used in this study were obtained from kenaf plantation at Jengka 8, Pahang. The age of the kenaf plant during the time of harversting was about four months old. The average height of the kenaf plant was about 4.5 m. Ten kenaf plants were selected randomly and harvested. The bottom portion of the plants were marked at about 30 cm, the middle at about 80 cm, and top was at about 140 cm from the ground level. After that, the kenaf stem were allow about two days to stablise the moisture content. Each stem was then cut equally into three portions namely bottom (B), middle (M), and top (T) and labeled accordingly. Then each portion of kenaf stem was cut into about 5.08 cm for each sample for the analysis.

Prior to determining the fibre morphology, fibre maceration procedure was carried out. The samples for each portion were cut into matchstick size. The matchstick sizes were put into conical flask and macerated with natrium chlorite ($NaClO_2$), 25% glacial acetic acid (CH_3CHOOH) and natrium hydroxide ($NaOH$) in water bath until the matchstick soften. Then the samples were screened and washed with distill water to remove the acid and alkaline solution. Ethanol was then applied to ensure the firmness of the fibres.

The fibres for each portion were mounted on glass slide by adding safranin solution to give color to the fibres and covered with a glass slip. The slides were then observed using a photomicroscopy microscope (LEICA DML S300) under 40 magnifications which is equipped with a set of digital camera. The image was captured and measured using the digital measurement from the computer screen. The best size of fibre was taken randomly and properly documented.

Results and Discussion

The means fiber length (FL) of kenaf *(Hibiscus Cannabinus* L.*)* is shown in Table 1. The means (mm) were 1.968, 1.735, and 1.565 from bottom to top respectively. It shows that the means decreased upward from bottom to top. From the ANOVA table (Table 2), there were significance differences between the bottom, middle to top portion.

From previous study it was found that softwood fibre length is around 3mm, normal tropical hardwood is less than 2mm and bamboo is around 2.8mm. From the result it shows that kenaf fiber is less than 2mm length. Kenaf fibre can be grouped under the tropical hardwood class.

Table 1: Fiber Length of Kenaf According to Portion

Portion	Mean (mm)	Standard Deviation	Maximum	Minimum
Bottom	1.968	0.090	2.17	1.86
Middle	1.735	0.041	1.80	1.65
Top	1.565	0.050	11.63	1.44

Table 2: Summary of the Analysis of Variance of the Effects of Portion on Fiber Properties

Source	DF	FL	FD	LD	CWT
Portion	2	240*.	3537*	960*	1818*

*F-values are significant at p<0.05, FL- fiber length, FD-fiber diameter, LD-lumen diameter and CWT- cellwall thickness

The means fibre diameter (FD) of Kenaf *(Hibiscus Cannabinus* L.*)* is shown in Table 3. The means were 86.963, 77.139, and 57.327 (μm) from bottom to top respectively. It shows that the means decreased upward from bottom to top. From the ANOVA table (Table 2) there were significance differences from bottom middle to top.

Table 3: Fiber Diameter of Kenaf According to Portion

Portion	Mean (μm)	Standard Deviation	Maximum	Minimum
Bottom	86.963	0.710	88.21	85.32
Middle	77.139	3.969	79.96	59.76
Top	57.327	1.095	59.81	55.32

The means lumen diameter (LD) of Kenaf *(Hibiscus Cannabinus* L.*)* is shown in Table 4. The means was 46.399, 38.601 and 36.140 (μm) from bottom to top respectively. It shows that the means decreased upward from bottom to top. From the ANOVA table (Table 2) there were significance differences from bottom middle to top.

Table 4: Lumen Diameter of Kenaf According to Portion

Portion	Mean (μm)	Standard Deviation	Maximum	Minimum
Bottom	46.399	0.677	47.73	44.78
Middle	38.601	1.143	40.01	36.08
Top	36.140	0.621	37.32	35.15

The means cell wall thickness (CWT) of Kenaf *(Hibiscus Cannabinus* L.*)* is shown in Table 5. The means were 20.287, 19.633 and 10.643 (μm) from bottom to top respectively. It shows that the means decreased upward from bottom to top. From ANOVA shown in Table 2 there were significance differences from bottom, middle and top. From the results, CWT is related to the SG. The thicker of CWT give the higher SG. From that it shows that CWT and SG decreased from bottom to top.

Table 5: Cell Wall Thickness of Kenaf According to Portion

Portion	Mean (μm)	Standard Deviation	Maximum	Minimum
Bottom	20.287	0.065	20.35	20.22
Middle	19.633	0.131	19.77	19.51
Top	10.643	0.289	10.83	10.31

Conclusion

It can be concluded that fiber properties of kenaf plant exhibited variation between the three height portions. Fiber length showed significant variation for the three portions levels with the longest fiber at the bottom portion. Similar trend was exhibited by fiber diameter and the value at the bottom was 86.9μm. The vertical variation of cell wall thickness and lumen width followed the same trend with the thickest fiber wall (20.3μm) and the largest lumen width (46.4 μm) for samples near the bottom portion. Kenaf plants has great potential in the hope to fulfill the need for alternative source of fibers much needed in the manufacture of composite materials including fiber-based products.

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