FIBER DIMENSION AND CHEMICAL CONTENTS OF FIBER FROM *PASSIFLORA FOETIDA*, L. AND THEIR SUITABILITY IN PAPER PRODUCTION

Brindha D, Vinodhini S and Alarmelumangai K

P. S. G. R. Krishnammal College for women, Peelamedu, Coimbatore-641 004.
winvino2004@yahoo.co.in

ABSTRACT

The plant *Passiflora foetida*,L. is a common weed in waste places. The fiber extracted from this plant was analyzed for their morphological and chemical properties. The studies on this properties revealed that the cellulose and hemicelluloses content of the fiber are 40% and 36% respectively and Runkel ratio of the fiber is 0.66 which should be less than 1 and the anatomical features of the plant shows the fiber richness of about 17.7%. So, it is suggested that it can be used for paper making industries.

Key words: *Passiflora foetida*, anatomical, chemical and morphological properties.

INTRODUCTION

The global consumption of paper is around 400 million tons for which we are cutting down about 7.2 billion trees to satisfy our need of paper as writing, printing, wrapping and packaging purposes Admin (Green tips, 2010). In India the consumption of paper and paper board is set to be doubled from 10 million tons per annum now to 20million tons per annum by 2020 (Madhukar Mishra, 2011).

Though the mills use a variety of raw materials such as wood, bamboo, recycled fibers, baggase, wheat straw and rise husk etc., (i.e. 35% of production is based on chemical pulp, 44% based on recycled fiber and 21% on agro residues) the growth of paper industry and its quest to attain the global standards in terms of scale, quality and competitiveness has been constrained by shortage of raw materials and its prohibitive cost and energy availability (Madhukar Mishra, 2011).

Hence to overcome this shortage and the increasing demand of paper product the non-woody plants were attracted by the researcher to use them as a source of paper production due to their several advantages such as short growth cycles, moderate irrigation and fertilization requirements and low lignin content which reduces the energy and chemicals used in pulping process (Hurter and Riccio, 1998). The plant *Passiflora foetida* (Fig.1) is a climbing herb and common in waste places. The length of the stem is about 5-6 feet. The leaves are 3-6X3.5 – 8cm, alternate, broadly ovate, 3-lobes, cordate at base and petioles are about 2.5-4cm long.

Investigations on the fiber dimension and chemical composition of the fiber extracted from the plant *Passiflora foetida have* not been carried out so far. Hence, the fiber was extracted from this plant and analyzed for their properties to find out the suitability of the fiber in paper industry.

MATERIALS AND METHODS

IDENTIFICATION OF FIBER IN PLANT MATERIAL:

The hand sections of plant material were taken and stained with safranin for 2minutes and mounted on glass slides with glycerin to identify the fiber bundle with the help of microscope and micrographs (Fig.2) were taken. The fiber richness of the plant material was calculated by measuring the fiber bundle and cross section of the plant with calibrated microscope with ocular meter using following formula,

Fiber richness (%) = Area of fiber bundle / Area of cross section X 100

EXTRACTION OF FIBER:

RETTING PROCESS:

The stems (100 gm) were cut down into equal size (25cm) and immersed in water. After 2 weeks of retting, the fibers were washed thoroughly with tap water to remove the retted skin, pith and other region except the fiber, then sun dried and cleaned to remove remaining dirt materials by combing (Sharma, 1996).

The weight of the fiber cleaned was taken to find out the yield percentage of the plant using the following formula,

Yield (%) = Weight of the fiber/ Weight of the plant material X 100.

FIBER DIMENSIONS AND DERIVED VALUES

MACERATION OF FIBER

The small amount of above cleaned fiber was immersed in acidic solution (10% aqueous nitric acid and 10% aqueous chromic acid in 1:1 ratio) by maintaining the liquor ratio of 1:50 and kept for overnight to digest the pectin substances which stick the fiber cell together to form fiber bundle. Then the fiber was washed thoroughly with water to remove the acidity by centrifugation and stained with safranin for half an hour. The stained fiber was mounted on a glass slide with a drop of glycerin and viewed under light microscope and the micrographs (Fig.3) were taken.

The fiber dimensions were determined using a calibrated microscope at reasonable magnifications of 10X for fiber length and 40X for fiber diameter, lumen diameter and cell wall thickness. For this 10 fibers were measured and the average was taken.

DERIVED VALUES:

Three derived values were calculated for assessing the fiber quality for paper production using the fiber dimensions (Saikia *et al.,* 1997; Ogbonnaya *et al.,* 1997).

A) Slenderness Ratio or Felting coefficient = Fiber length/ Fiber diameter

B) Runkel Ratio or Rigidity coefficient = 2 X Cell wall thickness/Lumen diameter

C) Flexibility Ratio or Elasticity coefficient= Fiber lumen diameter/ Fiber diameter X 100.

CHEMICAL COMPOSITION:

Direct method of cellulose, hemicelluloses and Lignin (Moubasher *et al.,* 1982):

2g of fiber was boiled in ethanol (4 times) for 15min, washed thoroughly with distilled water and kept in oven for dry weight at 40^0C over night, then divided into two parts in which one part is considered as A fraction. Second part of residue was treated with 24% KOH for 4hrs at 25^0C, washed thoroughly with distilled water dried at 80^0C over night and the dry weight taken as B fraction. The same samples again treated with 72% H_2SO_4 for 3hrs to hydrolyze the cellulose and the refluxed with 5% H_2SO_4 for 2hrs. H_2SO_4 was removed completely by washing it with distilled water, dried at 80^0C in oven for over night and dry weight taken as C fraction.

Cellulose = B-C

Hemi cellulose = A-B

Lignin = C itself.

RESULTS AND DISCUSSION

The richness, yield, Chemical and morphological properties of the fiber extracted from the plant *Passiflora foetida* were given in Table 1. The light microscopy of transverse section of the stem revealed the following regions (Fig.2): Epidermal, Cortex, Vascular bundle (secondary phloem and xylem) and pith. The fiber richness and the yield of fiber were 17.7% and 7.6% respectively.

The cellulose content of the fiber was 40% and the lignin content was 24%. The plant material with 34% and over cellulose content and less than 30% of lignin content is useful in paper production (Nieschlag *et al.,* 1960). The average fiber length of *Passiflora foetida* is 1.2mm which is smaller than softwood (2.7-4.6mm) and close to minimum value of hard wood fibers (0.7-1.6mm) (Atchison 1987) and almost same with *Eucalyptus globules* (Teresa *et al.* 2000). The width was 10µm which is lower than hard wood fiber (20-40µm). The fiber cell was thickness is higher than Rye straw (1.1µm) (Usta and Eroglu, 1987). The physical properties of pulp sheet are closely related to morphological properties of pulp fibers (Young, 1981). The strength properties of the papers were positively correlated with the Slenderness ratio. According to Young (1981) and Bektas *et al*., (1999), if the Slenderness ratio is lower than 70, it is invaluable for quality pulp and paper production. But, the Slenderness ratio of the fiber was found as 120 which are higher than 70 and so that it can be utilized in paper industry.

Runkel ratio is one of the most important parameter in qualifying the fiber for paper industry. The Runkel ratio of the *Passiflora foetida* fiber was calculated as 0.66 which is less than 1. Higher Runkel ratio gives lower paper strength properties especially lower burst, tear and tensile indexes (Bektas *et al.,* 1999). If the Runkel ratio is less than 1, the plant would be suitable for paper production (Volkomer, 1969).

Table 1Morphological and Chemical Properties of fiber of *Passiflora foetida,* L.

S.No.	Properties	Value
1	Fiber richness (%)	17.7
2	*Fiber Yield (%)*	*7.6*
3	***Chemical composition (%)***	
	a) Cellulose	*40*
	b) Hemicellulose	*36*
	c) Lignin	*24*
4	***Ultimate fiber cell***	
	a) Fiber cell length (mm)	*1.2*
	b) Fiber diameter (µm)	*10*
	c) Fiber lumen diameter (µm)	*6*
	d) Cell wall thickness	*2*
5	***Derived values***	
	a) Slenderness ratio	*120*
	b) Runkel ratio	*0.66*
	c) Flexibility ratio	*60*

Flexibility ratio is another important criterion for evaluating fiber quality. The Flexibility ratio of the fiber was about 60. If the flexibility ratio was between 50 and 70, this kind of fibers easily can be flat and give good paper with high strength properties (Istas *et al.,* 1954).

CONCLUSION

The investigations of fiber dimensions and cellulose hemicelluloses and lignin content of the plant *Passiflora foetida* along with their various indices showed that the fiber from this plant is suitable for various grades of paper production.

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