Effect of water retting on the chemical composition of *Calotropis gigantea* fibres: Analysis using FTIR Spectroscopy

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ABSTRACT

The use of unconventional natural fibres such as bast fibres from several plants is gaining importance as conventional natural fibres such as cotton, wool, silk are considered less sustainable fibres for several reasons such as the massive water and pesticide consumption for cultivation in case of cotton for instance. The need for sustainable fibres to partly replace these conventional fibres is gaining importance in the field of apparel and textiles. In this study, we have attempted to extract fibres from the stems of Calotropis gigantea using standing water and without any additives, for a period of 3 days. The FTIR spectroscopy of dry extracted calotropis fibres and water-retted fibres was performed. It is observed the effect of water retting is significant and there is a remarkable decrease in the lignin and pectin content. In addition, it is also noticed that the hemi-cellulose content in the fibre also decreased. This shows that water retting is also an efficient and sustainable method for fibre extraction from Calotropis gigantea.

Keywords: *calotropis, retting, cellulose, hemicellulose, lignin*

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1. INTRODUCTION

Calotropis gigantea, sometimes known as milkweed or mudar, is a wasteland weed that is one of the non-wood materials that has not yet reached industrial use. The Greek words "Kalos" for lovely and "tropis" for keel, which refer to the shape of the coronal scales, were combined to create the word "calotropis." A large shrub or small tree in the Asclepiadeae family known as *Calotropis gigantea* (crown flower) is distinguished by its smooth and soft tomentum on stems and lower leaf surfaces, numerous glands at the base of the calyx lobes, broadly campanulate corollas, and coronal scales with a recurved spur at the base.

This particular species, *C. gigantea*, is an Asiatic and can be found all over the Indian subcontinent, southern China, South East Asia, as well as the islands of New Guinea and Hawaii [1]. For the purpose of making fibres, calotropis has been grown throughout South America and the Caribbean Islands. The plant thrives in a wide range of soil types and climatic environments. Calotropis can grow wild up to 900 metres and is fairly tolerant of salt. Several sections of Calotropis gigantea were reported to have various pharmacological effects based on the phytochemicals present [2].

The interest to use unconventional natural fibres is increasing for achieving sustainability in textile products, either in their purest form or as blends with conventional natural fibres such as cotton. Raw bast fibres that are cellulosic contain lignin which is hydrophobic in nature, and the removal of lignin is also essential to improve the absorbency of the fibres. Retting of bast fibres is the conventional method for separation of fibres. In this paper, we discuss the effect of water retting on the chemical composition of the bast fibres extracted from the stem of *Calotropis gigantea.*

2. MATERIALS AND METHODS

2.1 FIBRE EXTRACTION WITHOUT RETTING

The stem of the plant is cut to a length of about 40 to 50 cm. The bark (the outer green cover) of the stem is removed and fibres are extracted from the inner layer of the bark. While extracting the fibres, a slight twist was given (as shown in Figure 1) to keep the fibres intact for further processing.

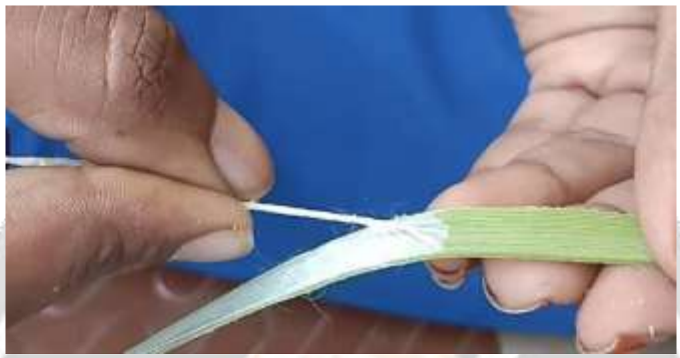

Fig – 1 Extraction of fibres from the bark of the *Calotropis gigantea* plant

2.2 FIBRE EXTRACTION POST RETTING

To ensure that the fibres could be easily removed from the stems without causing any damage, fresh stems were retted by soaking in plain water for 3 days. The barks were removed and the fibres were extracted by hand as described earlier. The fibres were air-dried and analysed for changes in chemical composition.

2.3 CHARACTERIZATION OF FIBRES

The fibres obtained without retting and post-retting were analysed for changes in their chemical composition through FTIR-ATR spectroscopy. The analysis was done in an in-house facility equipped with IRAffinity-1S (Shimadzu®) spectrometer at a resolution of 0.5 cm^{-1}.

3. RESULTS AND DISCUSSION

Calotropis fibre is cellulosic in nature and hence exhibits the characteristic spectra of cellulose in the 2800-3600 cm^{-1} range [3]. The typical cellulosic bands appear between 1000 and 1200 cm^{-1}, and lignin between 1200 and 1700 cm^{-1} (strong footprint in the range of 1500-1600 cm^{-1}).

FTIR spectra of fibre extracted without retting and post-retting are shown, respectively, in Figure 2 and Figure 3. In Figure 2, peaks around 890 cm^{-1} and 1030 cm^{-1} represent, respectively, the C-H of lignin and ethers of lignin and pectin, and the peaks in 1620-1640 cm^{-1} denote the C=C aromatic group of lignin. The broad band around 3348 cm^{-1} is ascribed to the stretching vibration of O-H, which is characteristic of all cellulose fibres.

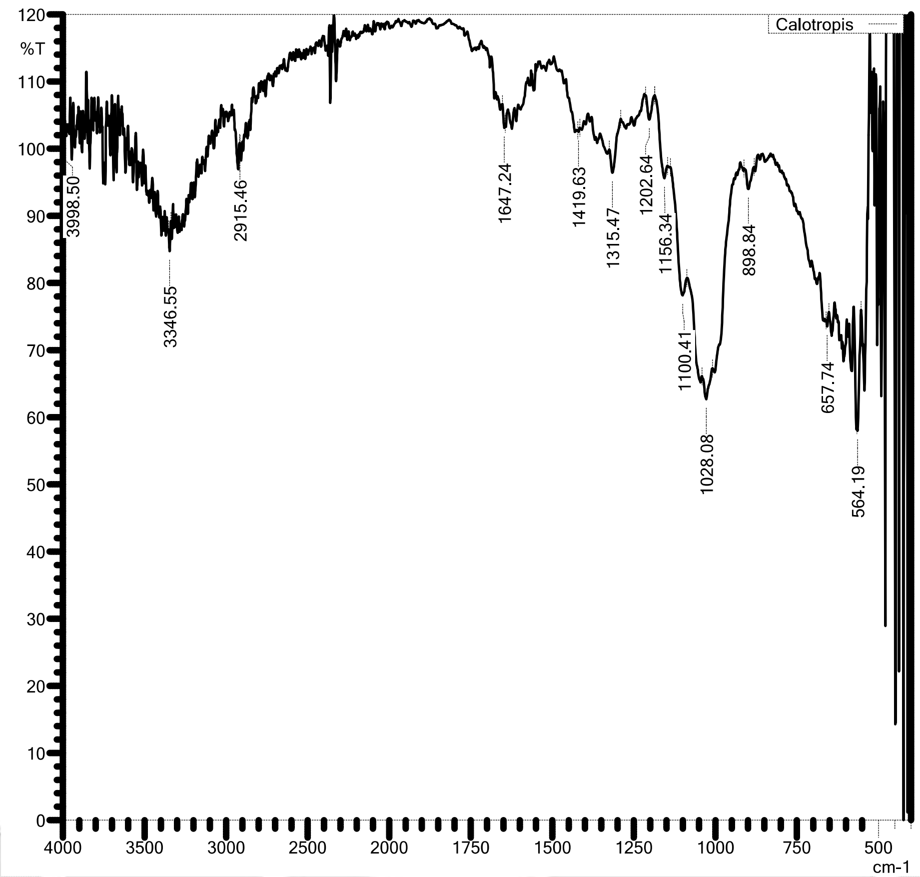

Chart – 1 FTIR spectrum of calotropis fibre as obtained from the plant

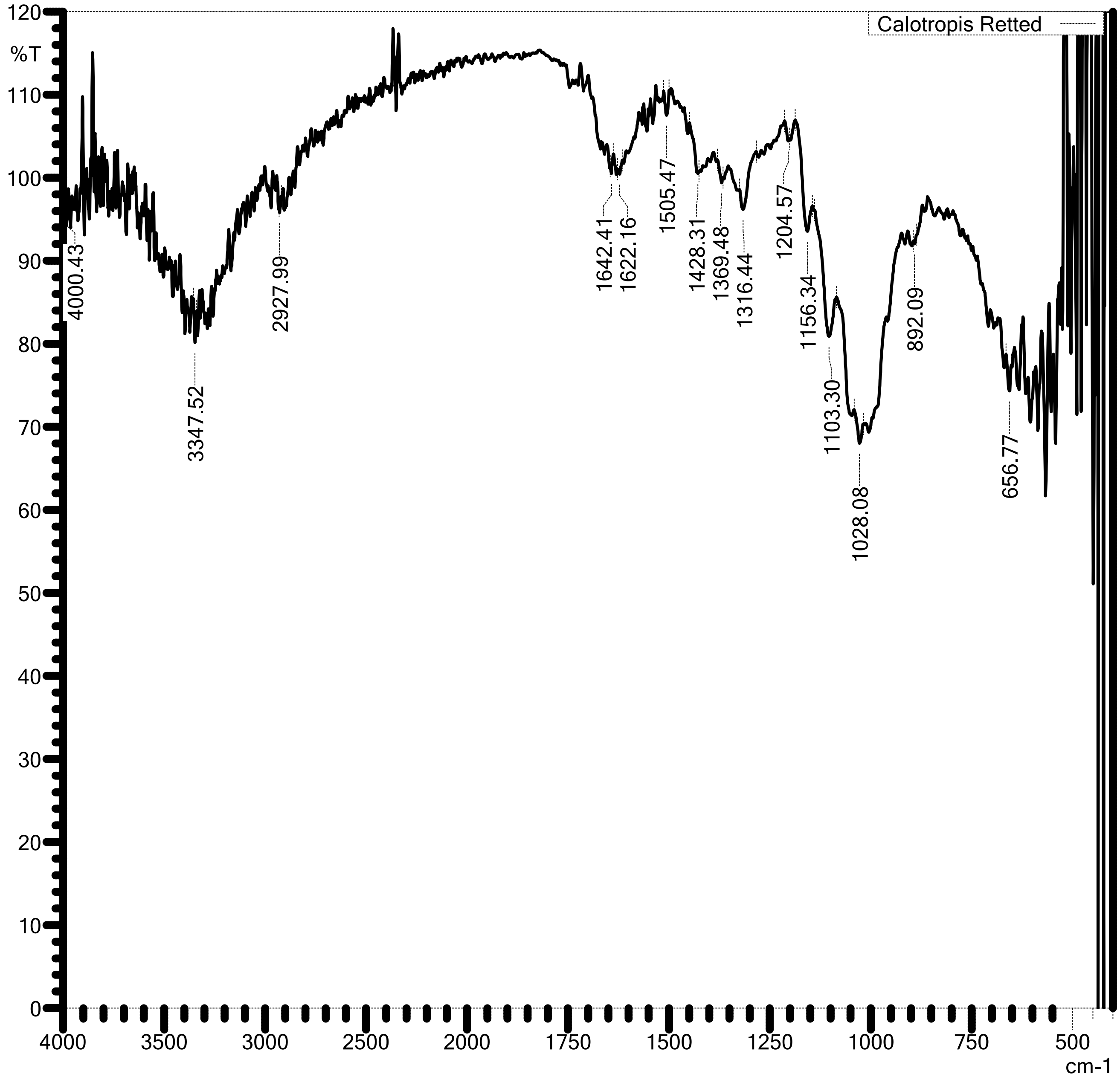

Chart – 2: FTIR spectrum of calotropis fibre after retting with water

Figure 3 shows the FTIR spectra of calotropis fibre post-retting. There is a significant decrease in the peak intensities between 700 and 900 cm^{-1} corresponding to the aromatic hydrogen of lignin and waxes. It is also seen that there is a notable decrease in the intensity of the peak at 890 cm^{-1} and 1030 cm^{-1} corresponding to lignin. These clearly indicate that lignin and waxes have been removed during the water retting process. It could also be seen that the intensity of peak at around 1315 cm^{-1} ascribed to ether in lignin has considerably reduced after retting. In addition, the methyl groups of hemicellulose and methoxyl groups of lignin are represented by peaks around 2900 cm^{-1} show a slight decrease in intensity after retting.

On the other hand, there is an increase in the peak at around 1105 cm^{-1} and around 1155 cm^{-1} corresponding to the C-C ring and ether band of polysaccharide components, respectively. This could be due to an increase in glycosidic components produced during the disintegration of pectin during retting [4].

4. CONCLUSION

Stand retting of bast fibres using water is one of the sustainable methods of fibre extraction from the plant. The use of chemicals for retting simply intoxicates water and the effluent post retting is hazardous to the environment. Efficiency of water retting for bast fibre extraction may be enhanced with the use of suitable enzymes in water [5]. The use of unconventional natural fibres such as from calotropis and their abundant cultivation can open new avenues for their use in apparel and technical textiles. Further study on their properties is required to explore their potential in the field of apparels and textiles.

6. REFERENCES

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