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Biological investigation of Pongamia Pinnata Pierre tree in India

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Abstract

Fourier Transform Infrared Spectroscopy (FT-IR) was used in this study to identify and determine the spectral features of *Padina pavonia* powder on *Pongamia pinnata* L. FT-IR analysis by KBr - pellet method was used for identification of functional groups present in the bioactive compounds of the wood samples of treated and control and their spectra were recorded in the range of 400 to 4000 cm^{-1}. Seaweed powder treatment was found to stimulate the chemical compound alkanes wavenumber 2934.59 cm^{-1} which were not found in control. Though some differences were observed in both treated and control, some chemical compounds were found common with variations in wavenumber. From this result, it is concluded that FT-IR analysis used the functional variations between control and treated wood of *Pongamia pinnata* L. This result may be supportive to find out ash and moisture content of them for future studies.

Key words: 1. Functional groups, 2.FTIR spectroscopy, 3.*Padina pavonica*, 4.*Pongamia pinnata.*

1. Introduction

FTIR Spectroscopy has been recognized as a dependable and sensitive method for finding the functional groups present in the plant extracts and they were determined with the aid of IR region in the range of 400-4000cm-1 (Florence and Jeeva, 2015). It can be employed to determine the structure of unknown composition and the intensity of the absorption spectra associated with molecular composition of the chemical group (Surewicz *et al*., 1993; Sahayaraja *et al*., 2015). Moreover, FT-IR spectroscopy is an established time saving method to characterise and identified functional groups. Infrared spectroscopy (IRS) has been widely used for qualitative and quantitative analysis not only in the food and pharmaceutical industries (Roggo *et al*., 2007;Huang *et al*., 2008; Paschalis *et al*., 2011) but it also has been proven able to produce qualitative and quantitative results for biomass application (Hames *et al*., 2003; Liebemann *et al*., 2010). FT-IR spectroscopy was used for characterization of wood biomass before and after drying process. For example, FTIR has been used successfully for compositional analysis of lignocellulosic biomass (Tucker *et al*., 2001).

Pongamia pinnata (Linn) Pierre is medium sized glabraous tree popularly known as Karanja in Hindi, Indian beech in English and Pongam in Tamil. The ‘Pongam Tree’ is being cultivated in a large number of garden and along the countless roads in India and is becoming the one of the most admired city tree (Duke, 1985). It is known for its multipurpose benefits and as a potential source of biodiesel (Naik *et al.,* 2008). The seeds are reported to contain on an average about 28-34% oil with high percentage of polyunsaturated fatty acids (Sarma *et al*., 2005). The present study is the first attempt to deal with spectroscopic fingerprinting to distinguish between control and treated wood of *Pongamia pinnata* because of the ability of Fourier Transform Infrared spectroscopy to provide information on vital functional groups present in wood samples.

2. Materials and methods

2.1. Experimental setup

To analyse biomass energy production potential of *Pongamia pinnata*, saplings of 2 year old were selected and were grown in the field for $1^1/_2$ years, by supplementing seaweed powder (*Padina pavonia*) 60 gm per month per tree. After $1^1/_2$ years of growth the main trunk was cut. Further, the wood samples were subjected to Fourier Transform Infrared Spectroscopic (FT-IR) analysis.

2.2. FT - IR spectroscopic analysis

Fourier Transform Infrared spectroscopy (FT-IR) by KBr - pellet method (Vijayabaskar and Shiyamala, 2012) was adopted for identification of functional groups present in the bioactive compounds of the wood samples. One milligram wood powder (*P. pinnata*) was mixed with 100 mg of dry potassium bromide (FT-IR grade) and then compressed into a pellet using hydraulic press (5000-10000 psi). The pellet was immediately put into the sample holder and FT-IR (Systronics 166) spectra were recorded in the range of 400 to 4000 cm^{-1}.

3. Results and discussion

FTIR spectroscopy has been used as a simple technique for obtaining rapid information on the structure of wood constituents and chemical changes taking place in wood due to various treatments (Popescu *et al*., 2010). In contrast to conventional chemical analysis, this method requires small sample sizes, short analysis time, and does not destroy the wood structure (Popescu *et al*., 2011). This technique measures the absorption of infrared light at various wavelengths by the materials of interest (Silverstein and Webster, 1998). Recently the FT-IR is being used as a fast reliable and easy analytical tool for analysis of wood and wood derivatives because of its improved spectral quality. Detectable differences in spectra could be obtained even in regions of high background absorption (Rutherford *et al*., 2004; Lammers *et al*., 2009). Several indicator bands in FT-IR spectrum that are pertained to functional groups represent the chemical components or metabolic products. The FT-IR spectrum pattern of treated and control was rather similar, exhibiting the same main band positions and relative intensities. But small differences were observed in the absorption range. The IR band positions observed in the spectra and their assignments are summarized in Table (1) and Fig. (1and 2). The strong absorption bands at 3346.86 cm^{-1} in both treated and control was assumed to be due to the O-H stretching vibrations. O-H stretching vibrations represented the characteristic of amino acids (Rao, 1963). The strong band at 2934.59 cm^{-1} in treated represented $-CH_3$, CH_2 groups which was a characteristic peak for alkanes which were not found in control. This might be attributed to the higher extractives content in this wood, since some compounds in organic extractives, like fatty acid methyl esters and phenolic acid methyl esters, contain methyl and methylene groups (Ishida *et al*., 2007; Popescu *et al*., 2009; Adel *et al*., 2011). The strong band at 1734.84 and 1739.51 cm^{-1} in both treated and control represented C=O stretching which showed the characteristic peaks for aldehydes and ketones. The strong bands between 1644.24 and 1632.92 cm^{-1} of the spectrum of both treated and control wood was due to the C=C stretching vibration. Similar result was recorded in earlier reports (Fagbohun Adebisi *et al*., 2014). The weak bands around 1508 and 1508.46 cm^{-1} of the spectrum of both control and treated wood material was due to the C=C stretching vibration indicative of lignin (Kubo and Kadla, 2005). Schwanninger *et al*., (2004) also studied that the absorption peak at 1510 cm^{-}1 arising from the aromatic skeletal vibration C=C of the benzene ring is characteristic of lignin. The absorption band at 1424.54 and 1429.88 cm^{-1} both control and treated wood material may be due to strong C-H stretching vibration of alkenes. The absorption bands in the region of 1374.55 and 1327.24 cm^{-1} could be assigned to ester sulphate compounds. The absorption band at 1249.86 and 1248.45 cm^{-1} were due to C-O-C stretching vibration of carboxylic acids and their derivatives. The absorption band at 1028.40 and 1249.86 both in control and treated wood material was due to =C-O-C stretching indicative of ethers. Absorption at 608.33 and 605.84 cm^{-1} for both control and treated wood material was due to C-Br stretching of halogen or bromo compounds. The peak intensity may be related to the chemical bond density in the chemical structure of tree barks (Ozgenc *et al.*, 2017). The results of FT-IR spectroscopy confirm the presence of various chemical constituents such as alcohol, alkanes, alkenes, ketone compound, esters, aromatic carboxylic acid, halogen compound and alkyls both in the seaweed treated and control wood of *Pongamia pinnata* with variations in wavenumber. This result may be helpful for identifying enhanced renewable energy biomass.

Fig. 1 FT-IR spectrum of *P. pinnata* wood (Control)

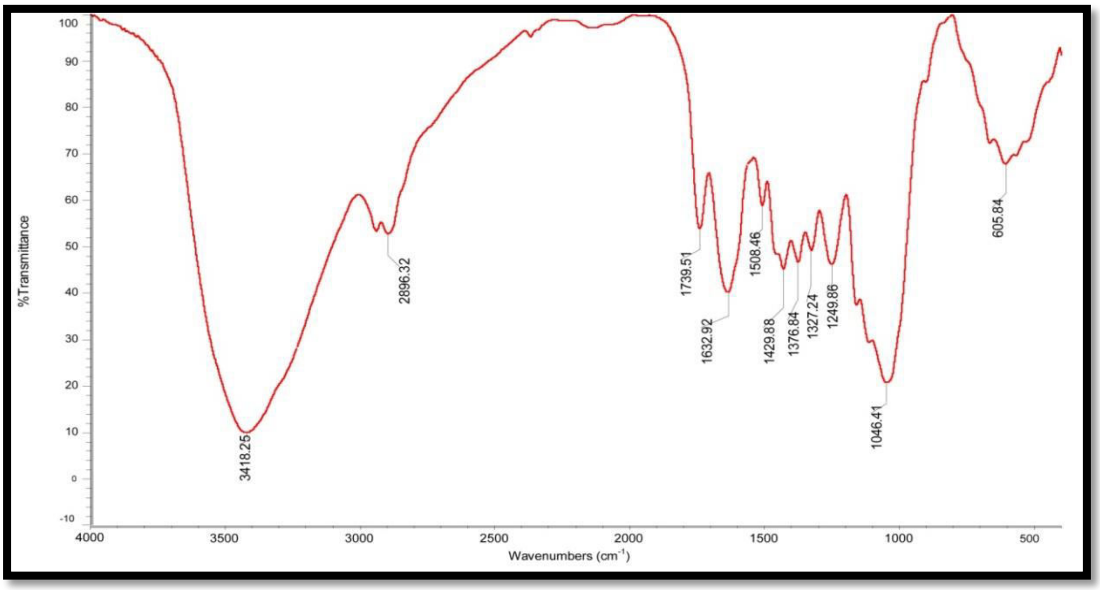

Fig. 2. FT-IR spectrum of *P. pinnata* wood (Treated)

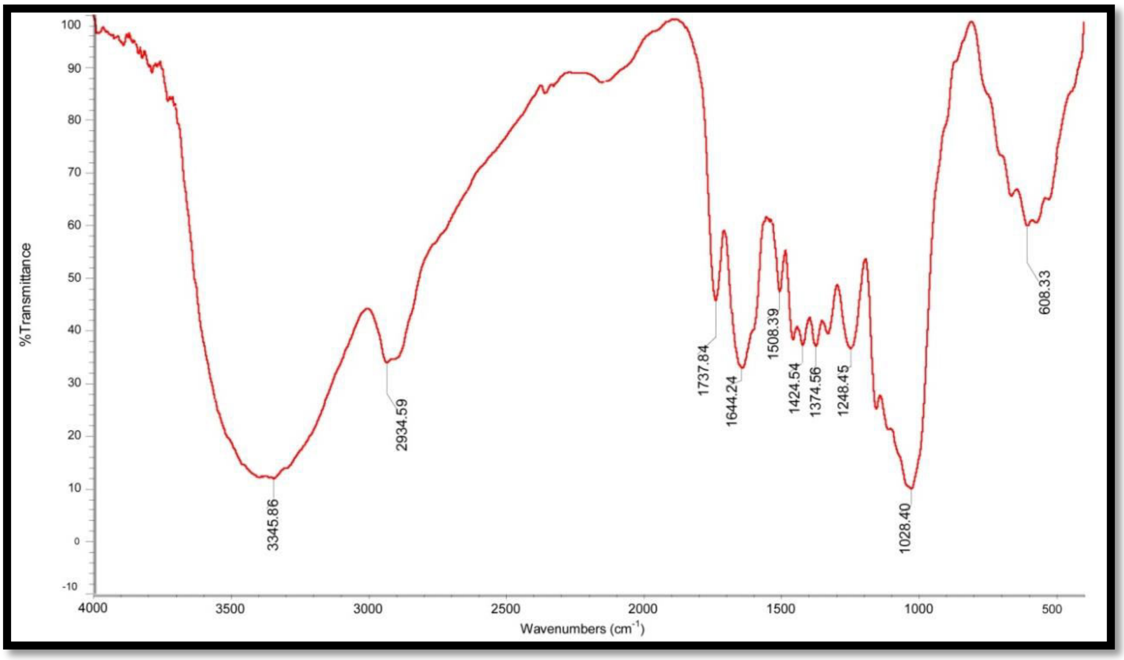

Table 1. FT-IR analysis of *P. pinnata* wood

Wave number (cm^{-1})		Functional group assignment		Compounds identified	
C	**T**	**C**	**T**	**C**	**T**
3418.25	3345.86	O-H stretch	O-H stretch	Polymeric hydroxyl compounds	Polymeric hydroxyl compounds
-	2934.59	-	C-H stretch	-	Alkanes
1739.51	1737.84	C=O stretch	C=O stretch	Ketone compound	Ketone compound
1632.92	1644.24	C=C stretch	C=C stretch	Alkenes	Alkenes
1508.46	1508.40	C=C stretch	C=C stretch	Aromatic compounds	Aromatic compounds
1429.88	1424.54	C-H stretch	C-H stretch	Alkenes	Alkenes
1376.84	1374.56	C-H stretch	C-H stretch	Alkanes and Alkyls	Alkanes and Alkyls
1249.86	1248.45	C-O-C stretch	C-O-C stretch	Esters	Esters
1046.41	1028.40	C-OH stretch	C-OH stretch	Alcohols	Alcohols

605.84	608.33	C-Br stretch	C-Br stretch	Bromo (or) Halogen compounds	Bromo (or) Halogen compounds

Dried samples were used for analysis. All the variables were recorded on 3½ years old plant. C = Control plants were irrigated with water. Treated (T) = 30 g seaweed powder (*Padina pavonia*) was administered as soil drench once in a month.

Conclusion

From this result it is concluded that functional groups variations identified between control and seaweed treated wood of *Pongamia pinnata* using FT-IR analysis. This result may be helpful for proceeding future studies like detecting moisture and ash content and volatile matter of this tree.

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