International Journal of Engineering Sciences &Research Technology

(A Peer Reviewed Online Journal)
Impact Factor: 5.164

IJESRT

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[Pandharipande, *et al.*, 8(10): October, 2019] ISSN: 2277-9655
IC™ Value: 3.00 Impact Factor: 5.164
CODEN: IJESS7

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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ISOLATION OF LIGNIN AND CELLULOSE FROM JACKFRUIT PEEL

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DOI: 10.5281/zenodo.3522928

ABSTRACT

In the recent times, cellulosic derivatives and lignin have become important materials in various industries. One of the sources, the Jackfruit peel, remains one of the lesser explored renewable alternatives to extract cellulose and lignin constituents. Jackfruit peels are usually discarded off as waste, which can be utilised to produce valuable entities. Hence it is substantial to find out the approximate content of cellulosic constituents and lignin in the jackfruit peel and to isolate them. The present work summarises isolation of cellulosic components and lignin using chemical treatment in a reflux setup under moderate conditions of temperature and pressure along with a thorough analysis of the isolated constituents for functional group presence using FTIR spectroscopy.

KEYWORDS: jackfruit peel, cellulosic constituents, lignin, isolation.

1. INTRODUCTION

Jackfruit (artocarpus heterophyllus) is one of the popular fruits in India, where the total area under cultivation for this fruit is about 13,460 ha. Around 1.4 million tones in India every year. It is the largest tree-borne fruit. It reaches up to 55kg in weight, 90 cm in length and 50 cm diameter. They are mostly found in tropical lowlands and utilized majorly in South Asia.

In India, even after the utilization of jackfruit produced, the resulting wastage is worth crores of rupees. The major ingredients present in jackfruit are starch, cellulose, hemi-cellulose etc. whereas the other components like lignin, pectin, protein and moisture are also present.
A typical partial composition of jackfruit peel is given in table below.

Table 1 composition of jackfruit peel

PARAMETERS	**WEIGHT (%)**
CELLULOSE	27.75 ± 0.06
PECTIN	7.52 ± 0.12
STARCH	4.12 ± 0.02
PROTEIN	6.27 ± 0.03
MOISTURE CONTENT	12.98 ± 0.42

Cellulose is an organic compound with formula $(C_6H_{10}O_5)_n$& is an important structural component of cell walls present in green plants. It is the most abundant organic polymer on earth. It is a linear polymer composed of single sugar molecule unit adjoined by β-1-4 glycosidic oxygen linkages. This polymer has versatile uses in textile cosmetic and pharmaceuticals industries.

ISSN: 2277-9655
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Fig 1.1 gives the structural formula for cellulose

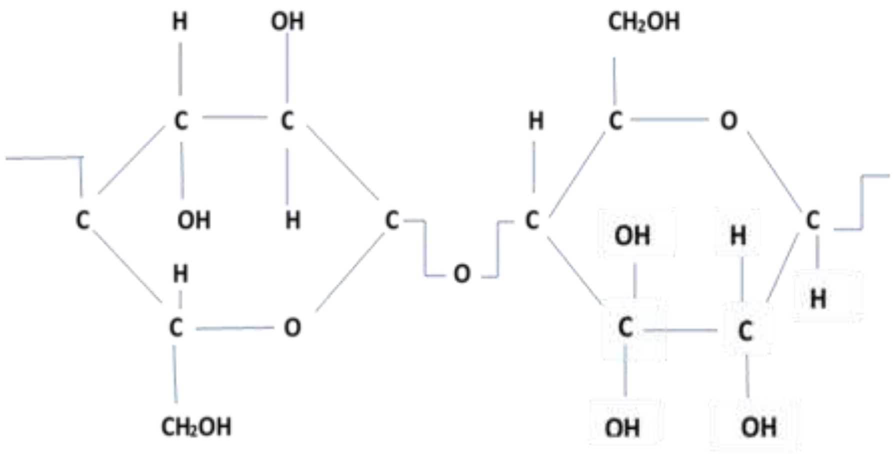


Figure 1.1 Structural formula for cellulose

Lignin is a complex, cross-linked organic polymer that support the tissues of vascular plants and some algae. It plays the role of an adhesive in connecting cellulose and hemicellulose and is also insoluble in water.Lignin is commercially important in food additives, thermosets, dispersants and as lignosulfates

2. LITERATURE REVIEW

Antony Allwyn Sundarraj and Thottiam Vasudevan Ranganathan [1] studied the jackfruit peel to investigate in detail the potential of the peels in manufacturing functional food additives. Proximate analysis of the peel showed high presence of cellulose (27.75%), pectin (7.52 ± 0.12 %), protein (6.27 ± 0.03%) and starch (4%). The outcome of the work from proximate analysis and FTIR spectroscopy shows that the jackfruit peel is immensely productive as a major alternative source of cellulosic and pectin materials that can be further utilized for food ingredient applications. Rokeya Begum et.al. [4] focused on extraction and characterization of pectin from jackfruit waste. The chemical composition found using Surface Structure analysis, is FTIR and statistical analysis. S.L. Pandharipande et.al. [2] conducted the extraction and a general characterization of dry coconut husk and wet coconut husk lignin through FTIR analysis and summarized the results of percent yield of lignin obtained from different isolation techniques.

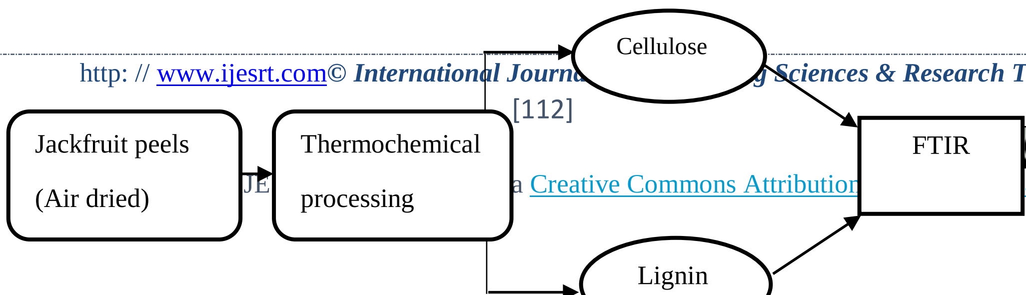
3. OBJECTIVE

The present work addresses to the utilization of waste material, jackfruit peels by isolation of lignin and cellulosic components.

4. MATERIALS AND METHODS

4.1 General Methodology

The general methodology adapted in present work is depicted in flow diagram as shown in Fig. 2



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ISSN: 2277-9655
Impact Factor: 5.164
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Figure 2 Flowchart of general methodology of present work

4.2 Chemicals and materials

Jackfruit Peels, DM water, NaOH pallets, conc.H_2SO_4, Hydrogen peroxide solution.

4.3 Experimental Procedure

The Important process steps are described as follows:

- Peels were chemically treated, cleaned, oven dried and stored.
- Some of the dry pieces were further cut into smaller sizes.
- Peel pieces were subjected to alkaline conditions in a reflux setup at 90℃ to 110℃ for around 4 hours.
- The content of still were filtered out.
- The cake was bleached with H_2O_2 solution.
- Cake was further oven dried at controlled temperature conditions.
- The filtrate was evaporated up to 1/10th of its original volume after adding sulphuric acid to maintain 1pH.
- The obtained concentrated solution was vacuum dried.
- The samples of lignin and cellulosic constituents are analyzed for functional group presence using FTIR.

Figure nos. 3&4 represent flow chart & actual photographic depiction of experimental procedure followed respectively.

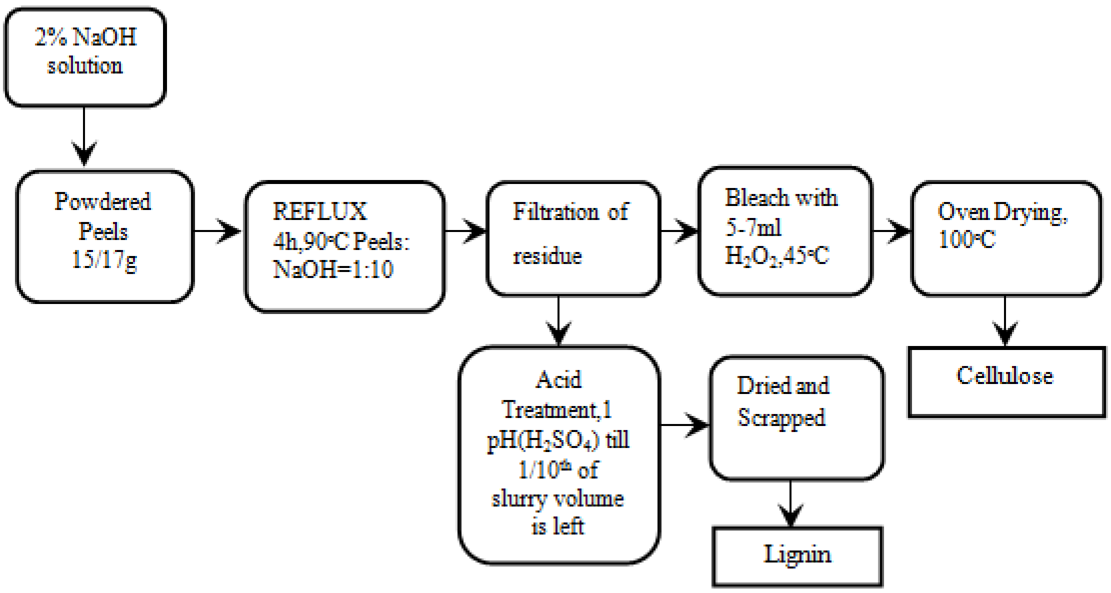

Figure 3 Flowchart of experimental procedure

Jackfruit

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Figure 4 Photographic representation of the procedure of present work

5. OBSERVATIONS

The sample observations of various process parameters are given in table no. 2 to 6.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Table 2 Drying of Peels

Weight of Peels/gram	20.01
Temperature of oven/℃	90℃ to 100℃
Weight of peels after drying/gram	17
Time required/min	90

Table 3 Parameters for Reflux setup process

Peels taken in the HTE setup/gram	17	
Concentration of alkaline solution	2% NaOH (3.5g NaOH/170CC water)	
Temperature/℃	110℃	
Time taken/min	250	
Nature of the solution in round bottom flask	Color	Brown
	Phases	2 (S+L)
	Nature of solid peels	Spongy

Table 4 Visual observations

Properties	Filtrate	Residue
Color	Brown/Dark Red	Dark Brown
Nature	Less viscous liquid	Spongy solid
Further Treatment carried out	Acid treatment	Bleaching

Table 5 Filtrate treatment

Acid	dil. Sulphuric Acid
pH to be maintained	1-2
Temperature/℃	90℃
Time/min	45-60
Volume after heating/ml	$1/10^{th}$ of original volume

Table 6 Residue treatment

Bleaching agent	3% Hydrogen Peroxide Solution
Volume of bleaching agent in ml	5-7
Temperature/ ℃	35-40
Color after bleaching	Faded brown

The spectrogram for Lignin & Cellulosic samplesof the present work as well as spectrogram of Lignin & Cellulosic samples of run 1&2 of the present work are given in Figure Nos. 5&6 and 7&8 respectively.

ISSN: 2277-9655
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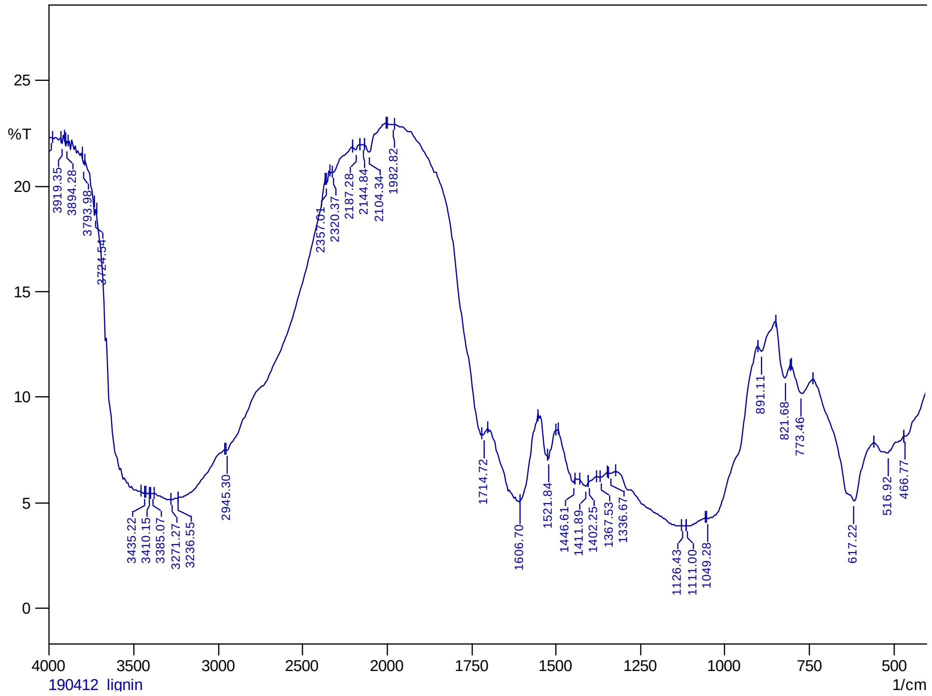

Figure 5 Spectrogram for lignin sample-1 of present work

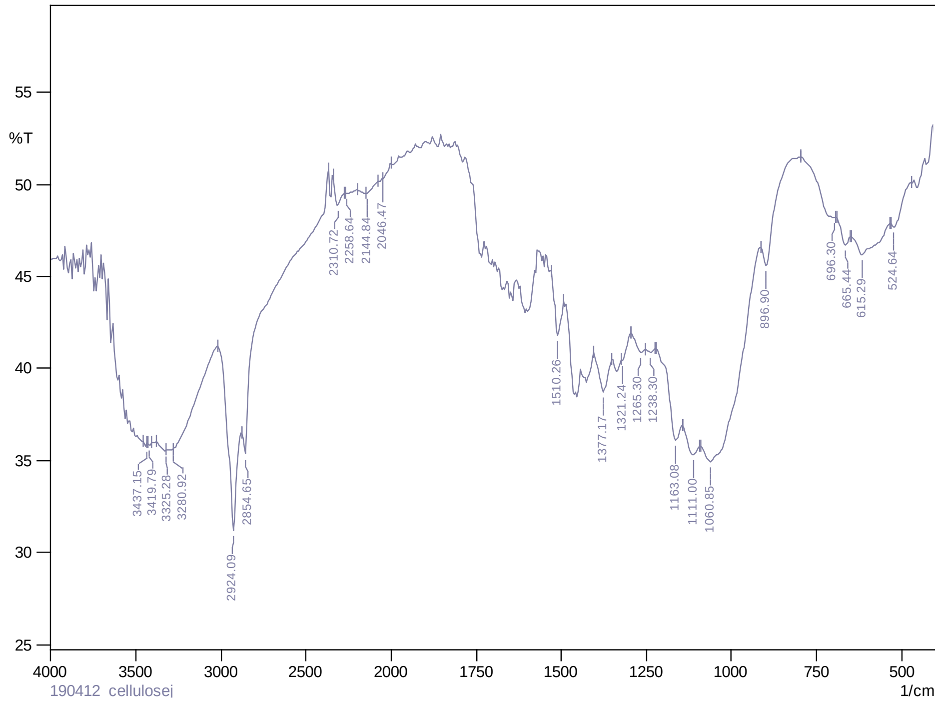

Figure 6 Spectrogram for cellulosic sample-1 of present work

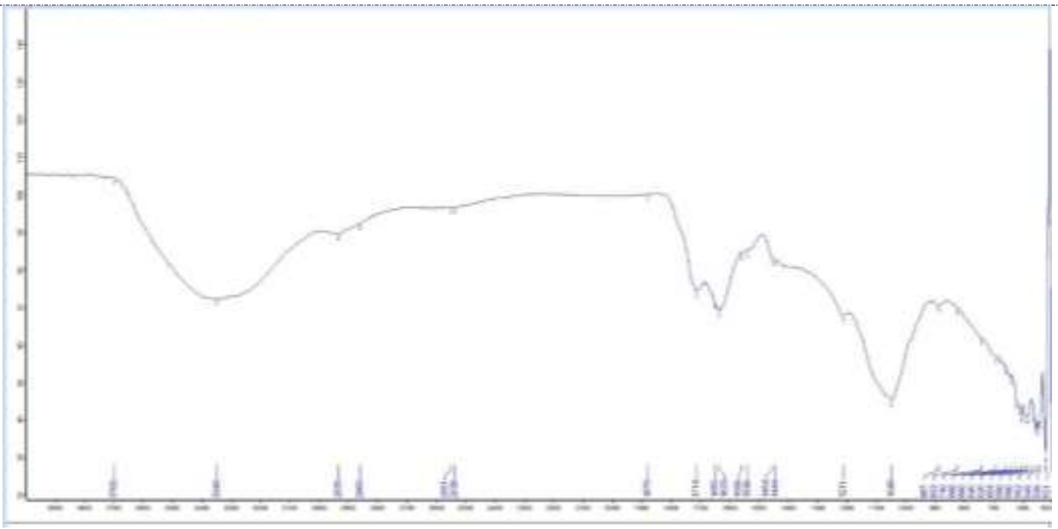

Figure 7 Spectrogram for Lignin sample-2 of present work

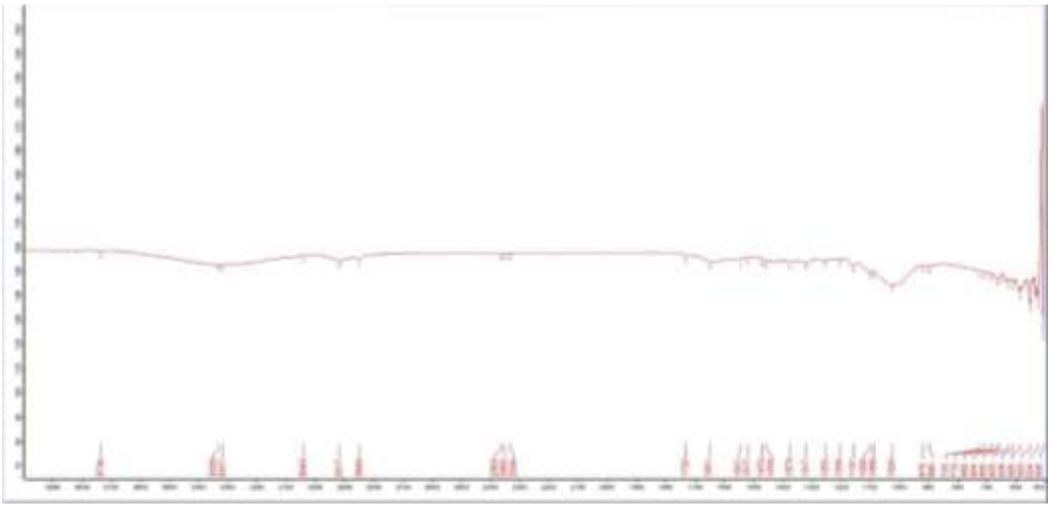

Figure 8 Spectrogram for Cellulosic sample-2 of present work

6. RESULT AND DISCUSSION

The dried samples of lignin & cellulosic constituents are subjected to FTIR analysis for establishing the presence of functional groups.

The graph is plotted with infrared spectrum on x-axis and absorbance/ frequency on y-axis.

The peaks in the spectrogram, called as absorbance band that correspond to various vibrations of atoms present in the sample.

The table7 constitutes the comparison of the wave numbers obtained in the spectrogram of sample 1 and sample 2 of present work with purified lignin and table 8 constitutes the comparison of the wave numbers of samples 1 and 2 for cellulose with purified cellulose reported in the literature.

ISSN: 2277-9655
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Table 7 Comparison of wave numbers of present work samples for lignin with literature

Sample-1 (lignin)	Sample-2 (lignin)	Purified lignin (literature)	Functional Group present
516.92	562	558.96	C-C bonding
821.68	823	835.41	CH_3 group
1049.28	1048	1035.72	C-O Stretching (secondary alcohol)
1111.00	1211	1119.78	C-O stretching (tertiary alcohol)
1411.89	1444	1425.41	CH Deformation
1606.70	1633	1604.00	C=C
1714.72	1714	1713.83	C=O
2945.30	2935	2927.39	CH_3
3410.35	3349	3413.44	O-H stretching

Table 8 Comparison of wave numbers of present work samples for cellulose with literature

Sample-1 (cellulose)	Sample-2 (cellulose)	Purified cellulose (literature)	Functional group presence
524.64	524	520	C-C
896.90	896	890	CH_3
750	725	750	C-O stretching
1060.85	1024	1050	C-O-C stretch
2046.47	2334	2000	C≡C stretch
2854.85	2849	2830	CH_2
3280.92	3317	3200	O-H stretching
3419.79	3330	3410	O-H
2258.64	2234	2250	C≡N stretch

As can be seen from the comparison, most of the wave numbers were found to be similar, as reported in literature, indicating that the lignin and cellulose obtained by the present method, closely resembled that of pure samples. The deviation observed is due to presence of impurities in samples of cellulosic constituents.

The yield of lignin obtained after oven drying of semi viscous slurry at moderate temperature is 2.89/10 g of dry perpeel.

Similarly, the yield of cellulosic constituents obtained after oven drying of spongy cake after bleaching is 3.57/10g of dry peel.

7. CONCLUSION

Jackfruit is a seasonal fruit abundantly found and grown in India during March to June. After consumption of jackfruit, a lot of waste in the form of peels is generated which is rich in ingredients like pectin, cellulose, lignin etc. The present work addresses to the isolation of cellulose and lignin from jackfruit peel using the novel alkaline reflux method. The obtained samples of lignin and cellulosic constituents are analyzed using FTIR for functional group presence. The comparison between the wavenumbers of the spectrogram of the present work samples have been carried out with that of pure lignin and cellulose samples reported in literature. Based on the comparison it can be concluded that the present work has successfully isolated the lignin and cellulosic constituents from the jackfruit peel. The average yield of lignin and cellulosic constituent are 2.89 g and 3.57 g respectively per 10 g of oven dried jackfruit peel powder.

The unique feature of the present work is moderate conditions of the temperature and atmospheric pressure in isolation of lignin from jackfruit peel.

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