Preparation and Characterization of Cellulose Film from The Stem Wood of Tamalan

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Abstract

In this research work, the stem wood of Tamalan was collected from Maw Lu, Indaw Township, Sagaing Region. The preliminary detection of phytochemical compounds, present in stem wood were carried out by phytochemical tests. The elemental analysis of these stem wood were also determined by using Energy Dispersive X-ray Fluorescence (EDXRF) spectroscopy. The cellulosic pulp were prepared by using sodium hydroxide. In order to know the effect of time on the yield of cellulosic pulp, various refluxing periods were used. The yield percent of the cellulosic pulp Tamalan from different conditions were determined. The Tamalan cellulosic pulps were confirmed by FT-IR spectroscopic method. Moreover, the preparation of cellulosic films were performed by using different ratios of sodium hydroxide and plasticizer (PVA). The elongation at break and elasticity of each film was determined by Young's Modulus. Furthermore, the tensile strength and elongation at break of the film prepared in condition (2) are higher than that of the film in condition (1).

Key words: stem wood, phytochemical compounds , cellulosic pulp, Tamalan

Introduction

Cellulose is one of the most widely used natural substances and has become one of the most important commercial raw materials. Cellulose is the substance that makes up most of a plant's cell walls. Since it is made by all plants, it is probably the most abundant organic compound on Earth. Aside from being the primary building material for plants, cellulose has many others uses. According to how it is treated, cellulose can be used to make paper, film, explosives, and plastics, in addition to having many other industrial uses. The paper in this book contains cellulose, as do some of the clothes we are wearing. For humans, cellulose is also a major source of needed fiber in our diet. (Encylopedia, 2018)Cellulose films are made from cellulose from wood, cotton, hemp, or other sources. Cellulose films are promptly decomposed in soil or compost and are degraded into water and carbon dioxide. In technical performance they possess many of the properties of paper, such as excellent folding characteristics and the ability to maintain a fold, easy printability and freedom from static. Cellulosic film applications include tapes, photographic film, coatings for paper, glass, and plastic. Medical applications for cellulosic films include dialysis membranes. (Lurence W. McKeen, 2010)

Tamalan is an extremely graceful tree, with its spreading crown of delicate, feathery-looking foliage. The heartwood is a dark red-brown; the sapwood white. (Gamble.J.S, 1972) The wood is close-grained, hard, heavy, and resistant to the attacks of termites. It has an attractive, veined structure and is easy to polish. As the colour and the figure are highly ornamental and attractive, it is used for fine decorative panels, parquetting and furniture. It is often used for making quality furniture, luxury cabinets, art and handicrafts etc, as well as the handles of agricultural implements. (Maharani *et al*., 2010)

Botanical Description

Botanical name	:	*Dalbergia oliveri* Gamble ex Prain
Family name	:	Fabaceae

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7- Msc student, Department of Chemistry, University of Mandalay

English name : Tulip wood
Myanmar name : Tamalan
Part used : Stem wood


Figure (1) Tamalan Tree

Material and Methods

Sampling

Stemwood of tamalan were collected from the Indaw Township, MawLu, Sagaing Region. The sawdust were sieved with 40- 60 mesh sieves to get powder sample and stored bag for the experiments.

Figure (2) Stemwood of Tamalan

Elemental Analysis of Stemwood

Elemental analysis of stem wood of *Dalbergia oliveri* was measured at Department of Chemistry, Monywa University, by applying EDXRF (Energy Dispersive X-ray Fluorescence Spectroscopy) method.

Extraction of Cellulose Pulp from Stem Wood Sawdust of Tamalan for Five Hours Refluxing Time with NaOH

The extraction procedure of Cross and Bevan, described by David and Nobuo (CRC press, 2000 and Adekunle, 2010). Which was based on chlorination and extraction with hot aqueous sodium sulphite was imployed.

In this research work, about 25 g of sawdust and 100 mL of 1% sodium sulphite were placed in flat bottom flask and refluxed for one hour. The flask was cooled under normal condition and filtered. 100 mL of 15% sodium hydroxide was added to the residuce and refluxed for 5 hours (condition 1). It was cooled again and filtered. The residuce was mixed with 100 mL of 5% potassium hydroxide and the mixture was shaken for one hour at 250 rpm and filtered .The residuce was mixed with 100 mL of 5% sodium hypochloride. It was bleached for 24 hours and filtered again. The residue was washed with 0.2 M of acetic acid and then distilled water until neutral. After that, the neutral cellulosic pulps were obtained.

Extraction of Cellulose Pulp from Stem Wood Sawdust of Tamalan for Ten Hours Refluxing Time with NaOH

About 25 g of sawdust and 100 mL of 1% sodium sulphite were placed in flat bottom flask and refluxed for one hour. The flask was cooled under normal condition and filtered. 100 mL of 15% sodium hydroxide was added to the residuce and refluxed for 10 hours (condition 2). It was cooled again and filtered. The residuce was mixed with 100 mL of 5% potassium hydroxide and the mixture was shaken for one hour at 250 rpm and filtered .The residuce was mixed with 100 mL of 5% sodium hypochloride. It was bleached for 24 hours and filtered again. The residue were washed with 0.2 M of acetic acid and then distilled water until neutral. After that, the neutral cellulosic pulps were obtained.

Figure (3) Extraction of Cellulose Pulp from Stem Wood Powder of Tamalan

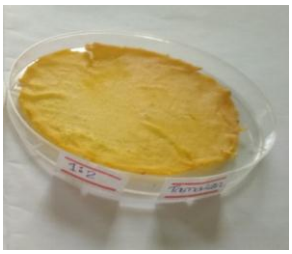
Identification of Cellulose from Sawdust of Tamalan by Fourier Transform Infrared Spectrum

FT-IR spectra of extracted cellulosic pulps for 5 and 10 hours refluxing time were measured at the Department of Chemistry, University of Monywa. The spectra were measured by a SHIMADZU (Japan) FT IR-410 spectrophotometer within the range 400-4000 cm^{-1} using a potassium bromide window.

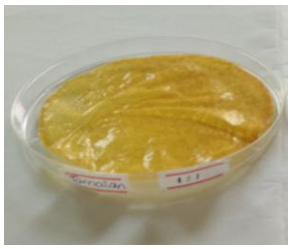
Preparation of Cellulose Film

The preparation procedure described by Norashikin and Ibrahim, 2010 which was based on chemical treatment with concentrated NaOH solution followed by hydrolysis with concentrated HCl solution at 80ºC for 2 hrs. The alkaline treated pulp was washed several times with distilled water until the pH became neutral before being dried at room temperature. 2 gram of starch and 100 milliliters distilled water was gelatinized by heating at 90°C. 2 gram of chitosan powder were dissolved with 100 milliliters acetic acid and both solution were mixed and stirred until become homogeneous. Then, the solution was added with 2 gram of sawdust fiber and 3 milliliters additive. After that the solution was degassed for 24 hours. The solution was poured onto a glass plate and dried at room temperature. The film was carefully removed by peeling from the glass plate. (Norashikin and Ibrahim, 2010)

In this research, 1 g of cellulose pulp was treated with 15 mL of 3 M HNO_3 acid and a few drops of acetic acid was added to dissolve it. Then it was filtered and the filtrate was mixed with 10 mL of 3 M NaOH solution and 0.5 g, 1 g of Poly Vinyl Alcohol powder. The mixture was stirred for about 2 hrs and was poured onto a glass petridish and dried at room temperature. The film was carefully removed from the petridish.



condition (1)



condition (2)

Figure (4) Preparation of Cellulose Films by Using Different Amounts of PVA

Determination of Mechanical Properties of Prepared Cellulose Films

The mechanical properties of the prepared cellulose films such as thickness, tensile strength, elongation at break and tear strength were determined at Universities Research Centre in Yangon University.

Results and Discussion

Preliminary Phytochemical Screening of the Tamalan Sawdust

The results of the preliminary phytochemical screening of the sawdust of tamalan (*Dalbergia oliveri*) were shown in table (1).

Table (1)The Results of Phytochemical Test for Sawdust of Tamalan

No.	Tests	Extract	Reagents	Observation	Results
1.	Alkaloids	1% HCl	Dragendorff's reagent Wagner's reagent	Orange ppt Reddish brown ppt	+ +
2.	Flavonoids	EtOH	conc:HCl, Mg tunning	Brown ppt	+
3.	Steroids	EtOH	Acetic anhydride, Conc:H_2SO_4,$CHCl_3$	Reddish brown ppt	+
4.	Terpenes	EtOH	Acetic anhydride, conc:H_2SO_4	Pale color ppt	_
5.	Polyphenol	EtOH	1% $FeCl_3$ and 1%$K_3[Fe(CN)_6]$	Deep blue ppt	+
6.	Glycosides	distilled water	Lead acetate	Pale yellow ppt	+
7.	Phenolic	distilled water	10% Ferric chloride	Brown ppt	+
8.	Reducing sugar	distilled water	Benedict's solution	Yellowish brown ppt	+
9.	Tannins	distilled water	10%$FeCl_3$, dilH_2SO_4	Pale brown ppt	+
10.	Saponin	distilled water	shaken vigorously	Froth	+
11.	Lipophenol	distilled water	0.5N KOH	No change in color	_

(+) = presence of constituents (–) = absence of constituents

According to this table, alkaloid, flavonoid, steroid, glycoside, reducing sugar, saponin, phenolic compound, polyphenol and tannin were present in the sawdust of tamalan.

Determination of Elemental Analysis of Sawdust of Tamalan

Elemental analysis of sawdust from tamalan was measured at the Department of Chemistry, University of Monywa by applying EDXRF (Energy Dispersive X- ray Fluorescence Spectroscopy) method.

Table (2) The Results of Elemental Composition of sawdust

No	Elements	symbols	Relative Abundance (%)
1.	Calcium	Ca	0.243
2.	Silicon	Si	0.131
3.	Sulfur	S	0.046
4.	Potassium	K	0.037
5.	Iron	Fe	0.003
6.	Phosphorus	P	0.002
7.	Manganese	Mn	0.002
8.	Copper	Cu	0.002
9.	Cobalt	Co	0.001

According to the EDXRF report, there are nine mineral elements in the sawdust of Tamalan. Among them, calcium is the most abundant element followed by silicon, sulphur and potassium. The least element present in the selected sawdust is cobalt.

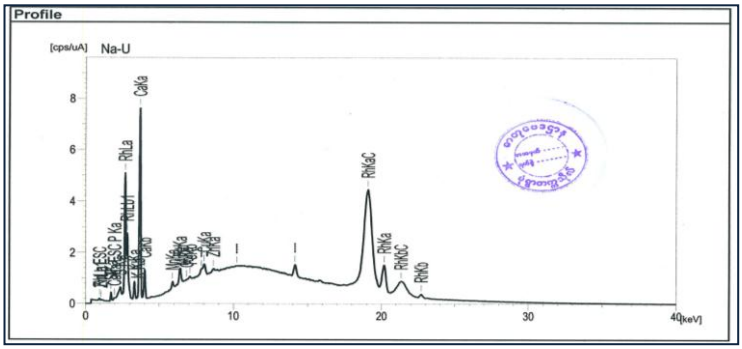


Figure (5) EDXRF Report of the Sawdust of Tamalan

Extraction of Cellulose Pulps from Tamalan Sawdust

The different weights of the cellulosic pulps extracted from the sawdust of Tamalan for 5 and 10 refluxing hours were weighted by using electrical balance. Their yield percents were calculated and described in these tables.

Table (3) Yield Percent of the Extracted Cellulosic Pulps from Tamalan Sawdust (Condition -1)

No.	Weight of Sawdust (g)	Time (hr)	Solvents	Weight of Pulp (g)	Yield Percent of Pulp (%)
1.	25	5	15% NaOH	12.00	48.00
2.	25	5	15%NaOH	11.60	46.40
3.	25	5	15%NaOH	12.00	48.00
					47±0.8

Table (4) Yield Percent of the Extracted Cellulosic Pulps from Tamalan Sawdust (Condition – 2)

No.	Weight of Sawdus (g)	Time (hr)	Solvents	Weight of Pulps(g)	Yield Percent of Pulp (%)
1.	25	10	15%NaOH	18.40	36.80
2.	52	10	15%NaOH	18.00	36.00
3.	25	10	15%NaOH	18.22	36.44
					36.40±0.4

According to these tables, the yield percent of cellulose pulp from experiment using 15% sodium hydroxide for 5 hours (condition-1) was high.

FT-IR Assignment of Cellulosic Pulp for Different Refluxing Hours

The FT-IR spectral measurements of the extracted cellulosic pulps were done at Department of Chemistry, University of Monywa and their assignments are discussed in this sections .

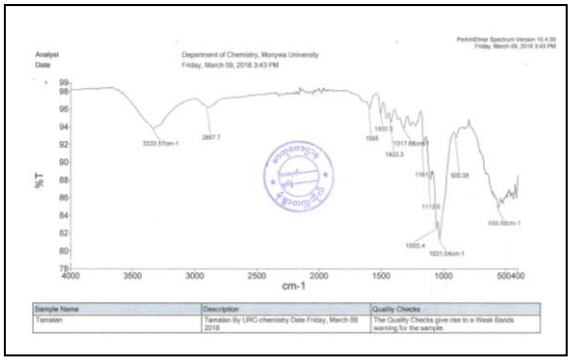


Figure (6) FT-IR Spectrum of Extracted Cellulosic Pulp for Five Hours Refluxing Time

Table (5) FT-IR Assignments of Extracted Cellulosic Pulps for Five Hours Refluxing Time

No.	Frequency(cm^{-1})	Assignments
1	3333.57	O-H stretching vibration of hydroxyl group
2	2897.7	C-H stretching vibration of sp3 hydrocarbons
3	1595 and 1502.3	C=C stretching vibrations of aromatic ring skeleton
4	1161,1112 and 1055.4	C-O-C stretching vibration of ether group
5	900.08	C-H out of plane bending vibration of cis or Z alkenic group

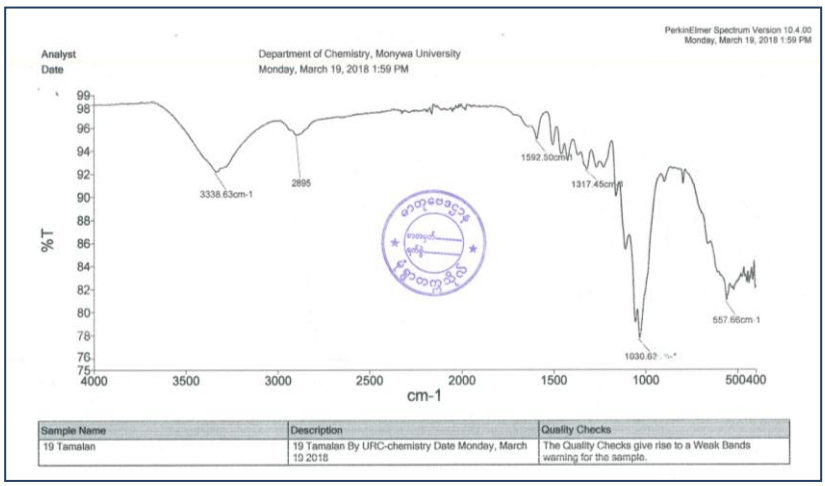


Figure (7) FT-IR Spectrum of Extracted Cellulosic Pulp for Ten Hours Refluxing Time

Table (6) FT-IR Assignments of Extracted Cellulosic Pulps for Ten Hours Refluxing Time

No.	Frequency(cm^{-1})	Assignments
1	3338.63	O-H stretching vibration of hydroxyl group
2	2895	C-H stretching vibration of sp^3 hydrocarbons
3	1592.50 and 1317.45	C=C stretching vibrations of aromatic ring skeleton
4	1030.63	C-O-C stretching vibration of ether group
5	557.66	C-H out of plane bending vibration of cis or Z alkenic group

Determination of Mechanical Properties of Prepared Cellulose Films

The results obtained from the determination of the mechanical properties of the prepared cellulose films such as thickness, tensile strength, elongation at break and tear strength were described in Table .

Table (7) Results of Mechanical Properties of Cellulosic Film from Poly Vinyl Alcohol

Conditions	Thickness	Tensile strength (MPa)	Elongation at break (%)	Tear strength (kN/m)
Condition (1)	0.40	0.1	30	0.3
Condition (2)	0.30	0.4	99	4.3

According to the table (4.7), the prepared film in condition (1) is thicker than that in condition (2). The tensile strength, elongation at break and tear strength of the film in condition (2) are higher than that in condition (1).

Conclusion

In this research work, the stem wood of Tamalan were collected from Mawlu, Indaw Township, Sagaing Region. The evaluation of phytochemical constituents and elemental compositions were done by standard method and EDXRF spectral analysis. According to the measurements, this stem wood of tamalan contains alkaloid, flavonoid, steroids, glycoside, phenolic, tannin, reducing sugar, saponin and polyphenol respectively.

EDXRF spectrometer was used for the elemental analysis. According to this report, 9 elements (Ca, Si, S, K, Fe, P, Mn, Cu and Co) were identified in the Tamalan stem wood powder. The amount of calcium is highest among other mineral elements followed by silicon, sulphur and potassium.

The cellulosic pulps were prepared by refluxing with sodium hydroxide. In order to know the effect of time on the yield of cellulosic pulp, various refluxing periods were used. The yield percent of the cellulosic pulp from Tamalan were 45.40% to 48.00% within the range for condition (1) and 36.00% to 36.80% within the range for condition (2).

The purity of cellulosic pulps extracted from Tamalan cellulosic pulps were checked by FT- IR spectroscopic method. According to IR spectral data (C=C stretching vibration of lignin at 1595 and 1592.3 cm^{-1}), both cellulosic pulps (conditions 1 and 2) still contain a little amount of lignin.

The cellulosic films were prepared from using different amounts of plasticizer (PVA) and sodium hydroxide. The mechanical properties of the prepared films were determined at University Research Centre, Yangon University. The thickness, tensile strength, elongation at break and tear strength of the films prepared in conditions (1) and (2) are 0.40 mm, 0.1 MPa, 30% and 0.3 kN/m and 0.30 mm, 0.4 MPa, 99%, 4.3kN/m respectively. Therefore, the film

prepared in condition (2) shows better mechanical properties than the film prepared in condition (1).

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Online Materials

Website-1 https:// en. m. Wikipedia. Org >wiki> celluloid
Website-2 https:// waste. Org >publications >fabrication…..
Website-3 https:// www. ijser. Org>researchpaper >C…….
Website-4 https:// www. Researchgate. net >publication