JOURNAL OF PURE AND APPLIED MICROBIOLOGY, April 2013. Vol. **7**(Spl. Edn.), p. 59-66

Separation Characteristics of Lignin from Eucalyptus Lignincellulose for Medicinal Biocellulose Preparation

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(Received: 03 March 2013; accepted: 14 April 2013)

Eucalyptus **biomass was used as the fine bioresources of medicinal cellulose for medical applications, however reasonable control of lignin was the key technology of medicinal biocellulose preparation. Therefore, the separation characteristics of lignin from lignincellulose were investigated and analyzed by FTIR, UV and XRD. The result showed that the maximum of SLR of** ***Eucalyptus urophydis*** **and** ***Eucalyptus urophynis*** **lignincellulose increased with the increase of temperature 10°C, 20°C and 30°C, and the best separation condition of lignin were 24h and 30°C. During lignin separation from lignincellulose by AAHP method, crystallinity of** ***Eucalyptus urophydis*** **and** ***Eucalyptus urophynis*** **lignincellulose were broken, and effect of temperature was very notable so as to use the lower temperature if cellulose would be kept natural structure. The side chain and benzene ring of lignin of** ***Eucalyptus urophydis*** **lignincellulose reached the largest bond breaking characteristics under the temperature of 10 °C at 17h, 20 °C at 5h and 30 °C at 24h, and ones of lignin of** ***Eucalyptus urophynis*** **lignincellulose reached the largest bond breaking characteristics under the temperature of 20 °C at 7h and 30 °C at 24h, however the FTIR didn't show bond breaking characteristics of lignin at 10 °C.**

Key words: Eucalyptus biomass; Medicinal biocellulose; Lignincellulose; Separation characteristics.

Cellulose, which consists of glucose unit joined by ß-(1,4) linkages, is found in cotton, hemp, wood, and other plant-based materials. It was first isolated from wood in 1885, and Dr Jacques Brandenberger developed thin transparent cellulose film into commercial production in 1913(Nicholas Hoenich, 2006). Subsequently, the researches became more and more. Cellophane was used in the early treatments of reversible or acute kidney failure by Kolff in the Netherlands in the 1940s(Jacobze *et al*, 2005). Cellulose microcapsules were extended to the delivery of drugs (Lin and Wu 1999; Weber *et al*, 2004; Fundueanu *et al*, 2005; Zhou *et al*, 2005). These approaches were used for bovine spermatozoa (Weber *et al*, 2006). Meanwhile, separation technology of cellulose became more and more important and necessary. QI Hong-chen *et al*(2012) first reported the effects of alkaline extraction on micro /nano particles of eucalyptus camaldulensis biology. Wanxi PENG (2013a) established digestion kinetics model of wood extractives from Eucalyptus camaldulensis biomass. The authors first molecular characteristics of wood extractives from Eucalyptus urophydis and Eucalyptus camaldulensis biomass(Lansheng WANG *et al*, 2013; Wanxi Peng *et al*, 2011; 2012; 2013b). Lignin was the second major component of annual plants and wood, and a highly branched and irregular macromolecule. In woody renewable materials, lignin played the role of the reinforcing elements made up of cellulose fibers(Alessandro, 2008; Jia-Long Wen *et al*, 2010). However, lignins

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were usually insoluble in all solvents, unless they were degraded by chemical or physical treatments (Jia-Long Wen *et al*, 2010).

The applications of medical cellulose had been most widely used as a membrane in the treatment of renal failure. The total trends of membranes application for the treatment of chronic renal failure stimulated a move away from biocellulose membranes for synthetic membranes (Grassmann *et al*, 2005). However, the bioresources were more and more shortage. And Eucalyptus bioresources are abundant in south China and the fine bioresources of medicinal cellulose. Therefore, the separation characteristics of lignin from lignincellulose were investigated and analyzed by FTIR, UV and XRD.

MATERIALS AND METHODS

Materials and Reagents

The 5-year-old *Eucalyptus urophynis* (*Eucalyptus urophylla* ×*Eucalyptus tereticornis*) and *Eucalyptus urophydis* (*Eucalyptus urophylla*×*Eucalyptus camaldulensis*) were collected from Yangjiang Forest Farm, Guangdong province, P. R. China. Their sample chips were processed from fresh material, and dried to absolute dry with rotary evaporator in 55°C and negative 0.01MPa. About 200 mesh powder was sieved out using AS200 Sieving Instrument (Made in America). Lignincellulose were obtained by benzene/ethanol, methanol and acetic ether extractions and alkali solution treatment, and dried to absolute dry with rotary evaporator in 55°C and negative 0.01MPa. The benzene-ethanol solution was mixed according to $V_{ethanol}$ /$V_{benzene}$ 2 double. Acetic acid, 30% hydrogen peroxide (analytically pure grade) were prepared for the subsequent experiments.

Experiment methods

Weighed the above-mentioned wood powders of *Eucalyptus urophydis* and *Eucalyptus urophynis*, each was about 10g. According to 1 g wood powder to 10 mL AAHP(acetic acid/hydrogen peroxide solution), 50mL acetic acid was slowly added along the wall with even agitation, and then 50mL 30% hydrogen peroxide with even agitation. The samples were treated under the temperature10°C, 20°C and 30°C for 1h, 5h, 7h, 12h, 17h and 24h, respectively. After treated, the samples were filtered, then dried in the air, and dried to absolute dry in an oven, finally reserved in the dryer. The acetic acid / hydrogen peroxide solution was made by volumetric mixture ratio 1 to 1 of acetic acid and 30% hydrogen peroxide.

FT-IR Analysis

KBr pellets of samples were recorded on a Thermo Nicolet FT-IR spectrometer(NEXUS 670FT-IR). The 0.1-0.3mg samples were mixed with 10-30mg KBr. The KBr pellets were prepared for measurement. Thirty-two scans were collected per sample at a spectral resolution of 4 cm^{-1}, and the collected spectra were ratioed against air. Spectral range was from 4000 to 500 cm^{-1}.

XRD Analysis

After sample preparation, the samples were measured by the XD-2 diffractometer(General analysis of Beijing General Instrument Co., Ltd.). X-ray tube was Cu tube, pipe pressure was 36 kv, pipe flow was 20 mA. Measurement method was 2 è / è continuous scanning, Use graphite crystal monochromator, Slit device DS = 1°, SS=1°, RS=0.3mm.

Requirement

Cu tube (X-ray wavelengths= 1.5406 nm), 36 kV voltage, current 20 mA. Diffraction direction θ~2 θ linkage scanning system, rotary half cone angle 2èis from 5°to 42°, scanning velocity was 2°/ min, Scan step angle was 0.01. Cellulose Crystallinity was calculated according to the formula (1).

$$CrI=(IC_{002}-I_{am})/I_{002}\times 100\% \quad ...(1)$$

Cr—percentage of relative Crystallinity; I_{002}— intensity of the peak at 002 of the crystal region; I_{am}—diffracted intensity of peak at 2è=18° of amorphous region.

UV Analysis

The sample solution were measured by UV-Vis SP-752 Spectrophotometer (Shanghai spectrum instrument Co., Ltd) , respectively. Wavelength Range: 190-1100nm/ 200nm-1000nm. Optical system: Single beam autocollimation type optical path. acetylbromide method: 10~25mg of degreasing wood powder was weighed accurately, then placed in test tubes with 10 ml of 25% acetyl bromide in acetic acid solution. The test tubes were kept in water bath for 30 min at 70°C, it does not need agitation at the beginning 15min, then every 3 ~ 5 min shake the test tubes, for 15 min, being aimed at making wood powder dissolve.Waiting

the tubes cooling, then transferred the material in test tubes to the 100 mL volumetric flask where have 9 mL 2mol/LNaOH and 50 mL acetic acid; then flush the tubes with a small amount of acetic acid solution to make sure the transfer was complete, added 1 mL 7.5mol/L hydroxylamine hydrochloride($NH_2OH.HCL$)into the 100 mL volumetric flask, Finally used acetic acid dilution this solution to scale. Absorbance of solution at 280nm was determined. Lignin content of the samples was calculated according to the formula (2)

lignin content=$100(A_s-A_b)\cdot V/amd-B(\%)$ ...(2)

A_s—absorbance of sample; A_b—absorbance of empty sample; V—volume of solution, L; A—standard absorption coefficient of lignin,$lg^{-1}cm^{-1}$;m—sample quality, g; B— Correction factor; d—thickness of the cuvettes, cm.

RESULTS AND DISCUSSION

Separation law of lignin from lignincellulose

According to lignin content, SLR (separated lignin rate) were obtained and listed in Table 1.

Table 1. SLR of two Eucalyptus lignincellulose [%]

time(h)	Eucalyptus urophydis			Eucalyptus urophynis		
	10°C	20°C	30°C	10°C	20°C	30°C
1	85.57	85.78	84.4	81.87	81.61	86.29
5	85.33	81.26	83.37	84.78	85.38	86.16
7	85.12	84.21	85.94	84.55	86.91	85.01
12	87.69	85.78	86.13	83.84	86.15	88.07
17	87.59	86.76	86.33	83.12	85.43	89.31
24	87.35	86.45	89.51	83.79	84.67	92.51

On the Basis of the variance analysis of the data in Table 1 at the level of 0.05, treatment time had a notably significant effect on SLR of *Eucalyptus urophydis* lignincellulose (F=5.957 > $F_{0.05}(5,10)$=3.33), however the temperature had no significant effect on SLR of *Eucalyptus urophydis* lignincellulose (F= 2.395 < $F_{0.05}(2,10)$=4.10), and the maximum SLR were 86.44% at 10°C, 85.04% at 20°C and 85.95% at 30°C. When the treatment time was prolonged, SLR of *Eucalyptus urophydis* lignincellulose firstly decreased and then increased, namely they were 85.25%, 83.32%, 85.09%, 86.53%, 86.89% and 87.77% when treatment time were 1, 5, 7, 12, 17 and 24h, respectively**.** This phenomenon disagreed with KOH treatment effect on 1h SLR of *Eucalyptus urophydis* lignincellulose.

Temperature had a notably significant effect on SLR of *Eucalyptus urophynis* lignincellulose (F= 7.664> $F_{0.05}(2,10)$=4.10), however the treatment time had no significant effect on SLR of *Eucalyptus urophynis* lignincellulose (F=1.269 <$F_{0.05}(5,10)$=3.33), and SLR increased gradually with the increase of temperature, the maximum SLR were 83.66% at 10°C, 85.03% at 20°C and 87.89% at 30°C. With the extension of treatment time, SLR firstly increased, then declined, and then increased, namely SLR were 83.26%, 85.44%, 85.49%, 86.02%, 85.95% and 86.99% when treatment time were 1, 5, 7, 12, 17 and 24h, respectively.

Table 1 showed that the SLR of *Eucalyptus urophydis* lignincellulose reached maximum at 12h(87.69%), 17h(86.76%) and 24h(89.51%) under the temperature of 10°C, 20°C and 30°C, respectively. The SLR of *Eucalyptus urophynis* lignincellulose reached the maximum at 5h(84.789%), 7h(86.91%), and 24h(92.51%) under the temperature of 10°C, 20°C and 30°C, respectively. The maximum of SLR of *Eucalyptus urophydis* and *Eucalyptus urophynis* lignincellulose increased from 10°C to 30°C. Consequently, the best separation condition of lignin were 24h and 30°C.

Crystallinity changes during lignin separation from lignincellulose

CrI was calculated by XRD, O 'KI and NO' KI index would be received based on the FTIR

spectrum, band at 1430cm^{-1} was assigned to CH_2 shear vibration, band at 893 cm^{-1} was assigned to Glycosidic vibration and the vibration deformation of the first carbon atom; band at 1372 cm^{-1} was assigned to C-H vibration deformation, band at 2900 cm^{-1} was assigned to C-H and CH_2 stretching vibration. The ratios of band-heights at 1430cm^{-1}and 893 cm^{-1} (O'KI=A_{1429}/A_{893}) and at 1372 and 2900 cm^{-1} (NO'KI=A_{1372}/A_{2900}) had been used as relative measures of cellulose Crystallinity. The results were showed in table 2.

Table 2. Cellulose crystallinity of *Eucalyptus* lignincellulose

Tree species	Time[h]	10°C			20°C			30°C		
		CrI [%]	O'KI	NO'KI	CrI [%]	O'KI	NO'KI	CrI [%]	O'KI	NO'KI
Eucalyptus urophydis	0	55.38	1.93	1.30	55.38	1.93	1.30	55.38	1.93	1.30
	1	61.72	2.51	1.23	60.09	2.24	1.22	64.68	1.88	1.32
	5	68.78	2.42	1.19	56.65	2.14	1.20	56.54	1.77	1.24
	7	60.94	2.13	1.20	53.24	2.12	1.24	58.65	1.77	1.26
	12	54.25	2.66	1.16	54.41	2.21	1.19	60.52	1.67	1.19
	17	62.89	2.56	1.16	67.00	2.14	1.23	63.71	1.73	1.23
	24	55.40	2.14	1.20	54.32	2.15	1.21	68.70	1.53	1.27
Eucalyptus urophynis	0	52.32	2.00	1.38	52.32	2.00	1.38	52.32	2.00	1.38
	1	47.79	2.42	1.23	60.06	2.16	1.20	60.72	2.02	1.18
	5	53.65	2.47	1.23	57.06	2.18	1.19	59.49	1.89	1.23
	7	53.95	2.36	1.25	69.39	2.52	1.17	60.72	1.96	1.23
	12	63.30	3.83	1.00	50.58	1.91	1.27	69.92	1.93	1.22
	17	48.96	2.21	1.25	69.82	2.26	1.20	66.89	1.94	1.25
	24	54.21	2.40	1.21	57.06	1.92	1.22	69.86	1.76	1.17

According to Table 2, crystallinity of *Eucalyptus urophydis* lignincellulose firstly increased and then decreased under the temperature of 10°C when the treatment time was prolonged, and reached the maximum 68.78% at 5h, its crystallinity at 24h was 55.4%. Crystallinity of *Eucalyptus urophydis* lignincellulose firstly decreased, then increased, and then decreased under the temperature of 20°C when the treatment time was prolonged, and reached the maximum 67.00% at 17h. Crystallinity of *Eucalyptus urophydis* lignincellulose firstly decreased and then increased under the temperature of 30°C when the treatment time was prolonged, and reached the maximum 68.70% at 24h. The crystallinity of untreated sample were lower than ones of treated sample at 10°C, 20°C and 30°C, suggesting that the cellulose of amorphous region could have oxidation reaction, or acid hydrolysis reaction when lignin was separated from *Eucalyptus urophydis* lignincellulose by AAHP method. O'KI and CrI changed similarly, but NO'KI changed inversely.

Crystallinity of *Eucalyptus urophynis* lignincellulose firstly increased, then decreased, and then increase under the temperature of 10°C when the treatment time was prolonged, and reached the maximum 63.30% at 12h. Crystallinity of *Eucalyptus urophynis* lignincellulose indirectly increased under the temperature of 20°C when the treatment time was prolonged, and reached the maximum 69.82% at 17h. Crystallinity of *Eucalyptus urophynis* lignincellulose ups and downs changed under the temperature of 30°C when the treatment time was prolonged, and reached the maximum 69.92% at 12h. The crystallinity of untreated sample were lower than ones of treated sample at 10°C, 20°C and 30°C, suggesting that the cellulose of amorphous region could have oxidation reaction, or acid hydrolysis reaction when lignin was separated from *Eucalyptus urophynis* lignincellulose by AAHP method. O'KI and CrI changed similarly, but NO'KI changed inversely.

During lignin separation from lignincellulose by AAHP method, Crystallinity of *Eucalyptus urophydis* and *Eucalyptus urophynis* lignincellulose increased by13.40%,17.60%, respectively, suggesting that cellulose of *Eucalyptus urophynis* were the more destructive

by AAHP, however cellulose of Eucalyptus urophydis was the smaller damage by AAHP. Effect of temperature was very notable so as to use the lower temperature if cellulose would be kept natural structure during lignin separation from lignincellulose. O'KI and CrI could be chosen to analyze the crystallinity during lignin separation from lignincellulose.

Bond breaking characteristics during lignin separation from lignincellulose

Based on FTIR spectra**,** bands at 3420 cm^{-1}, 2918cm^{-1}, 1460cm^{-1}, 1330cm^{-1}, 1231cm^{-1}, 1158cm^{-1}, 1122cm^{-1}, 897cm^{-1} were assigned to O–H stretching in hydroxgl group, C-H stretching in methyl and methyene group, C-H deformation in methyl and methyene, Syringl, C-C plus C-O plus C=O stretching($G_{condensed}$>$G_{etherified}$), C-O-C asymmetric stretching, Aromatic C-H(typical Syringic aldehyde), polysaccharide *â*- bond stretching vibration**.** Characteristic peaks attributed to lignin were bands at 1593 cm^{-1},1504 cm^{-1} and 1420 cm^{-1}. Their assignments were showed in Table 3.

Table 3. Group assignments of *Eucalyptus* lignincellulose

Peak [cm^{-1}]	Assignment
3417	O–H stretching in hydroxgl group
1593	Aromatic skeletal vibration plus C=O stretching
1504	Aromatic skeletal vibrations
1420	Aromatic skeletal vibration combined with C-H in plane deformation
1330	Syringyl ring plus guaiacyl ring condensed
1230	C–C, C–O and C=O stretch(G condensed > G etherified)

FTIR spectra of *Eucalyptus urophydis* lignincellulose samples were showed in Figure 1. The most important O-H stretching in hydroxgl group was assigned to the 3100 -3650 cm^{-1} region. The absorbance of a peak appeared at 3417 cm^{-1} was the strongest. At 3417 cm^{-1}, 1593 cm^{-1}, 1504 cm^{-1}, 1420 cm^{-1}, 1330 cm^{-1}, 1230 cm^{-1} were O-H stretching in hydroxgl group, aromatic skeletal vibration plus C=O stretching, aromatic skeletal vibrations, aromatic skeletal vibration combined with C-H in plane deformation, syringl vibrations, benzene ring**-**hydrogen bond vibrations, respectively.

At 10°C, the absorbance of peaks at 3417 cm^{-1} increased from 0.996 to 0.999 indicating that the O-H increased. The absorbance of peaks at 1593 cm^{-1} reduced from 0.529 to 0.467 at 17h, the absorbance of peaks at 1504 cm^{-1} reduced from 0.376 to 0.327 at 17h, and the absorbance of peaks at 1420 cm^{-1} reduced from 0.564 to 0.492 at 17h, resulting that the benzene ring of lignin reached the most destructive under the temperature of 10 °C at 17h. the absorbance of peaks at 1330 cm^{-1} reduced from 0.427 to 0.379 at 17h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.380 to 0.346 at 17h, result that side chain of lignin also reached the most destructive under the temperature of 10 °C at 17h.

At 20°C, the absorbance of peaks at 3417 cm^{-1} increased from 0.996 to 0.999 indicating that the O-H changed stable. The absorbance of peaks at 1593 cm^{-1} reduced from 0.506 to 0.416 at 5h, the absorbance of peaks at 1504 cm^{-1} reduced from 0.363 to 0.318 at 5h, and the absorbance of peaks at 1420 cm^{-1} reduced from 0.544 to 0.462 at 5h, resulting that the benzene ring of lignin reached the most destructive under the temperature of 20 °C at 5h. the absorbance of peaks at 1330 cm^{-1} reduced from 0.437 to 0.398 at 5h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.395 to 0.372 at 5h, result that side chain of lignin also reached the most destructive under the temperature of 20 °C at 5h.

At 30°C, the absorbance of peaks at 3417 cm^{-1} decreased from 1.000 to 0.984 indicating that the O-H decreased to a certain extent. The absorbance of peaks at 1593 cm^{-1} reduced from 0.481 to 0.42 at 24h, the absorbance of peaks at 1504 cm^{-1} reduced from from 0.350 to 0.265 at 24h, and the absorbance of peaks at 1420 cm^{-1} reduced from 0.509 to 0.504 at 24h, resulting that the benzene ring of lignin reached the most destructive under the temperature of 30 °C at 24h. The absorbance of peaks at 1330 cm^{-1} disappeared from 0.427 to 0.379 at 24h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.445 to 0.412 at 24h, result that side

chain of lignin also reached the most destructive under the temperature of 30 °C at 24h.

FTIR spectra of *Eucalyptus urophynis* lignincellulose were showed in Figure 2. The most important O-H stretching in hydroxgl group was assigned to the 3100 -3650 cm^{-1} region. The absorbance of a peak appeared at 3417 cm^{-1} was the strongest. At 3417 cm^{-1}, 1593 cm^{-1}, 1504 cm^{-1}, 1420 cm^{-1}, 1330 cm^{-1} and 1230 cm^{-1} were O-H stretching in hydroxgl group, aromatic skeletal vibration plus C=O stretching, aromatic skeletal vibrations, aromatic skeletal vibration combined

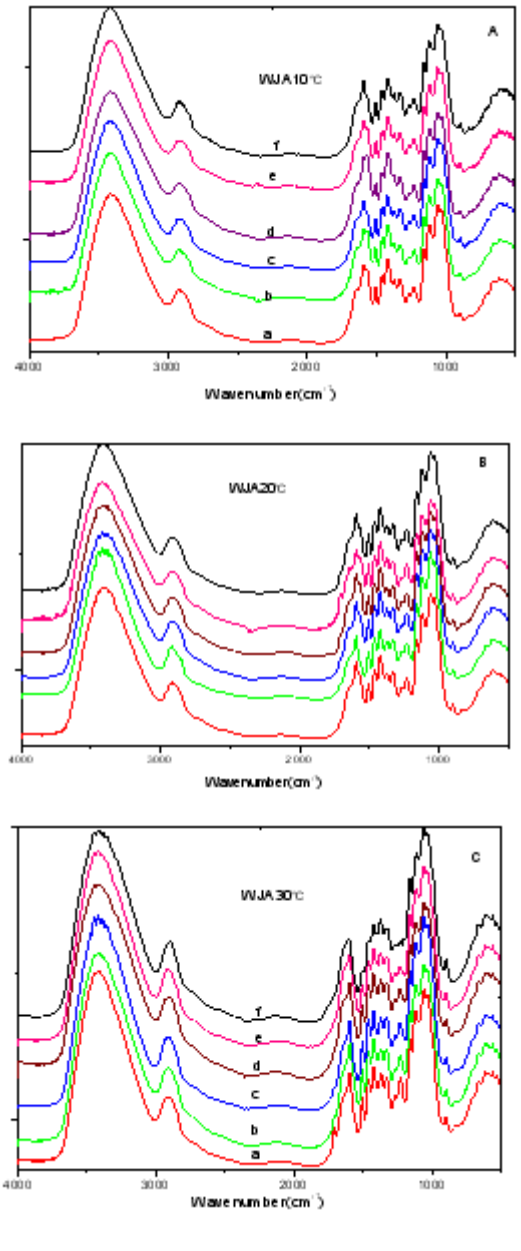

Fig. 1. FTIR spectra of sample of treated *Eucalyptus urophydis* lignincellulose at 10°C, 20°C, 30°C, respectively. (a)1h, (b)5h, (c)7h, (d)12h, (e)17h, (f)24h

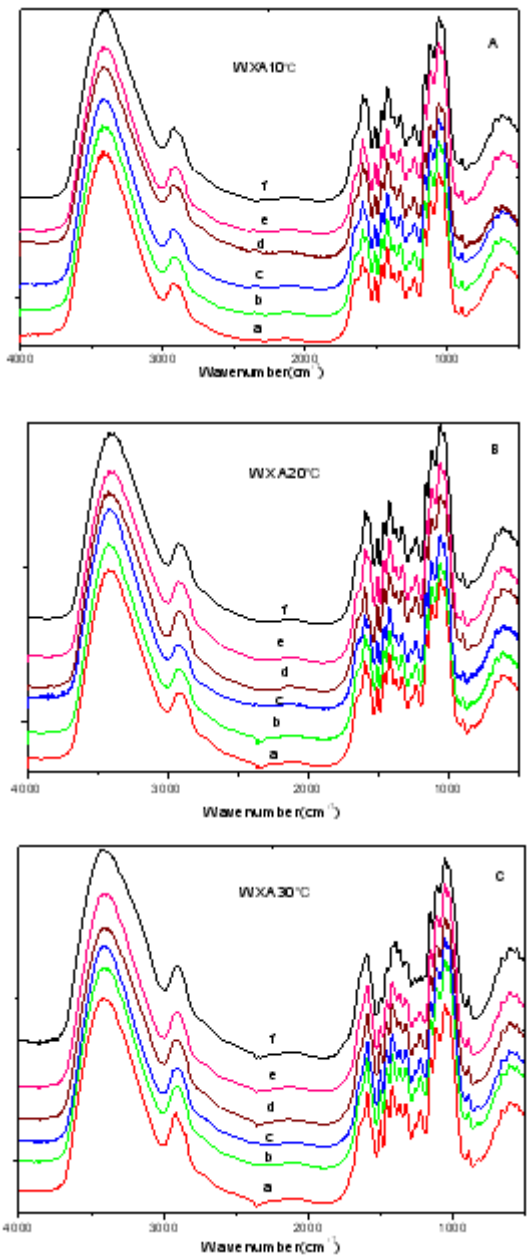

Fig. 2. FTIR spectra of samples of treated *Eucalyptus urophynis* lignincellulose at 10°C, 20°C, 30°C, respectively. (a)1h, (b)5h, (c)7h, (d)12h, (e)17h, (f)24h

with C-H in plane deformation, syringl vibrations, benzene ring-hydrogen bond vibrations, respectively.

At 10°C, the absorbance of peaks at 3417 cm^{-1} increased from 0.993 to 0.999 indicating that the O-H increased. The absorbance of peaks at 1593 cm^{-1} increased from 0.439 to 0.556 at 24h, the absorbance of peaks at 1504 cm^{-1} increased from 0.331 to 0.395 at 24h, and the absorbance of peaks at 1420 cm^{-1} increased from 0.495 to 0.596 at 24h. The absorbance of peaks at 1330 cm^{-1} reduced from 0.377 to 0.450 at 12h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.335 to 0.315 at 12h. The FTIR didn't show bond breaking characteristics of lignin at 10 °C.

At 20°C, the absorbance of peaks at 3417 cm^{-1} decreased from 0.998 to 0.952 indicating that the O-H decreased. The absorbance of peaks at 1593 cm^{-1} reduced from 0.538 to 0.518 at 12h, the absorbance of peaks at 1504 cm^{-1} reduced from 0.406 to 0.337 at 7h, and the absorbance of peaks at 1420 cm^{-1} reduced from from 0.580 to 0.517 at 7h, resulting that the benzene ring of lignin reached the most destructive under the temperature of 10 °C at 7h. the absorbance of peaks at 1330 cm^{-1} reduced from 0.464 to 0.377 at 7h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.420 to 0.334 at 7h, result that side chain of lignin also reached the most destructive under the temperature of 10 °C at 7h.

At 30°C, the absorbance of peaks at 3417 cm^{-1} weakly decreased indicating that the O-H decreased to a certain extent. The absorbance of peaks at 1593 cm^{-1} reduced from 0.544 to 0.491 at 24h, the absorbance of peaks at 1504 cm^{-1} reduced from 0.406 to 0.286 at 24h, and the absorbance of peaks at 1420 cm^{-1} reduced from 0.573 to 0.542 at 24h, resulting that the benzene ring of lignin reached the most destructive under the temperature of 30 °C at 24h. The absorbance of peaks at 1330 cm^{-1} disappeared at 24h, the absorbance of peaks at 1230 cm^{-1} reduced from 0.461 to 0.385 at 24h, result that side chain of lignin also reached the most destructive under the temperature of 30 °C at 24h.

CONCLUSION

The SLR of *Eucalyptus urophydis* lignincellulose reached maximum at 12h(87.69%), 17h(86.76%) and 24h(89.51%) under the temperature of 10°C, 20°C and 30°C, respectively. The SLR of *Eucalyptus urophynis* lignincellulose reached the maximum at 5h(84.789%), 7h(86.91%), and 24h(92.51%) under the temperature of 10°C, 20°C and 30°C, respectively. The maximum of SLR of *Eucalyptus urophydis* and *Eucalyptus urophynis* lignincellulose increased with the increase of temperature 10°C, 20°C and 30°C. And the best separation condition of lignin were 24h and 30°C.

During lignin separation from lignincellulose by AAHP method, Crystallinity of *Eucalyptus urophydis* and *Eucalyptus urophynis* lignincellulose were broken. And effect of temperature was very notable so as to use the lower temperature if cellulose would be kept natural structure during lignin separation from lignincellulose.

The side chain and benzene ring of lignin of *Eucalyptus urophydis* lignincellulose reached the largest bond breaking characteristics under the temperature of 10 °C at 17h, 20 °C at 5h and 30 °C at 24h. The side chain and benzene ring of lignin of *Eucalyptus urophynis* lignincellulose reached the largest bond breaking characteristics under the temperature of 20 °C at 7h and 30 °C at 24h, however the FTIR didn't show bond breaking characteristics of lignin at 10 °C.

ACKNOWLEDGMENTS

This work was financially supported by the Project Supported by National Natural Science Foundation of China (No.31070497), Program for New Century Excellent Talents in University (No. NCET-10-0170), A Project Supported by Scientific Research Fund of Hunan Provincial Education Department(No.10A131), the Key Project of Chinese Ministry of Education.(No. 211128).

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