

Effect and control of energy input on tissue and cell dissociation and chemical depolymerization in pure subcritical water autohydrolysis of naked oat stem

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Tables

Table 1 Chemical compositions of the naked oat stem.

Chemical composition	Content (%)
Klason lignin	19.3
Acid soluble lignin	3.2
Glucose	36.3
Xylose	16.6
Galactose	3.8
Arabinose	1.5
Mannose	1.4
Benzene-alcohol extractive	6.9
Ash content	7.7

Table 2 Pressure parameters corresponding to autohydrolysis temperature

Temperature (°C)	Pressure (MPa)
170	0.76
180	0.99
190	1.22
200	1.53
210	1.91

Errors in tables below are standard errors of three independent experiments.

Table 3 Effect of P-factor on the degree of tissue dissociation, errors are standard errors of three independent experiments

P-factor	The degree of tissue dissociation (%)				
	170℃	180℃	190℃	200℃	210℃
61	47.6±0.4	44.6±0.5	39.8±0.2		
104	65.0±0.3	65.5±0.3	61.4±0.2		
147	68.2±0.4	68.5±0.4	66.5±0.1	71.2±0.4	
190	67.7±0.6	71.3±0.5	69.1±0.5	76.1±0.2	75.7±0.3
233	70.5±0.3	77.8±0.6	77.9±0.1	83.4±0.2	84.3±0.5
276	75.3±0.5	93.7±0.9	90.8±0.2	97.8±0.7	96.0±0.6
319	92.3±0.6	97.2±0.4	96.2±0.5	98.7±0.2	98.6±0.4

Table 4 Effect of P-factor on the hemicellulose content the hydrolysis residues, errors are standard errors of three independent experiments

P-factor	Hemicellulose content (%)				
	170℃	180℃	190℃	200℃	210℃
61	15.2±0.2	17.5±0.3			
104	12.7±0.3	9.6±0.2	13.3±0.1		
147	11.7±0.1	8.7±0.2	9.0±0.2	4.0±0.3	
190	8.5±0.1	7.7±0.1	7.1±0.1	2.3±0.1	2.1±0.1
233	8.6±0.3	4.4±0.2	2.9±0.2	2.1±0.2	2.2±0.2
276	8.2±0.2	3.2±0.1	2.4±0.2	2.2±0.1	2.3±0.1
319	7.4±0.1	2.9±0.1	2.3±0.1	2.6±0.1	2.4±0.1

Table 5 Effect of P-factor on the cellulose content the hydrolysis residues, errors are standard errors of three independent experiments

P-factor	Cellulose content (%)				
	170℃	180℃	190℃	200℃	210℃
61	54.0±0.2	59.8±0.3	62.3±0.2		
104	66.8±0.4	66.6±0.6	64.2±0.2		
147	72.4±0.2	69.2±0.3	70.1±0.4	75.3±0.3	
190	69.7±0.3	67.8±0.2	69.4±0.4	70.3±0.1	56.7±0.3
233	73.6±0.4	70.3±0.6	69.8±0.3	70.5±0.3	71.5±0.1
276	72.6±0.2	65.7±0.2	69.4±0.1	71.8±0.2	74.6±0.4
319	71.8±0.5	53.8±0.2	64.0±0.2	69.7±0.2	61.2±0.2

Table 6 Effect of P-factor on the lignin content the hydrolysis residues, errors are standard errors of three independent experiments

P-factor	Lignin content (%)				
	170°C	180°C	190°C	200°C	210°C
61	25.2±0.2	23.8±0.2	24.7±0.1		
104	27.5±0.2	28.2±0.2	26.4±0.2		
147	28.0±0.3	24.3±0.1	27.8±0.3	23.9±0.1	
190	28.8±0.2	25.0±0.3	27.6±0.3	23.1±0.2	23.6±0.1
233	29.2±0.3	25.9±0.1	29.0±0.2	25.1±0.4	23.4±0.2
276	28.2±0.1	28.3±0.5	28.3±0.4	24.0±0.1	23.0±0.3
319	27.8±0.2	26.6±0.2	29.7±0.1	26.7±0.3	23.4±0.1

Table 7 Effect of P factor on the fibre length of dissociated tissues

P-factor	Fiber length (mm)				
	170°C	180°C	190°C	200°C	210°C
61	1.258±0.004	1.266±0.002	1.192±0.003		
104	1.327±0.006	1.298±0.003	1.124±0.002		
147	1.258±0.003	1.213±0.002	1.172±0.004	1.240±0.004	
190	1.217±0.001	1.241±0.001	1.030±0.001	1.241±0.002	1.241±0.005
233	1.224±0.004	1.222±0.005	1.063±0.005	1.233±0.005	1.155±0.001
276	0.962±0.001	0.956±0.003	0.826±0.001	0.989±0.003	1.011±0.003
319	0.940±0.003	0.935±0.002	0.816±0.003	0.941±0.001	0.930±0.003

Table 8 Effect of P factor on the fibre length-width ratio of dissociated tissues. The length-width ratio of fibres is calculated by dividing the average length by the average width. Therefore no error is given

P-factor	length-width ratio				
	170°C	180°C	190°C	200°C	210°C
61	52.2	51.2	50.7		
104	60.7	56.6	55.7		
147	57.4	52.5	58.2	53.8	
190	50.1	52.8	53.5	54.3	
233	50.2	55.5	50.3	54.8	51.3
276	46.0	45.6	32.9	37.8	47.2
319	43.7	41.8	32.6	32.0	42.4

Table 9 Effect of P factor on the Broken ends of dissociated tissues

P-factor	Broken ends (%)				
	170℃	180℃	190℃	200℃	210℃
61	33.9±0.3	34.4±0.2	34.2±0.4		
104	34.9±0.1	36.4±0.1	39.0±0.1		
147	34.9±0.4	36.3±0.4	38.2±0.3	35.3±0.4	
190	36.3±0.2	36.5±0.6	37.9±0.3	35.2±0.2	35.3±0.2
233	36.9±0.2	36.9±0.2	35.8±0.5	35.4±0.3	37.1±0.1
276	38.0±0.3	37.6±0.2	41.7±0.1	41.7±0.1	40.1 ±0.2
319	40.9±0.5	38.9±0.1	41.7±0.4	42.4±0.4	42.0±0.4

Table 10 Effect of P factor on the fine elements of dissociated tissues

P-factor	Fine elements (%)				
	170℃	180℃	190℃	200℃	210℃
61	38.5±0.3	38.5±0.4	44.2±0.4		
104	32.8±0.1	36.7±0.2	41.0±0.5		
147	35.05±0.3	37.1±0.4	33.6±0.2	33.0±0.2	
190	37.4±0.4	38.1±0.3	46.7±0.1	35.4±0.3	38.3±0.2
233	36.6±0.6	38.8±0.1	45.8±0.3	31.5±0.1	37.9±0.2
276	46.6±0.2	39.4±0.5	68.8±0.4	40.5±0.4	42.1±0.1
319	59.5±0.4	54.5±0.4	69.7±0.1	52.1±0.2	50.5±0.2

Table 11 Effect of P factor on the fiber curl of dissociated tissues

P-factor	Curl (%)				
	170℃	180℃	190℃	200℃	210℃
61	7.2±0.1	7.8±0.1	7.9±0.2		
104	7.6±0.2	8.1±0.2	8.2±0.1		
147	8.8±0.1	7.9±0.1	9.1±0.3	7.9±0.1	
190	9.2±0.3	9.7±0.3	9.3±0.1	8.8±0.2	8.9±0.1
233	9.8±0.1	11.2±0.2	11.7±0.2	9.9±0.1	9.2±0.2
276	8.1±0.3	9.2±0.2	8.5±0.3	7.9±0.2	8.6±0.3
319	8.0±0.1	8.6±0.2	8.5±0.1	7.5±0.1	8.6±0.2

Table 12 Effect of P factor on the fiber kinking of dissociated tissues

P-factor	kinked fibers (%)				
	170℃	180℃	190℃	200℃	210℃
61	15.6±0.1	15.5±0.2	19.7±0.1		
104	20.1±0.3	19.1±0.1	20.2±0.3		
147	22.9±0.2	20.6±0.3	25.4±0.2	21.4±0.1	
190	23.6±0.3	27.1±0.5	30.2±0.1	25.1±0.1	22.9±0.1
233	30.9±0.4	30.0±0.4	32.5±0.5	29.6±0.4	29.2±0.2
276	21.4±0.2	24.5±0.1	18.2±0.1	21.5±0.3	19.8±0.2
319	23.6±0.1	23.6±0.1	17.6±0.3	23.0±0.4	19.6±0.2

Table 13 Effect of P factor on the coarseness of dissociated tissues

P-factor	Coarseness (mg/100m)				
	170℃	180℃	190℃	200℃	210℃
61	7.7±0.3	8.9±0.1	9.8±0.3		
104	7.1±0.2	7.3±0.3	9.2±0.1		
147	7.1±0.3	8.4±0.4	9.2±0.2	7.5±0.3	
190	9.2±0.1	8.6±0.3	9.7±0.1	8.7±0.1	8.9±0.4
233	9.0±0.1	9.8±0.2	9.7±0.2	8.7±0.3	8.3±0.1
276	9.6±0.3	11.6±0.1	21.5±0.5	16.6±0.3	11.9±0.1
319	12.1±0.4	13.0±0.1	24.4±0.3	26.0±0.4	16.0±0.2

Table 14 Effect of P factor on macrofibrills rate of dissociated tissues

P-factor	Rate of macrofibrills (%)				
	170℃	180℃	190℃	200℃	210℃
61	0.729±0.004	0.718±0.002	0.634±0.003		
104	0.592±0.001	0.780±0.003	0.678±0.001		
147	0.741±0.002	0.655±0.001	0.670±0.003	0.581±0.001	
190	0.704±0.002	0.724±0.002	0.816±0.004	0.688±0.001	0.785±0.002
233	0.751±0.001	0.640±0.003	0.772±0.005	0.756±0.002	0.707±0.001
276	0.888±0.006	1.001±0.003	1.096±0.003	0.932±0.004	0.793±0.005
319	0.917±0.001	1.000±0.004	1.121±0.002	1.100±0.006	0.950±0.002

Table 15 Effect of P factor on the fibre length of undissociated tissues

P-factor	Fiber length (mm)				
	170℃	180℃	190℃	200℃	210℃
61	1.487±0.004	1.412±0.005	1.485±0.002		
104	1.504±0.006	1.466±0.003	1.477±0.005		
147	1.504±0.003	1.423±0.006	1.477±0.004	1.349±0.001	
190	1.450±0.007	1.375±0.002	1.452±0.001	1.317±0.003	1.312±0.003
233	1.389±0.004	1.322±0.004	1.398±0.011	1.250±0.004	1.188±0.004
276	1.112±0.006	1.152±0.005	1.162±0.001	0.917±0.003	0.930±0.003
319	1.004±0.004	0.915±0.002	1.111±0.006	0.879±0.005	0.900±0.002

Table 16 Effect of P factor on the fibre length-width ratio of undissociated tissues The length-width ratio of fibres is calculated by dividing the average length by the average width. Therefore no error is given

P-factor	length-width ratio				
	170°C	180°C	190°C	200°C	210°C
61	67.8	66.2	70.4		
104	71.4	71.0	69.7		
147	70.8	64.9	70.0	66.3	
190	63.1	64.3	73.3	66.0	64.6
233	63.5	61.9	68.2	61.3	57.1
276	50.9	56.0	54.8	37.1	39.3
319	50.2	38.4	52.9	36.4	38.1

Table 17 Effect of P factor on the Broken ends of undissociated tissues

P-factor	Broken ends (%)				
	170°C	180°C	190°C	200°C	210°C
61	28.2±0.1	29.5±0.1	27.8±0.1		
104	30.1±0.4	28.7±0.4	27.5±0.3		
147	29.8±0.1	27.6±0.2	27.5±0.4	26.7±0.1	
190	28.2±0.3	26.4±0.1	25.9±0.1	26.6±0.2	26.3±0.2
233	26.5±0.2	26.9±0.4	27.6±0.2	26.6±0.4	28.4±0.3
276	31.9±0.6	29.0±0.1	29.6±0.3	36.5±0.2	35.4±0.1
319	34.4±0.3	36.0±0.3	29.5±0.1	37.6±0.1	40.9±0.2

Table 18 Effect of P factor on the fine elements of undissociated tissues

P-factor	Fine elements (%)				
	170°C	180°C	190°C	200°C	210°C
61	23.2±0.2	23.1±0.3	26.2±0.1		
104	20.0±0.1	21.3±0.1	22.4±0.2		
147	18.8±0.4	19.8±0.1	21.1±0.2	20.6±0.1	
190	19.9±0.3	20.0±0.3	21.0±0.2	20.3±0.2	20.9±0.1
233	22.1±0.2	24.4±0.1	22.0±0.1	23.4±0.1	22.1±0.4
276	27.5±0.1	24.2±0.2	28.0±0.4	39.6±0.1	37.9±0.2
319	29.3±0.5	33.6±0.1	33.9±0.2	46.8±0.2	39.8±0.2

Table 19 Effect of P factor on the fiber curl of undissociated tissues

P-factor	Curl (%)				
	170℃	180℃	190℃	200℃	210℃
61	7.9±0.1	7.7±0.2	7.1±0.3	□	□
104	9.9±0.2	9.0±0.1	6.8±0.1		
147	9.1±0.1	7.3±0.3	6.9±0.1	8.5±0.1	
190	7.9±0.2	7.2±0.1	7.6±0.3	7.5±0.2	7.3±0.2
233	8.4±0.3	8.2±0.2	7.8±0.2	7.4±0.1	7.4±0.3
276	8.3±0.1	8.8±0.3	6.8±0.1	6.7±0.1	6.6±0.2
319	9.5±0.2	6.7±0.1	6.2±0.1	6.9±0.2	7.8±0.1

Table 20 Effect of P factor on the fiber kinking of undissociated tissues

P-factor	kinked fibers (%)				
	170℃	180℃	190℃	200℃	210℃
61	16.8±0.1	17.8±0.2	13.3±0.1	□	□
104	20.0±0.1	21.4±0.4	14.6±0.2		
147	26.8±0.3	23.0±0.3	16.7±0.1	20.4±0.3	
190	28.2±0.2	22.7±0.1	24.2±0.1	24.4±0.1	24.3±0.2
233	28.7±0.1	27.8±0.4	26.4±0.2	26.9±0.2	27.4±0.1
276	24.1±0.3	22.0±0.3	21.0±0.1	18.5±0.2	18.3±0.1
319	20.3±0.2	19.3±0.1	16.0±0.3	16.9±0.1	18.0±0.2

Table 21 Effect of P factor on the coarseness of undissociated tissues

P-factor	Coarseness (mg/100m)				
	170℃	180℃	190℃	200℃	210℃
61	6.5±0.2	6.3±0.3	5.7±0.1		
104	5.3±0.1	5.2±0.2	5.9±0.2		
147	6.6±0.4	6.6±0.1	5.4±0.3	6.5±0.2	
190	7.5±0.3	6.5±0.1	5.2±0.2	6.3±0.1	6.5±0.2
233	6.8±0.1	6.2±0.2	6.0±0.1	7.5±0.2	9.6±0.3
276	7.2±0.3	8.2±0.2	6.4±0.3	11.3±0.4	14.2±0.1
319	7.6±0.2	14.6±0.4	6.6±0.2	14.7±0.1	20.1±0.2

Table 22 Effect of P factor on macrofibrills rate of undissociated tissues

P-factor	Rate of macrofibrills(%)				
	170℃	180℃	190℃	200℃	210℃
61	0.353±0.002	0.370±0.003	0.418±0.001		
104	0.407±0.003	0.363±0.001	0.399±0.002		
147	0.331±0.004	0.374±0.002	0.406±0.001	0.356±0.004	
190	0.388±0.001	0.349±0.002	0.389±0.003	0.356±0.001	0.363±0.003
233	0.461±0.002	0.375±0.004	0.383±0.005	0.364±0.002	0.384±0.001
276	0.502±0.002	0.396±0.001	0.469±0.003	0.644±0.004	0.575±0.004
319	0.516±0.001	0.586±0.001	0.555±0.004	0.787±0.005	0.837±0.005

