

## Supplementary Materials

**Table S1.** ANOVA for response surface quadratic model of bulk density as affected by temperature and residence time of steam explosion pretreatment.

Source	Sum of Squares	df	Mean Square	F Value	p-value	
<b>Model</b>	366.16	5	73.23	5.07	0.02	<b>significant</b>
<b>A-Temperature (°C)</b>	21.66	1	21.66	1.50	0.26	
<b>B-Time (min)</b>	8.64	1	8.64	0.59	0.46	
<b>AB</b>	144	1	144	9.97	0.01	
<b>A<sup>2</sup></b>	190.42	1	190.42	13.19	0.00	
<b>B<sup>2</sup></b>	17.21	1	17.21	1.19	0.31	
<b>Residual</b>	101.04	7	14.43			
<b>Lack of Fit</b>	73.15	3	24.38	3.49	0.12	<b>not significant</b>

**Table S2.** ANOVA for response surface quadratic model of particle density as affected by temperature and residence time of steam explosion pretreatment.

Source	Sum of Squares	df	Mean Square	F Value	p-value	
<b>Model</b>	3966.18	5	793.23	3.28	0.07	<b>not significant</b>
<b>A-Temperature (°C)</b>	345.04	1	345.04	1.42	0.27	
<b>B-Time (min)</b>	607.02	1	607.02	2.51	0.15	
<b>AB</b>	956.35	1	956.35	3.95	0.08	
<b>A<sup>2</sup></b>	1870.51	1	1870.51	7.74	0.02	
<b>B<sup>2</sup></b>	14.62	1	14.62	0.06	0.81	
<b>Residual</b>	1691.48	7	241.64			
<b>Lack of Fit</b>	629.78	3	209.92	0.79	0.55	<b>not significant</b>

**Table S3.** ANOVA for for response surface quadratic model of pellet density as affected by temperature and residence time of steam explosion pretreatment.

Source	Sum of Squares	df	Mean Square	F Value	p-value	
<b>Model</b>	27195.52	5	5439.10	10.42	0.00	<b>significant</b>
<b>A-Temperature (°C)</b>	17003.31	1	17003.31	32.59	0.00	
<b>B-Time (min)</b>	2276.19	1	2276.19	4.36	0.07	

<b>AB</b>	0.40	1	0.40	0.00	0.97	
<b>A<sup>2</sup></b>	2051.47	1	2051.47	3.93	0.08	
<b>B<sup>2</sup></b>	2867.47	1	2867.47	5.49	0.05	
<b>Residual</b>	3651.10	7	521.58			
<b>Lack of Fit</b>	2890.36	3	963.45	5.06	0.07	<b>not significant</b>

**Table S4.** ANOVA for for response surface quadratic model of tensile strength as affected by temperature and residence time of steam explosion pretreatment.

<b>Source</b>	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F Value</b>	<b>p-value</b>	
<b>Model</b>	19.73	5	3.94	3.27	0.07	<b>not significant</b>
<b>A-Temperature (°C)</b>	8.68	1	8.68	7.20	0.03	
<b>B-Time (min)</b>	0.37	1	0.37	0.31	0.59	
<b>AB</b>	0.74	1	0.74	0.62	0.45	
<b>A<sup>2</sup></b>	3.57	1	3.57	2.96	0.12	
<b>B<sup>2</sup></b>	2.58	1	2.58	2.14	0.18	
<b>Residual</b>	8.44	7	1.20			
<b>Lack of Fit</b>	3.59	3	1.19	0.98	0.48	<b>not significant</b>

**Table S5.** ANOVA for for response surface quadratic model of dimensional stability as affected by temperature and residence time of steam explosion pretreatment.

<b>Source</b>	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F Value</b>	<b>p-value</b>	
<b>Model</b>	0.00	5	0.00	5.03	0.02	<b>significant</b>
<b>A-Temperature (°C)</b>	0.00	1	0.00	18.35	0.00	
<b>B-Time (min)</b>	1.67E-05	1	1.67E-05	0.37	0.55	
<b>AB</b>	0.00	1	0.00	2.24	0.17	
<b>A<sup>2</sup></b>	9.93E-06	1	9.93E-06	0.22	0.65	
<b>B<sup>2</sup></b>	0.00	1	0.00	4.07	0.08	
<b>Residual</b>	0.00	7	4.45E-05			
<b>Lack of Fit</b>	0.00	3	6.38E-05	2.12	0.23	<b>not significant</b>

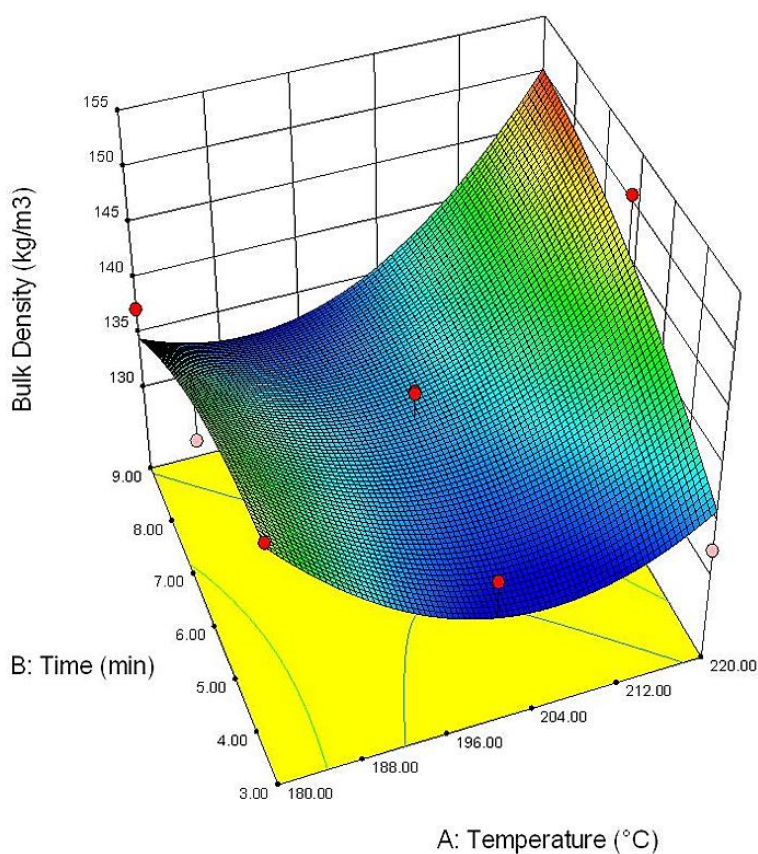
**Table S6.** ANOVA for for response surface quadratic model of ash content as affected by temperature and residence time of steam explosion pretreatment.

<b>Source</b>	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F Value</b>	<b>p-value</b>	
<b>Model</b>	1.10	5	0.22	12.10	0.00	<b>significant</b>
<b>A-Temperature (°C)</b>	0.62	1	0.62	34.09	0.00	
<b>B-Time (min)</b>	0.06	1	0.06	3.40	0.10	
<b>AB</b>	0.09	1	0.09	5.10	0.05	
<b>A<sup>2</sup></b>	0.31	1	0.31	17.48	0.00	

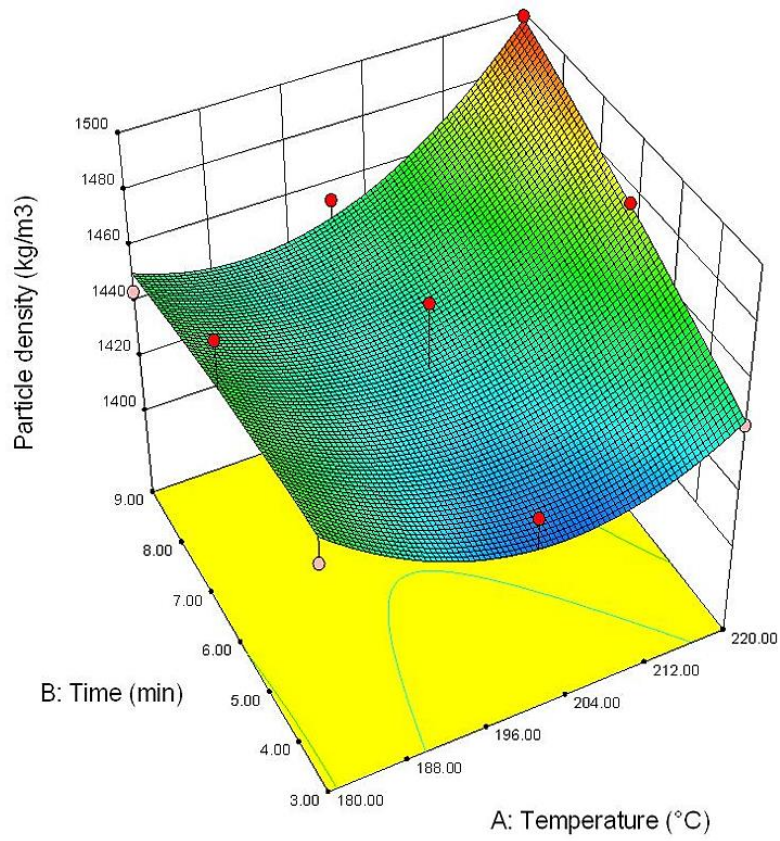
<b>B<sup>2</sup></b>	0.017	1	0.01	0.98	0.35	
<b>Residual</b>	0.12	7	0.01			
<b>Lack of Fit</b>	0.11	3	0.03	10.21	0.02	<b>significant</b>

**Table S7.** ANOVA for response surface quadratic model of high heating value (HHV) as affected by temperature and residence time of steam explosion pretreatment.

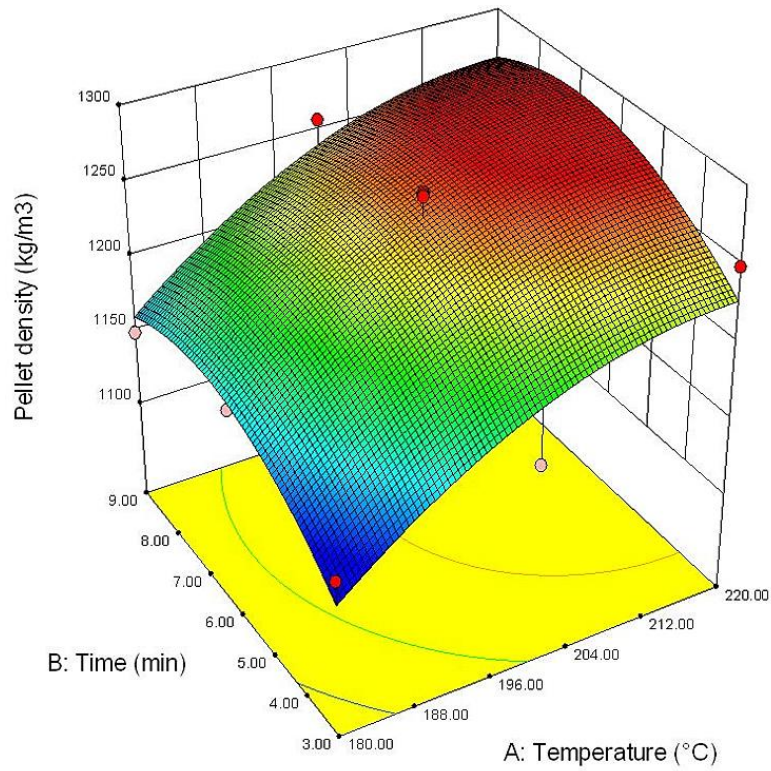
Source	Sum of Squares	df	Mean Square	F Value	p-value	
<b>Model</b>	0.87	5	0.17	14.61	0.00	<b>significant</b>
<b>A-Temperature (°C)</b>	0.16	1	0.16	13.34	0.00	
<b>B-Time (min)</b>	0.25	1	0.25	21.36	0.00	
<b>AB</b>	0.00	1	0.00	0.16	0.69	
<b>A<sup>2</sup></b>	0.36	1	0.36	30.82	0.00	
<b>B<sup>2</sup></b>	0.00	1	0.00	0.15	0.70	
<b>Residual</b>	0.08	7	0.01			
<b>Lack of Fit</b>	0.03	3	0.01	0.76	0.56	<b>not significant</b>



**Figure S1.** Response surface chart for bulk density of steam treated sawdust as affected by temperature and residence time of steam explosion pretreatment.

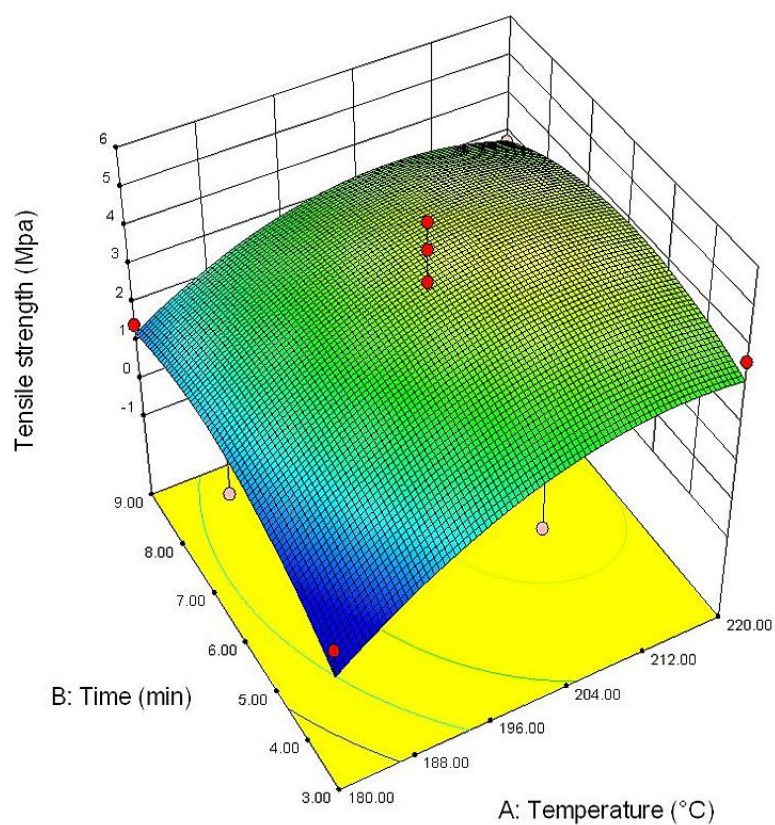


**Figure S2.** Response surface chart for particle density of steam treated sawdust as affected by temperature and residence time of steam explosion pretreatment.

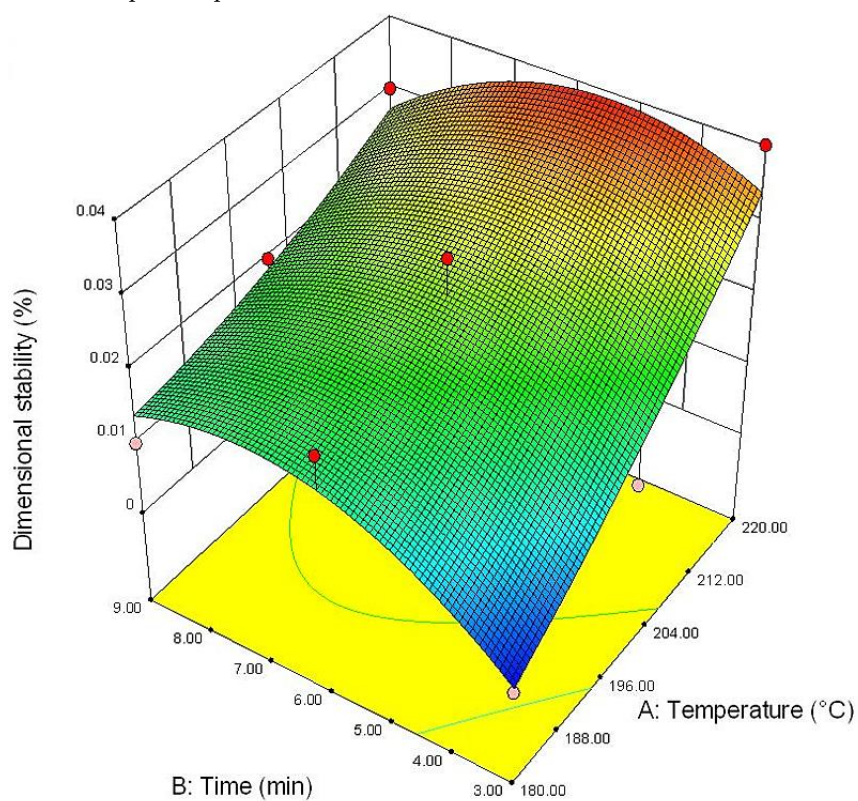


**Figure S3.** Response surface chart for pellet density of steam treated pellets as affected by temperature and residence time of steam explosion pretreatment.

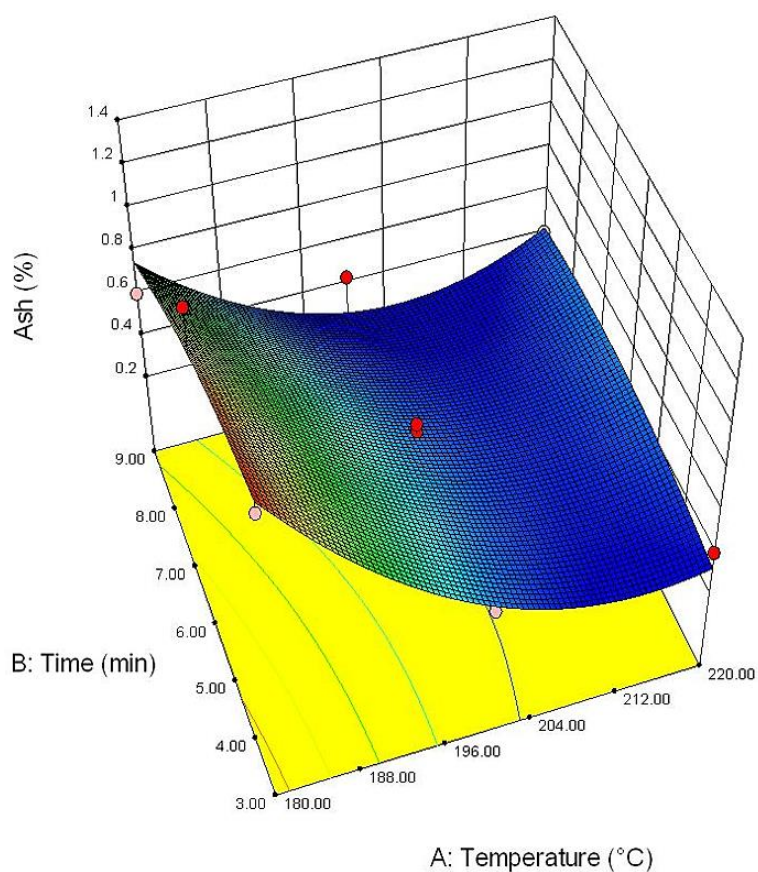




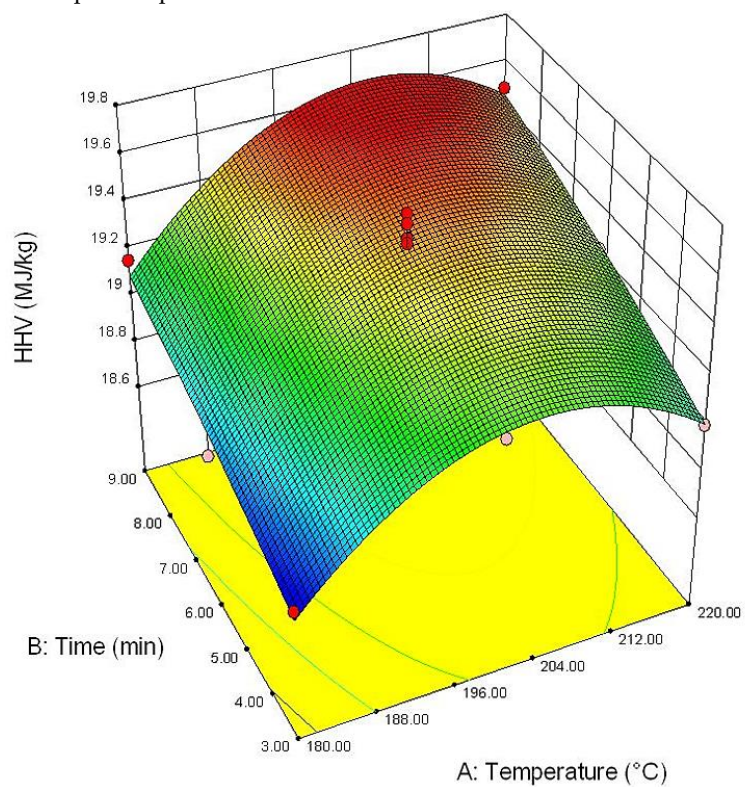
**Figure S4.** Response surface chart for tensile strength of steam treated pellets as affected by temperature and residence time of steam explosion pretreatment.



**Figure S5.** Response surface chart for dimensional stability of steam pretreated pellets as affected by temperature and residence time of steam explosion pretreatment.



**Figure S6.** Response surface chart for ash content of steam pretreated sawdust as affected by temperature and residence time of steam explosion pretreatment.



**Figure S7.** Response surface chart for higher heating value (HHV) of steam pretreated sawdust as affected by temperature and residence time of steam explosion pretreatment.