CLAIMS

What is claimed is:

1. A method of increasing the level of C_6 monosaccharides and C_6 oligosaccharides produced from lignocellulosic biomass, comprising:

providing lignocellulosic biomass, comprising:

a first solid fraction comprising:

cellulose; and

lignin; and

a first liquid fraction;

optionally, separating said first solid fraction and said first liquid fraction;

mixing said first solid fraction with water to form a slurry;

pre-heating said slurry to a temperature of about 210ºC to about 240ºC at a pressure of about 225 bar to about 250 bar;

contacting said slurry with a second reaction fluid to form a second reaction mixture comprising:

a second solid fraction comprising:

lignin; and

a second liquid fraction comprising:

a soluble C_6 saccharide selected from the group consisting of C_6 monosaccharides, C_6 oligosaccharides, and mixtures thereof;

wherein said second reaction fluid comprises hot compressed water and, optionally, carbon dioxide;

wherein said second reaction fluid is at a temperature of at least about 373ºC under a pressure sufficient to maintain said second reaction fluid in supercritical form; and

reducing the temperature of said ~~slurry~~ second reaction mixture to a temperature less than about 140ºC; and

optionally, hydrolyzing said second liquid fraction to form a composition comprising at least one C_6 saccharide selected from the group consisting of C_6

oligosaccharide having lower mer units, glucose, galactose, mannose, fructose, and mixtures thereof.

2. A method of claim 1, further comprising:

~~wherein said slurry is preheated~~preheating said slurry to a temperature of about 245ºC to about 255ºC at a pressure of about 200 bar to about 260 bar for a residence time of about 5 seconds to about one minute.

3. A method of claim 1,

wherein said second reaction mixture has a temperature of about 358ºC to about 380ºC at a pressure of about 200 bar to about 260 bar.

4. A method of claim 1,

wherein said slurry is contacted with said second reaction fluid for less than about 5 seconds.

5. A method of claim 1,

wherein, prior to said reducing the temperature step, said second reaction mixture is cooled to a temperature of about 260ºC to about 280ºC at a pressure of about 200 bar to about 260 bar.

6. A method of claim 1, further comprising:

fractionating said lignocellulosic biomass prior to said providing step;

wherein said step of fractionating comprises contacting said lignocellulosic biomass with a first reaction fluid comprising hot compressed water and, optionally, carbon dioxide;

wherein said first reaction fluid further comprises acid, when said lignocellulosic biomass comprises softwood; and

wherein said first reaction fluid is at a temperature of at least about 100ºC under a pressure sufficient to maintain said first reaction fluid in liquid form.

7. A method of claim 1,

wherein said method is continuous.

8. A method of claim 1,

wherein said reducing the temperature of said second reaction mixture comprises contacting said second reaction mixture with a composition comprising water.

9. A method of claim 8,

wherein said composition further comprises at least one C_1-C_5 alcohol.

10. A method of claim 1,

wherein said reducing the temperature of said second reaction mixture comprises contacting said second reaction mixture with a composition comprising water and acid, wherein said acid is present at a level less than about 1%, by weight, based on the total weight of said composition.

11. A method of claim 10,

wherein said composition further comprises at least one C_1-C_5 alcohol.

12. A method of claim 1,

wherein said hydrolyzing said second liquid fraction is carried out enzymatically.

13. A method of claim 1,

wherein said hydrolyzing said second liquid fraction is carried out with immobilized enzyme.

14. A method of claim 1,

wherein said hydrolyzing said second liquid fraction comprises addition of at least one aqueous acid.

15. A method of claim 1,

wherein said hydrolyzing said second liquid fraction comprises contact with a gaseous compound that forms acid *in situ*.

16. A method of claim 1,

wherein said hydrolyzing said second liquid fraction comprises contact with at least one solid acid catalyst.

17. A method of claim 1,

wherein the yield of said glucose is at least about 63% of theoretical yield.

~~18. A product produced by the method of claim 1.~~

~~19~~18. A method of controlling the rate of cellulose hydrolysis, comprising:

providing lignocellulosic biomass, comprising:

a first solid fraction comprising:

cellulose; and

lignin; and

a first liquid fraction;

optionally, separating said first solid fraction and said first liquid fraction;

mixing said first solid fraction with water to form a slurry;

pre-heating said slurry to a temperature of about 210ºC to about 240ºC at a pressure of about 225 bar to about 250 bar;

contacting said slurry with a second reaction fluid to form a second reaction mixture comprising:

a second solid fraction comprising:

lignin; and

a second liquid fraction comprising:

a soluble C_6 saccharide selected from the group consisting of C_6 monosaccharides, C_6 oligosaccharides, and mixtures thereof;

wherein said second reaction fluid comprises hot compressed water and, optionally, carbon dioxide;

wherein said second reaction fluid is at a temperature of at least about 373ºC under a pressure sufficient to maintain said second reaction fluid in supercritical form; and

reducing the temperature of said ~~slurry~~ second reaction mixture to a temperature less than about 140ºC; and

optionally, hydrolyzing said second liquid fraction to form a composition comprising at least one C_6 saccharide selected from the group consisting of C_6 oligosaccharide having lower mer units, glucose, galactose, mannose, fructose, and mixtures thereof.

~~20~~19. A method of claim ~~19~~18, further comprising:

~~wherein said slurry is preheated~~preheating said slurry to a temperature of about 245ºC to about 255ºC at a pressure of about 200 bar to about 260 bar for a residence time of about 5 seconds to about one minute.

~~21. A method of claim 19,~~

~~wherein said second reaction fluid has a temperature of about 358ºC to about 380ºC at a pressure of about 200 bar to about 260 bar.~~

~~22. A method of claim 19,~~

~~wherein said slurry is contacted with said second reaction fluid for less than about 5 seconds.~~

~~23. A method of claim 19,~~

~~wherein said second reaction mixture is cooled to a temperature of about 260ºC to about 280ºC at a pressure of about 200 bar to about 260 bar.~~

~~24~~20. A method of claim ~~19~~18, further comprising:

fractionating said lignocellulosic biomass prior to said providing step;

wherein said step of fractionating comprises contacting said lignocellulosic biomass with a first reaction fluid comprising hot compressed water and, optionally, carbon dioxide;

wherein said first reaction fluid further comprises acid, when said lignocellulosic biomass comprises softwood; and

wherein said first reaction fluid is at a temperature of at least about 100ºC under a pressure sufficient to maintain said first reaction fluid in liquid form.

~~25. A method of claim 19,~~

~~wherein said method is continuous.~~

~~26. A method of claim 19,~~

~~wherein said reducing the temperature of said reaction mixture comprises contacting said reaction mixture with a composition comprising water.~~

~~27. A method of claim 26,~~

~~wherein said composition further comprises at least one C_1-C_5 alcohol.~~

~~28. A method of claim 19,~~

~~wherein said reducing the temperature of said reaction mixture comprises contacting said reaction mixture with a composition comprising water and acid, wherein said acid is present at a level less than about 1%, by weight, based on the total weight of said composition.~~

~~29. A method of claim 28,~~

~~wherein said composition further comprises at least one C_1-C_5 alcohol.~~

~~30. A method of claim 19,~~

~~wherein said hydrolyzing said second liquid fraction is carried enzymatically.~~

~~31. A method of claim 19,~~

~~wherein said hydrolyzing said second liquid fraction is carried with immobilized enzyme.~~

~~32. A method of claim 19,~~

~~wherein said hydrolyzing said second liquid fraction comprises addition of at least one aqueous acid.~~

~~33. A method of claim 19,~~

~~wherein said hydrolyzing said second liquid fraction comprises contact with a gaseous compound that forms acid *in situ*.~~

~~34. A method of claim 19,~~

~~wherein said hydrolyzing said second liquid fraction comprises contact with at least one solid acid catalyst.~~

~~35~~21. A method of claim ~~19~~18,

wherein the yield of said glucose is at least about 63% of theoretical yield.

~~36. A product produced by the method of claim 19.~~

~~37~~22. A method of reducing the rate of glucose degradation, comprising:

providing lignocellulosic biomass, comprising:

a first solid fraction comprising:

cellulose; and

lignin; and

a first liquid fraction;

optionally, separating said first solid fraction and said first liquid fraction;

mixing said first solid fraction with water to form a slurry;

pre-heating said slurry to a temperature of about 210ºC to about 240ºC at a pressure of about 225 bar to about 250 bar;

contacting said slurry with a second reaction fluid to form a second reaction mixture comprising:

a second solid fraction comprising:

lignin; and

a second liquid fraction comprising:

a soluble C_6 saccharide selected from the group consisting of C_6 monosaccharides, C_6 oligosaccharides, and mixtures thereof;

wherein said second reaction fluid comprises hot compressed water and, optionally, carbon dioxide;

wherein said second reaction fluid is at a temperature of at least about 373ºC under a pressure sufficient to maintain said second reaction fluid in supercritical form; and

reducing the temperature of said ~~slurry~~ second reaction mixture to a temperature less than about 140ºC; and

optionally, hydrolyzing said second liquid fraction to form a composition comprising at least one C_6 saccharide selected from the group consisting of C_6 oligosaccharide having lower mer units, glucose, galactose, mannose, fructose, and mixtures thereof.

~~38~~23. A method of claim ~~37~~22, further comprising:

~~wherein said slurry is preheated~~preheating said slurry to a temperature of about 245ºC to about 255ºC at a pressure of about 200 bar to about 260 bar for a residence time of about 5 seconds to about one minute.

~~39~~24. A method of claim ~~37~~22,

wherein said second reaction mixture has a temperature of about 358ºC to about 380ºC at a pressure of about 200 bar to about 260 bar.

~~40~~25. A method of claim ~~37~~22,

wherein said slurry is contacted with said second reaction fluid for less than about 5 seconds.

41. A method of claim 37,

wherein said second reaction mixture is cooled to a temperature of about 260ºC to about 280ºC at a pressure of about 200 bar to about 260 bar.

42. A method of claim 37,

wherein said fractionating comprises contacting said lignocellulosic biomass with a first reaction fluid comprising hot compressed water and, optionally, carbon dioxide;

wherein said first reaction fluid further comprises acid, when said lignocellulosic biomass comprises softwood; and

wherein said first reaction fluid is at a temperature of at least about 100ºC under a pressure sufficient to maintain said first reaction fluid in liquid form.

43. A method of claim 37,

wherein said method is continuous.

44. A method of claim 37,

wherein said reducing the temperature of said reaction mixture comprises contacting said reaction mixture with a composition comprising water.

45. A method of claim 44,

wherein said composition further comprises at least one C_1-C_5 alcohol.

46. A method of claim 37,

wherein said reducing the temperature of said reaction mixture comprises contacting said reaction mixture with a composition comprising water and acid, wherein said acid is present at a level less than about 1%, by weight, based on the total weight of said composition.

47. A method of claim 46,

wherein said composition further comprises at least one C_1-C_5 alcohol.

~~48. A method of claim 37,~~

~~wherein said hydrolyzing said second liquid fraction is carried enzymatically.~~

~~49. A method of claim 37,~~

~~wherein said hydrolyzing said second liquid fraction is carried with immobilized enzyme.~~

~~50. A method of claim 37,~~

~~wherein said hydrolyzing said second liquid fraction comprises addition of at least one aqueous acid.~~

~~51. A method of claim 37,~~

~~wherein said hydrolyzing said second liquid fraction comprises contact with a gaseous compound that forms acid *in situ*.~~

~~52. A method of claim 37,~~

~~wherein said hydrolyzing said second liquid fraction comprises contact with at least one solid acid catalyst.~~

~~53. A method of claim 37,~~

~~wherein the yield of said glucose is at least about 63% of theoretical yield.~~

~~54. A product produced by the method of claim 37.~~

~~55~~26. A method, comprising:

providing lignocellulosic biomass, comprising:

a first solid fraction comprising:

cellulose; and

lignin; and

a first liquid fraction;

optionally, separating said first solid fraction and said first liquid fraction;

mixing said first solid fraction with water to form a slurry;

pre-heating said slurry to a temperature of about 210ºC to about 240ºC at a pressure of about 225 bar to about 250 bar;

contacting said slurry with a second reaction fluid to form a second reaction mixture comprising:

a second solid fraction comprising:

lignin; and

a second liquid fraction comprising:

a soluble C_6 saccharide selected from the group consisting of C_6 monosaccharides, C_6 oligosaccharides, and mixtures thereof;

wherein said second reaction fluid comprises hot compressed water and, optionally, carbon dioxide;

wherein said second reaction fluid is at a temperature of at least about 373ºC under a pressure sufficient to maintain said second reaction fluid in liquid form; and

reducing the temperature of said ~~slurry~~ second reaction mixture to a temperature less than about 140ºC; and

hydrolyzing said second liquid fraction to form a composition comprising at least one C_6 saccharide selected from the group consisting of C_6 oligosaccharide having lower mer units, glucose, galactose, mannose, fructose, and mixtures thereof; and

converting by fermentation, catalysis, or a combination thereof said C_6 saccharides to a fermentation product, a catalysis product, or a mixture thereof.

~~56. A product produced by the method of claim 55.~~

~~57. A composition, comprising:~~

~~glucose;~~

~~water;~~

~~glyceraldehyde; and~~

~~glycolic acid;~~

~~wherein said glyceraldehyde is present at a level of less than about 13.0% glyceraldehyde, by weight, based on the total weight of the composition;~~

~~wherein said glycolic acid is present at a level of less than about 2.0% glycolic acid, by weight, based on the total weight of the composition; and~~

~~wherein said glucose is produced from said lignocellulosic biomass using supercritical or near critical fluids.~~