WHAT IS CLAIMED IS:

1. A method of refining a sugar stream, comprising

(i) contacting the sugar stream with an amine extractant to form a mixture;

(ii) separating from the mixture a first stream comprising the amine extractant and an acid or an impurity; and a second stream comprising one or more sugars.

2. The method of claim 1, wherein the first stream is an organic stream and the second stream is an aqueous stream.

3. The method of claim 1, wherein the first stream comprises less than 0.5 % w/w sugars.

4. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w acid.

5. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w amine.

6. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w impurities.

7. The method of claim 1, wherein impurities are extracted from the sugar stream into the amine extractant.

8. The method of claim 1, further comprising, prior to step (i), contacting the sugar stream with a strong acid cation exchanger to remove residual cations.

9. The method of claim 1, wherein the amine extractant comprises an amine and a diluent.

10. The method of claim 9, wherein the ratio of the amine and the diluent is between 3:7 and 6:4.

11. The method of claim 9, wherein the diluent comprises a C6, C8, C10, C12, C14, C16 alcohol or kerosene.

12. The method of claim 9, wherein the diluent comprises hexanol.

13. The method of claim 9, wherein the amine is an amine comprising at least 20 carbon atoms.

14. The method of claim 9, wherein the amine is tri-laurylamine.

15. The method of claim 1, further comprising contacting the sugar stream with a strong acid cation exchanger to remove residual amines, thereby forming an amine-removed hydrolysate.

16. The method of claim 15, further comprising contacting the amine-removed hydrolysate with a weak base anion exchanger to form a neutralized hydrolysate.

17. The method of claim 15 or 16, further comprising fractionating the hydrolysate into a monomeric sugar stream and an oligomeric sugar stream.

18. The method of claim 1, further comprising contacting the first stream with a base solution to form a neutralized amine extractant.

19. The method of claim 18, prior to contacting the first stream with a base solution, further comprising washing the first stream with an aqueous stream to remove sugar from the third stream.

20. The method of claim 19, wherein the washed first stream comprises less than 0.1% weight/weight sugar.

21. The method of claim 18, further comprising washing at least a portion of the neutralized amine extractant with water, and recycling the washed amine extractant.

CLAIMS

WHAT IS CLAIMED IS:

1. A method of refining a sugar stream, comprising
(i) contacting the sugar stream with an amine extractant to form a mixture;
(ii) separating from the mixture a first stream comprising the amine extractant and an acid or an impurity; and a second stream comprising one or more sugars.

2. The method of claim 1, wherein the first stream is an organic stream and the second stream is an aqueous stream.

3. The method of claim 1, wherein the first stream comprises less than 0.5 % w/w sugars.

4. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w acid.

5. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w amine.

6. The method of claim 1, wherein the second stream comprises less than 0.5 % w/w impurities.

7. The method of claim 1, wherein impurities are extracted from the sugar stream into the amine extractant.

8. The method of claim 1, further comprising, prior to step (i), contacting the sugar stream with a strong acid cation exchanger to remove residual cations.

9. The method of claim 1, wherein the amine extractant comprises an amine and a diluent.

10. The method of claim 9, wherein the ratio of the amine and the diluent is 3:7.

11. The method of claim 9, wherein the ratio of the amine and the diluent is 5.5:4.55.

12. The method of claim 9, wherein the ratio of the amine and the diluent is between 3:7 and 6:4.

13. The method of claim 9, wherein the diluent comprises an alcohol.

14. The method of claim 9, wherein the diluent comprises a C6, C8, C10, C12, C14, C16 alcohol or kerosene.

15. The method of claim 9, wherein the diluent comprises hexanol.

16. The method of claim 9, wherein the amine is an amine comprising at least 20 carbon atoms.

17. The method of claim 9, wherein the amine is tri-laurylamine.

18. The method of claim 1, further comprising removing diluent from the second stream using a packed distillation column.

19. The method of claim 18, wherein at least 95% of diluent in the second stream is removed.

20. The method of claim 1, further comprising contacting the sugar stream with a strong acid cation exchanger to remove residual amines, thereby forming an amine-removed hydrolysate.

21. The method of claim 20, further comprising contacting the amine-removed hydrolysate with a weak base anion exchanger to form a neutralized hydrolysate.

22. The method of claim 20 or claim 21, further comprising evaporating the hydrolysate to form a concentrated hydrolysate.

23. The method of any of claims 20-22, further comprising fractionating the hydrolysate into a monomeric sugar stream and an oligomeric sugar stream.

24. The method of claim 23, further comprising purifying or concentrating the monomeric sugar stream.

25. The method of claim 1, further comprising, prior to contacting the sugar stream with an amine extractant to form a first mixture, allowing residual acid in the sugar stream hydrolyze at least some oligomeric sugars in the sugar stream into monomeric sugars.

26. The method of claim 25, further comprising, prior to allowing, diluting the sugar stream to a lower sugar concentration.

27. The method of claim 25, further comprising, prior to allowing, increasing the acid concentration in the sugar stream.

28. The method of claim 27, wherein the acid concentration is increased to be more than 0.5%.

29. The method of claim 23, further comprising combining the oligomeric sugar stream with the sugar stream of claim 1 before the sugar stream is contacted with the amine extract; wherein the residual acid in the sugar stream hydrolyzes at least some oligomeric sugars in the oligomeric sugar stream into monomeric sugars.

30. The method of claim 1, further comprising contacting the first stream with a base solution to form a neutralized amine extractant.

31. The method of claim 30, wherein the contacting is conducted at 70 °C.

32. The method of claim 30, prior to contacting the first stream with a base solution, further comprising washing the first stream with an aqueous stream to remove sugar from the first stream.

33. The method of claim 32, wherein the washed first stream comprises less than 0.1% weight/weight sugar.

34. The method of claim 30, further comprising washing at least a portion of the neutralized amine extractant with water, and recycling the washed amine extractant.

35. The method of claim 34, further comprising treating part of the washed neutralized amine extractant stream by heating it with 10% lime.

36. The method of claim 35, wherein the heating is conducted at 80-90 °C.

37. A method for removing acid from an acidic hemicellulose sugars stream comprising:
(i) contacting an acidic hemicellulose sugar stream comprising an acid and one or more hemicellulose sugars with an amine extractant to form an amine mixture; and
(ii) separating from the amine mixture a first stream comprising the acid and the amine extractant, and a second stream comprising the hemicellulose sugar stream.

38. The method of claim 37, further comprising, prior to step (i), contacting a lignocellulosic feedstock with an acidic aqueous solution; and separating the acidic aqueous solution from the lignocellulosic feedstock thereby forming a lignocellulosic stream and the acidic hemicellulose sugar stream.

39. The method of claim 37, wherein the first stream is an organic stream and the second stream is an aqueous stream.

40. The method of claim 37, wherein the first stream comprises less than 0.5 % w/w hemicellulose sugars.

41. The method of claim 37, wherein the second stream comprises less than 0.5 % w/w acid.

42. The method of claim 37, wherein the second stream comprises less than 0.5 % w/w amine.

43. The method of claim 37, wherein the second stream comprises less than 0.5 % w/w impurities.

44. The method of claim 37, wherein impurities are extracted from the acidic hemicellulose sugar stream into the amine extractant.

45. The method of claim 37, wherein the amine extractant comprises an amine and a diluent.

46. The method of claim 45, wherein the ratio of the amine and the diluent is 3:7.

47. The method of claim 45, wherein the ratio of the amine and the diluent is 5.5:4.55.

48. The method of claim 45, wherein the ratio of the amine and the diluent is between 3:7 and 6:4.

49. The method of claim 45, wherein the diluent comprises an alcohol.

50. The method of claim 45, wherein the diluent comprises a C6, C8, C10, C12, C14, C16 alcohol or kerosene.

51. The method of claim 50, wherein the diluent comprises hexanol.

52. The method of claim 45, wherein the amine is an amine comprising at least 20 carbon atoms.

53. The method of claim 45, wherein the amine is tri-laurylamine.

54. The method of claim 38, wherein the acidic aqueous solution comprises 0.1–2% acid.

55. The method of claim 54, wherein the acid comprises H2SO4 and/or SO2 and/or H2SO3, and/or HCl.

56. The method of claim 45, further comprising removing diluent from the second stream using a packed distillation column.

57. The method of claim 56, wherein at least 95% of diluent in the second stream is removed.

58. The method of claim 37, further comprising contacting the second stream with a strong acid cation exchanger to remove residual amines thereby forming an amine-removed sugar stream.

59. The method of claim 58, further comprising contacting the amine-removed sugar stream with a weak base anion exchanger to form a neutralized sugar stream.

60. The method of claim 58 or claim 59, further comprising evaporating the sugar stream thereby forming a concentrated sugar solution.

61. The method of any of claims 58-60, further comprising fractionating the sugar stream into a xylose-enriched stream and a mixed sugar stream.

62. The method of claim 61, wherein the sugars are fractionated using an ion-exchange resin.

63. The method of claim 62, wherein the ion-exchange column is an anion exchange resin.

64. The method of claim 63, wherein the anion exchange resin has a particle size in the range of 200- 400 μm.

65. The method of claim 63, wherein the anion exchange resin has a particle size in the range of 280- 320 μm.

66. The method of claim 61, wherein the fractionation is carried out in a simulated moving bed mode.

67. The method of claim 61, wherein the fractionation is carried out in a sequential simulated moving bed mode.

68. The method of claim 67, wherein the sequential simulated moving bed chromatography system comprises steps 1-3; a feed stream in passed into an adsorbent and a first raffinate stream is flushed from the adsorbent during step 1; a second raffinate stream is flushed from the adsorbent with a desorbent stream during step 2; and the desorbent is recycled back to the adsorbent during step 3; wherein the xylose-enriched stream is extracted in both step 1 and step 2.

69. The method of claim 67, wherein the desorbent flow rate of the chromatography system is equal to the sum of the extract flow rate and the raffinate flow rate.

70. The method of any of claims 61-69, further comprising crystallizing xylose from the xylose-enriched stream.

71. The method of claim 37, further comprising contacting the first stream with a base solution to form a neutralized extractant.

72. The method of claim 71, prior to contacting the first stream with a base solution, further comprising washing the first stream with an aqueous stream to remove hemicellulose sugar from the first stream.

73. The method of claim 72, wherein the washed first stream comprises less than 0.1% weight/weight sugar.

74. The method of claim 71, further comprising washing the neutralized extractant with water, and recycling the washed amine extractant.

75. The method of claim 74, further comprising treating part of the washed neutralized extractant by heating it with 10% lime.

76. The method of claim 38, wherein the lignocellulosic stream is used to make bioenergy pellets.

77. A method of fractionating a liquid sample comprising a mixture of a first fraction and a second fraction, comprising:
(i) fractionating the liquid sample with a sequential simulated moving bed chromatography system; wherein the sequential simulated moving bed chromatography system comprises steps 1-3; a feed stream in passed into an adsorbent and a first raffinate stream is flushed from the adsorbent during step 1; a second raffinate stream is flushed from the adsorbent with a desorbent stream during step 2; and the desorbent is recycled back to the adsorbent during step 3;
(ii) recovering one or more product stream from the chromatography system;
wherein the product stream is extracted in both step 1 and step 2.

78. The method of claim 77, wherein the liquid sample further comprises a third fraction.

79. The method of claim 77, wherein desorbent flow rate of the chromatography system is equal to the sum of the extract flow rate and the raffinate flow rate.

80. The method of claim 77, wherein the chromatography system comprises an ion-exchange resin.

81. The method of claim 80, wherein the ion-exchange resin is an anion exchange resin.

82. The method of claim 80, wherein the ion-exchange resin has a particle size in the range of 200- 400 μm.

83. The method of claim 80, wherein the ion-exchange resin has a particle size in the range of 280- 320 μm.

84. A hemicellulose sugar mixture comprising one or more, two or more, three or more, four or more, five or more, or six or seven or eight or more of the following characteristics:
(i) monosaccharides in a ratio to total dissolved sugars > 0.50 weight/weight;
(ii) glucose in a ratio to total monosaccharides < 0.25 weight/weight;
(iii) xylose in a ratio to total monosaccharides > 0.18 weight/weight;
(iv) fructose in a ratio to total monosaccharides < 0.10 weight/weight;
(v) fructose in a ratio to total monosaccharides > 0.01 weight/weight;
(vi) furfurals in an amount up to 0.01 % weight/weight;
(vii) one or more phenols in an amount up to 500 ppm; and
(viii) hexanol in an amount up to 0.1% weight/weight.

85. A mixture of claim 84, wherein the monosaccharides to total dry solid ratio is > 0.70 weight/weight.

86. A mixture of claim 84, wherein the monosaccharides to total dry solid ratio is > 0.90 weight/weight.

87. A mixture of claim 84, wherein the glucose to total monosaccharides ratio is < 0.15 weight/weight.

88. A mixture of claim 84, wherein the glucose to total monosaccharides ratio is < 0.13 weight/weight.

89. A mixture of claim 84, wherein the glucose to total monosaccharides ratio is < 0.06 weight/weight.

90. A mixture of claim 84, wherein the xylose to total monosaccharides ratio is > 0.20 weight/weight.

91. A mixture of claim 84, wherein the xylose to total monosaccharides ratio is > 0.50 weight/weight.

92. A mixture of claim 84, wherein the xylose to total monosaccharides ratio is > 0.70 weight/weight.

93. A mixture of claim 84, wherein the fructose to total monosaccharides ratio is > 0.02 weight/weight.

94. A mixture of claim 84, wherein the fructose to total monosaccharides ratio is < 0.08 weight/weight.

95. A mixture of claim 84 comprising furfurals in an amount up to 0.005% weight/weight.

96. A mixture of claim 84 comprising furfurals in an amount up to 0.001% weight/weight.

97. A mixture of claim 84 comprising phenols in an amount up to 400 ppm.

98. A mixture of claim 84 comprising phenols in an amount up to 300 ppm.

99. A xylose-enriched stream hemicellulose sugar mixture comprising one or more, two or more, three or more, four or more, five or more, six or more, seven or more, eight or more, nine or more, or ten or more of the following characteristics:
(i) oligosaccharides in a ratio to total dissolved sugars < 0.10 weight/weight;
(ii) xylose in a ratio to total dissolved sugars > 0.50 weight/weight;
(iii) arabinose in a ratio to total dissolved sugars < 0.10 weight/weight;
(iv) galactose in a ratio to total dissolved sugars < 0.05 weight/weight;
(v) the sum of glucose and fructose in a ratio to total dissolved sugars < 0.10 weight/weight;
(vi) mannose in a ratio to total dissolved sugars < 0.02 weight/weight;
(vii) fructose in a ratio to total dissolved sugars < 0.05 weight/weight;
(viii) furfurals in an amount up to 0.01 % weight/weight;
(ix) phenols in an amount up to 500 ppm; and
(x) hexanol in an amount up to 0.1% weight/weight.

100. A mixture of claim 99, wherein the oligosaccharides to total dissolved sugars ratio is < 0.07.

101. A mixture of claim 99, wherein the oligosaccharides to total dissolved sugars ratio is < 0.05.

102. A mixture of claim 99, wherein the xylose to total dissolved sugars ratio is > 0.40 weight/weight.

103. A mixture of claim 99, wherein the xylose to total dissolved sugars ratio is > 0.70 weight/weight.

104. A mixture of claim 99, wherein the xylose to total dissolved sugars ratio is > 0.80 weight/weight.

105. A mixture of claim 99, wherein the sum of glucose and fructose to total dissolved sugars ratio is < 0.09.

106. A mixture of claim 99, wherein the sum of glucose and fructose to total dissolved sugars ratio is < 0.05.

107. A mixture of claim 99 comprising furfurals in an amount up to 0.005% weight/weight.

108. A mixture of claim 99 comprising furfurals in an amount up to 0.001% weight/weight.

109. A mixture of claim 99 comprising phenols in an amount up to 60 ppm.

110. A mixture of claim 99 comprising phenols in an amount up to 0.05 ppm.

111. A xylose-removed hemicellulose sugar mixture comprising one or more, two or more, three or more, four or more, five or more, six or more, seven or more, eight or more, nine or more, or ten or more of the following characteristics:
(i) oligosaccharides in a ratio to total dissolved sugars > 0.15 weight/weight;
(ii) the sum of glucose and fructose in a ratio to total dissolved sugars > 0.20 weight/weight;
(iii) arabinose in a ratio to total dissolved sugars > 0.02 weight/weight;
(iv) galactose in a ratio to total dissolved sugars > 0.02 weight/weight;
(v) xylose in a ratio to total dissolved sugars < 0.20;
(vi) mannose in a ratio to total dissolved sugars > 0.01;
(vii) fructose in a ratio to total dissolved sugars < 0.05;
(viii) furfurals in an amount up to 0.01 % weight/weight;
(ix) phenols in an amount up to 500 ppm; and
(x) hexanol in an amount up to 0.1% weight/weight.

112. A mixture of claim 111, wherein the oligosaccharides to total dissolved sugars ratio is > 0.20 weight/weight.

113. A mixture of claim 111, wherein the oligosaccharides to total dissolved sugars ratio is > 0.23 weight/weight.

114. A mixture of claim 111, wherein the oligosaccharides to total dissolved sugars ratio is > 0.25 weight/weight.

115. A mixture of claim 111, wherein the sum of glucose and fructose to total dissolved sugars ratio is > 0.10 weight/weight.

116. A mixture of claim 111, wherein the sum of glucose and fructose to total dissolved sugars ratio is > 0.25 weight/weight.

117. A mixture of claim 111, wherein the sum of glucose and fructose to total dissolved sugars ratio is > 0.35 weight/weight.

118. A mixture of claim 111 comprising furfurals in an amount up to 0.005% weight/weight.

119. A mixture of claim 111 comprising furfurals in an amount up to 0.001% weight/weight.

120. A mixture of claim 111 comprising phenols in an amount up to 60 ppm.

121. A mixture of claim 111 comprising phenols in an amount up to 0.05 ppm.

122. A mixture of claim 111, wherein the xylose to total dissolved sugars ratio is < 0.30 weight/weight.

123. A mixture of claim 111, wherein the xylose to total dissolved sugars ratio is < 0.15 weight/weight.

124. A mixture of claim 111, wherein the xylose to total dissolved sugars ratio is < 0.10 weight/weight.

125. A mother liquor hemicellulose sugar mixture comprising one or more, two or more, three or more, four or more, five or more, six or more, seven or more, eight or more, nine or more, or ten or more of the following characteristics:

(i) oligosaccharides in a ratio to total dissolved sugars < 0.15 weight/weight;

(ii) xylose in a ratio to total dissolved sugars > 0.40 weight/weight;

(iii) arabinose in a ratio to total dissolved sugars < 0.15 weight/weight;

(iv) galactose in a ratio to total dissolved sugars < 0.06 weight/weight;

(v) the sum of glucose and fructose in a ratio to total dissolved sugars < 0.20 weight/weight;

(vi) mannose in a ratio to total dissolved sugars < 0.03;

(vii) fructose in a ratio to total dissolved sugars < 0.04;

(viii) furfurals in an amount up to 0.01 % weight/weight;

(ix) phenols in an amount up to 500 ppm; and

(x) hexanol in an amount up to 0.1% weight/weight.

126. A mixture of claim 125, wherein the oligosaccharides to total dissolved sugars ratio is < 0.12.

127. A mixture of claim 125, wherein the oligosaccharides to total dissolved sugars ratio is < 0.10.

128. A mixture of claim 125, wherein the oligosaccharides to total dissolved sugars ratio is < 0.20.

129. A mixture of claim 125, wherein the xylose to total dissolved sugars ratio is > 0.50 weight/weight.

130. A mixture of claim 125, wherein the xylose to total dissolved sugars ratio is > 0.60 weight/weight.

131. A mixture of claim 125, wherein the xylose to total dissolved sugars ratio is > 0.70 weight/weight.

132. A mixture of claim 125, wherein the sum of glucose and fructose to total dissolved sugars ratio is < 0.30.

133. A mixture of claim 125, wherein the sum of glucose and fructose to total dissolved sugars ratio is < 0.20.

134. A mixture of claim 125, wherein the sum of glucose and fructose to total dissolved sugars ratio is < 0.10.

135. A mixture of claim 125 comprising furfurals in an amount up to 0.005% weight/weight.

136. A mixture of claim 125 comprising furfurals in an amount up to 0.001% weight/weight.

137. A mixture of claim 125 comprising phenols in an amount up to 60 ppm.

138. A mixture of claim 125 comprising phenols in an amount up to 0.05 ppm.

139. A method of producing a cellulose sugar stream, comprising

(i) moving a lignocellulosic stream and an acid stream counter-currently through a plurality of stirred tank reactors to produce an acidic hydrolysate stream and an acidic lignin stream; and

(ii) separating the acidic hydrolysate stream from the acidic lignin stream;

wherein the plurality of stirred tank reactors includes a first reactor, a last reactor, and one or more intermediate reactors; wherein the lignocellulosic stream enters the first reactor, the acid stream enters the last reactor, the acidic hydrolysate stream exits from the first reactor, and the lignin stream exits from the last reactor.

140. The method of claim 139, further comprising, prior to step (i), contacting a lignocellulosic feedstock with an acidic aqueous solution; and separating the acidic aqueous solution from the lignocellulosic feedstock thereby forming an acidic hemicellulose sugar stream and the lignocellulosic stream.

141. The method of claim 139, further comprising, prior to step (i), reducing particle size in the lignocellulosic stream to 400 to 5000 microns.

142. The method of claim 139, wherein the acidic hydrolysate stream comprises one or more cellulose sugars.

143. The method of claim 142, wherein the acidic hydrolysate stream further comprises one or more hemicellulose sugars.

144. The method of claim 139, further comprising:

(iii) contacting the acidic hydrolysate stream comprising an acid and one or more cellulose sugars with a S1 solvent extractant to form a first mixture; and

(iv) separating from the first mixture a first stream comprising the acid and the S1 solvent extractant and a second stream comprising the one or more cellulose sugars; wherein the acid is extracted from the acidic hydrolysate stream into the S1 solvent extractant.

145. The method of claim 144, wherein the contacting is conducted at 50 °C.

146. The method of claim 144, further comprising

(v) evaporating the second stream comprising the one or more cellulose sugars to form a concentrated second stream; and

(vi) repeating step (iii) and (iv) of claim 144 to form a stream comprising the acid and the S1 solvent extractant and a stream comprising the one or more cellulose sugars.

147. The method of claim 144, wherein the acidic hydrolysate stream is evaporated before the acidic hydrolysate stream is contacted with the S1 solvent extractant, thereby reducing the acid concentration in the acidic hydrolysate stream to azeotrope.

148. The method of claim 144, wherein the first stream is an organic stream and the second stream is an aqueous stream.

149. The method of claim 144, further comprising:
(v) contacting the second stream with an amine extractant to form a second mixture; and
(vi) separating from the second mixture a third stream comprising the acid and the amine extractant and a fourth stream comprising the one or more cellulose sugars.

150. The method of claim 149, further comprising, prior to contacting the second stream with an amine extractant to form a second mixture, allowing the residual acid in the second stream hydrolyze at least some oligomeric sugars in the sugar stream into monomeric sugars thereby forming a cellulose sugar stream.

151. The method of claim 150, further comprising, prior to allowing, diluting the second stream to a lower sugar concentration.

152. The method of claim 150, further comprising, prior to allowing, increasing the acid concentration in the second stream.

153. The method of claim 152, wherein the acid concentration is increased to be more than 0.5%.

154. The method of claim 149, wherein an oligomeric sugar stream is added to the second stream before the second stream is contacted with the amine extract; wherein the residual acid in the second stream hydrolyzes at least some oligomeric sugars in the mixture of the oligomeric sugar stream and the second stream into monomeric sugars.

155. The method of claim 149, wherein the third stream is an organic stream and the fourth stream is an aqueous stream.

156. The method of claim 139, wherein the acidic hydrolysate stream is separated from the lignin stream using a filter, membrane, or hydroclone.

157. The method of claim 139, wherein the acid stream comprise at least 40% weight/weight acid.

158. The method of claim 144, wherein the S1 solvent extractant comprises an alcohol.

159. The method of claim 144, wherein the S1 solvent extractant comprises a C6, C8, C10, C12, C14, C16 alcohol or kerosene or a mixture thereof.

160. The method of claim 144, wherein the S1 solvent extractant comprises hexanol.

161. The method of claim 149, wherein the amine extractant comprises an amine and a diluent.

162. The method of claim 161, wherein the ratio of the amine and the diluent is 3:7.

163. The method of claim 161, wherein the ratio of the amine and the diluent is 5.5:4.55.

164. The method of claim 161, wherein the ratio of the amine and the diluent is between 3:7 and 6:4.

165. The method of claim 161, wherein the diluent comprises an alcohol.

166. The method of claim 161, wherein the diluent comprises a C6, C8, C10, C12, C14, C16 alcohol or kerosene.

167. The method of claim 161, wherein the diluent comprises hexanol.

168. The method of claim 161, wherein the amine is an amine comprising at least 20 carbon atoms.

169. The method of claim 161, wherein the amine is tri-laurylamine.

170. The method of claim 140, wherein the lignocellulosic feedstock comprises mainly cellulose and lignin.

171. The method of claim 139, wherein at least a portion of the acidic hydrolysate stream leaving one or more intermediate tank is added to the lignocellulosic stream before the lignocellulosic stream enters the first reactor.

172. The method of claim 171, wherein the lignocellulosic stream is heated.

173. The method of claim 139, wherein the acid hydrolysate stream contains 22-33% acid weight/weight.

174. The method of claim 149, further comprising removing diluent from the fourth stream using a packed distillation column.

175. The method of claim 174, wherein at least 95% of diluent in the fourth stream is removed.

176. The method of claim 149, further comprising contacting the fourth stream with a strong acid cation exchanger to remove residual amines, thereby forming an amine-removed hydrolysate.

177. The method of claim 176, further comprising contacting the amine-removed hydrolysate with a weak base anion exchanger to form a neutralized hydrolysate.

178. The method of claim 176 or claim 177, further comprising evaporating the hydrolysate to form a concentrated hydrolysate.

179. The method of any of claims 176-178, further comprising fractionating the hydrolysate into a monomeric sugar stream and an oligomeric sugar stream.

180. The method of claim 179, further comprising purifying or concentrating the monomeric sugar stream.

181. The method of claim 179, further comprising combining the oligomeric sugar stream with the second stream before the second stream is contacted with the amine extract; wherein the residual acid in the second stream hydrolyzes at least some oligomeric sugars in the oligomeric sugar stream into monomeric sugars.

182. The method of claim 144, further comprising contacting the first stream comprising the acid and the S1 solvent extractant with an aqueous solution to form a deacidified extractant and an aqueous back-extract; wherein the acid is extracted from the first stream into the aqueous back-extract.

183. The method of claim 182, wherein the contacting is conducted at 50 °C.

184. The method of claim 182, further comprising, prior to contacting the first stream with an aqueous solution to form a deacidified extractant and an aqueous back-extract, contacting the first stream with an azeotropic or higher concentration acid solution to recover sugars from the first stream.

185. The method of claim 182, wherein the aqueous back-extract comprising 15-20% acid and is used in a downstream process.

186. The method of claim 182, further comprising evaporating the aqueous back-extract under a first pressure, thereby generates a super-azeotropic acid solution having an acid concentration higher than that of the aqueous back-extract prior to the evaporation.

187. The method of claim 186, further comprising evaporating the super-azeotropic acid solution under a second pressure to generate a super-azeotropic gaseous acid, wherein the second pressure is higher than the first pressure.

188. The method of claim 187, further comprising absorbing the super-azeotropic gaseous acid in an aqueous solution to produce a concentrated acid solution.

189. The method of claim 149, further comprising contacting the third stream with a base solution to form a neutralized amine extractant.

190. The method of claim 189, wherein the contacting is conducted at 70 °C.

191. The method of claim 189, prior to contacting the third stream with a base solution, further comprising washing the third stream with an aqueous stream to remove cellulose sugar from the third stream.

192. The method of claim 190, wherein the washed third stream comprises less than 0.1% weight/weight cellulose sugar.

193. The method of claim 189, further comprising washing at least a portion of the neutralized amine extractant with water, and recycling the washed amine extractant.

194. The method of claim 193, further comprising treating part of the washed neutralized amine extractant stream by heating it with 10% lime.

195. The method of claim 194, wherein the heating is conducted at 80-90 °C.

196. A method of hydrolyzing oligomeric sugars comprising
(i) contacting an acidic hydrolysate stream comprising an acid and one or more cellulose sugars with a S1 solvent extractant to form a first mixture;

(ii) separating from the first mixture a first stream comprising the acid and the S1 solvent extractant and a second stream comprising the one or more cellulose sugars; wherein the acid is extracted from the acidic hydrolysate stream into the S1 solvent extractant;
(iii) allowing the residual acid in the second stream hydrolyze at least some oligomeric sugars in the sugar stream into monomeric sugars thereby forming a cellulose sugar stream; and
(iv) fractionating the cellulose sugar stream into a monomeric sugar stream and an oligomeric sugar stream.

197. The method of claim 196, further comprising, prior to fractionating, adding an oligomeric sugar stream into the second stream, wherein the residual acid in the second stream hydrolyzes at least some oligomeric sugars in the mixture of the second stream and the oligomeric sugar stream into monomeric sugars thereby forming a cellulose sugar stream.

198. The method of claim 196, further comprising, prior to allowing, diluting the second stream to a lower sugar concentration.

199. The method of claim 196, further comprising, prior to allowing, increasing the acid concentration in the second stream.

200. The method of claim 199, wherein the acid concentration is increased to be more than 0.5%.

201. The method of claim 196, wherein the acidic hydrolysate stream is evaporated before the input stream is contacted with the S1 solvent extractant, thereby reducing the acid concentration in the acidic hydrolysate stream to azeotrope.

202. The method of claim 196, further comprising contacting the cellulose sugar stream with an anion exchanger to remove acid from the stream.

203. The method of claim 196, wherein said hydrolyzing is catalyzed by HCl at a concentration of not more than 1.2 % weight/weight.

204. The method of claim 196, wherein said hydrolyzing is catalyzed by HCl at a concentration of not more than 0.7 % weight/weight.

205. The method of claim 196, wherein said hydrolyzing is performed at a temperature in the range between 60 °C and 150 °C.

206. The method of claim 196, wherein said secondary hydrolysate contains at least 70% monomeric sugars out of total sugars weight/weight.

207. The method of claim 196, wherein the total sugar content of said secondary hydrolysate is at least 90% weight/weight of the sugar content of said aqueous, low acid mixture.

208. A high concentration C6 sugar mixture comprising one or more, two or more, three or more, or four or more, five or more, or six or more of the following characteristics:
(i) monosaccharides in a ratio to total dissolved sugars > 0.85 weight/weight;
(ii) glucose in a ratio to total dissolved sugars in the range of 0.40-0.70 weight/weight;
(iii) 1-200 ppm chloride;
(iv) furfurals in an amount up to 0.01 % weight/weight;
(v) phenols in an amount up to 500 ppm; and
(vi) hexanol in an amount up to 0.1% weight/weight.

209. A mixture of claim 208, wherein the monosaccharides to total dissolved sugars ratio is > 0.90 weight/weight.

210. A mixture of claim 208, wherein the monosaccharides to total dissolved sugars ratio is > 0.95 weight/weight.

211. A mixture of claim 208, wherein the glucose to total dissolved sugars ratio is in the range of 0.40-0.60 weight/weight.

212. A mixture of claim 208, wherein the glucose to total dissolved sugars ratio is in the range of 0.50-0.60 weight/weight.

213. A mixture of claim 208, wherein the chloride concentration is in the range of 10-100 ppm.

214. A mixture of claim 208, wherein the chloride concentration is in the range of 10-50 ppm.

215. A mixture of claim 208 comprising furfurals in an amount up to 0.005% weight/weight.

216. A mixture of claim 208 comprising furfurals in an amount up to 0.001% weight/weight.

217. A mixture of claim 208 comprising phenols in an amount up to 400 ppm.

218. A mixture of claim 208 comprising phenols in an amount up to 100 ppm.

219. A mixture of claim 208, wherein xylose to total dissolved sugars ratio is in the range of 0.03-0.12 weight/weight.

220. A mixture of claim 208, wherein xylose to total dissolved sugars ratio is in the range of 0.05-0.10 weight/weight.

221. A mixture of claim 208, wherein arabinose to total dissolved sugars ratio is in the range of 0.005-0.015 weight/weight.

222. A mixture of claim 208, wherein galactose to total dissolved sugars ratio is in the range of 0.025-0.035 weight/weight.

223. A mixture of claim 208, wherein mannose to total dissolved sugars ratio is in the range of 0.14-0.18 weight/weight.

224. A method of producing a high purity lignin, comprising
(i) adjusting the pH of an aqueous solution comprising lignin to an acidic pH;
(ii) contacting the acidic aqueous lignin solution with a lignin extraction solution comprising a limited-solubility solvent thereby forming a first stream comprising the lignin and the lignin extraction solution, and a second stream comprising water soluble impurities;
(iii) contacting the first stream with a strong acid cation exchanger to remove residual cations thereby obtaining a purified first stream; and
(iv) separating the limited-solubility solvent from the lignin thereby obtaining a high purity lignin composition.

225. The method of claim 224, wherein the separating step comprises precipitating the lignin by contacting the purified first stream with water.

226. The method of claim 225, wherein the purified first stream is contacted with hot water thereby flash evaporating the limited-solubility solvent.

227. The method of claims 224, wherein the separating step comprises evaporating the limited-solubility solvent from the lignin.

228. The method of claim 226, wherein the evaporating comprises spray drying.

229. The method of claim 225, further comprising filtering the lignin particles from the water.

230. The method of claim 224, wherein the aqueous solution comprising lignin is generated by dissolving a lignin material in an alkaline solution.

231. The method of claim 224, wherein the aqueous solution comprising lignin is generated by a process selected from a pulping, a milling, a biorefining, kraft pulping, sulfite pulping, caustic pulping, hydro-mechanical pulping, mild acid hydrolysis of lignocellulose feedstock, concentrated acid hydrolysis of lignocellulose feedstock, supercritical water or sub-supercritical water hydrolysis of lignocellulose feedstock, ammonia extraction of lignocellulose feedstock.

232. The method of claim 224, wherein the lignin material is a deacidified lignin; the method further comprising, prior to step (i), contacting an acidic lignin with a hydrocarbon solvent to form a mixture; heating the hydrocarbon solvent to remove acid from the mixture thereby obtaining a deacidified lignin.

233. The method of claim 224, wherein the pH of the aqueous lignin solution is adjusted to 3.5-4.

234. The method of claim 224, wherein the first stream is an organic stream and the second stream is an aqueous stream.

235. The method of claim 224, wherein the lignin material is an acidic lignin obtained by extracting hemicellulose sugar from a lignocellulosic feedstock followed by cellulose hydrolysis using an acid.

236. The method of claim 224, wherein the lignin material is a deacidified lignin.

237. The method of claim 224, wherein the aqueous solution is water.

238. The method of claim 224, wherein the aqueous solution is an acidulant.

239. A method of producing a deacidified lignin, comprising contacting an acidic lignin with a hydrocarbon solvent; and heating the hydrocarbon solvent to remove an acid from the acidic lignin thereby obtaining a deacidified lignin.

240. The method of claim 232 or claim 239, wherein the acidic lignin is obtained by removing hemicellulose and cellulose material from a lignocellulosic feedstock.

241. The method of claim 232 or claim 239, wherein the hydrocarbon is ISOPARK.

242. The method of claim 224, wherein the limited-solubility solvent is methylethylketone.

243. The method of claim 232 or claim 239, wherein the acidic lignin is washed with an aqueous wash solution to remove residual sugars and acid before the acidic lignin is contacted with the hydrocarbon solvent.

244. The method of claim 243, wherein the aqueous wash solution is the aqueous back-extract of claim 182.

245. The method of claim 243, wherein the lignin material is washed with the aqueous solution counter-currently.

246. The method of claim 243, wherein the lignin material is washed in multiple stages.

247. The method of claim 224, wherein the high purity lignin is characterized by at least one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve or thirteen characteristic selected from the group consisting of:

(i) lignin aliphatic hydroxyl group in an amount up to 2 mmole/g;

(ii) at least 2.5 mmole/g lignin phenolic hydroxyl group;

(iii) at least 0.4 mmole/g lignin carboxylic hydroxyl group;

(iv) sulfur in an amount up to 1 % weight/weight;

(v) nitrogen in an amount up to 0.05 % weight/weight;

(vi) chloride in an amount up to 0.1 % weight/weight;

(vii) 5% degradation temperature higher than 250 °C;

(viii) 10% degradation temperature higher than 300 °C;

(ix) low ash content;

(x) a formula of CaHbOc; wherein a is 9, b is less than 10 and c is less than 3;

(xi) a degree of condensation of at least 0.9;

(xii) a methoxyl content of less than 1.0; and

(xiii) an O/C weight ratio of less than 0.4.

248. A lignin composition characterized by at least one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve or thirteen characteristic selected from the group consisting of:

(i) lignin aliphatic hydroxyl group in an amount up to 2 mmole/g;

(ii) at least 2.5 mmole/g lignin phenolic hydroxyl group;

(iii) at least 0.35 mmole/g lignin carboxylic hydroxyl group;

(iv) sulfur in an amount up to 1 % weight/weight;

(v) nitrogen in an amount up to 0.05 % weight/weight;

(vi) chloride in an amount up to 0.1 % weight/weight;

(vii) 5% degradation temperature higher than 250 °C;

(viii) 10% degradation temperature higher than 300 °C;

(ix) low ash content;

(x) a formula of CaHbOc; wherein a is 9, b is less than 10 and c is less than 3;

(xi) a degree of condensation of at least 0.9;

(xii) a methoxyl content of less than 1.0; and

(xiii) an O/C weight ratio of less than 0.4.

249. The lignin composition of claim 248, wherein the lignin composition comprises lignin aliphatic hydroxyl group in an amount up to 1 mmole/g.

250. The lignin composition of claim 248, wherein the lignin composition comprises lignin aliphatic hydroxyl group in an amount up to 0.5 mmole/g.

251. The lignin composition of claim 248, wherein the lignin composition comprises at least 2.7 mmole/g lignin phenolic hydroxyl group.

252. The lignin composition of claim 248, wherein the lignin composition comprises at least 3.0 mmole/g lignin phenolic hydroxyl group.

253. The lignin composition of claim 248, wherein the lignin composition comprises at least 0.4 mmole/g lignin carboxylic hydroxyl group.

254. The lignin composition of claim 248, wherein the lignin composition comprises at least 0.9 mmole/g lignin carboxylic hydroxyl group.

255. A lignin composition characterized by at least one, two, three, or four characteristic selected from the group consisting of:

(i) at least 97% lignin on a dry matter basis;

(ii) an ash content in an amount up to 0.1% weight/weight;

(iii) a total carbohydrate content in an amount up to 0.05% weight/weight; and

(iv) a volatiles content in an amount up to 5% weight/weight at 200 °C.

256. A composition according to claim 255, having a non-melting particulate content in an amount up to 0.05% weight/weight.

257. A method of producing high purity lignin from a biomass, comprising:

(i) removing hemicellulose sugars from the biomass thereby obtaining a lignin-containing remainder; wherein the lignin-containing remainder comprises lignin and cellulose;
(ii) contacting the lignin-containing remainder with a lignin extraction solution to produce a lignin extract and a cellulosic remainder; wherein the lignin extraction solution comprises a limited-solubility solvent, an organic acid, and water, wherein the limited-solubility solvent and water form an organic phase and an aqueous phase;
(iii) separating the lignin extract from the cellulosic remainder; wherein the lignin extract comprises lignin dissolved in the limited-solubility solvent.

258. The method of claim 257, wherein the removal of the hemicellulose sugars does not remove a substantial amount of the cellulosic sugars.

259. The method of claim 257, wherein the limited-solubility solvent and the water in the lignin extraction solution is in a ratio of about 1:1.

260. The method of claim 257, further comprising purifying the cellulosic remainder to obtain cellulose pulp.

261. The method of claim 260, wherein the cellulose pulp comprises lignin in an amount up to 10% weight/weight.

262. The method of claim 260, wherein the cellulose pulp comprises lignin in an amount up to 7% weight/weight.

263. The method of claim 257, further comprising contacting the lignin extract with a strong acid cation exchanger to remove residual cations thereby obtaining a purified lignin extract.

264. The method of claim 257 or claim 263, further comprising separating the limited-solubility solvent from the lignin extract thereby obtaining high purity lignin.

265. The method of claim 263, wherein separating comprises evaporating the limited-solubility solvent from the lignin.

266. The method of claim 265, wherein the evaporating comprises spray drying.

267. The method of claim 257, further comprising washing the cellulose remainder with the limited-solubility solvent and with water thereby obtaining cellulose pulp.

268. The method of claim 267, further comprising contacting the cellulose pulp with an acid to produce an acidic hydrolysate stream comprising cellulose sugars.

269. The method of claim 268, further comprising

(i) contacting the acidic hydrolysate stream comprising an acid and one or more cellulose sugars with a S1 solvent extractant to form a first mixture; and

(ii) separating from the first mixture a first stream comprising the acid and the S1 solvent extractant and a second stream comprising the one or more cellulose sugars; wherein the acid is extracted from the acidic hydrolysate stream into the S1 solvent extractant.

270. The method of claim 269, further comprising

(iii) evaporating the second stream comprising the one or more cellulose sugars to form a concentrated second stream; and

(vi) repeating step (iii) and (iv) of claim 269 to form a stream comprising the acid and the S1 solvent extractant and a stream comprising the one or more cellulose sugars.

271. The method of claim 269, further comprising

(v) contacting the second stream with an amine extractant to form a second mixture;

(vi) separating from the second mixture a third stream comprising the acid and the amine extractant and a fourth stream comprising the one or more cellulose sugars.

272. The method of claim 267, further comprising hydrolyzing the cellulose pulp in an aqueous suspension comprising hydrolytic enzymes.

273. The method of claim 272, further comprising

(i) agitating or stirring of the suspension comprising the cellulose pulp, the hydrolytic enzymes and an acidulating agent in a temperature controlled tank;

(ii) separating from the suspension a first stream comprising cellulose pulp and a second stream comprising hydrolyzed cellulose sugars;

(iii) returning the first stream to the temperature controlled tank for further hydrolysis.

274. The method of claim 273, wherein the separating is carried out using a separation device selected from a filter, a membrane, a centrifuge, a hydrocylone.

275. The method of claim 273, wherein the concentration of dissolved glucose in the aqueous suspension is controlled below the inhibition level of the hydrolytic enzymes.

276. The method of claim 273, further comprising

(i) contacting the second stream with an amine extractant to form a first mixture; and

(ii) separating from the first mixture a third stream comprising the acid and the amine extractant and a fourth stream comprising the one or more cellulose sugars.

277. The method of claim 269 or claim 273, further comprising allowing the residual acid in the fourth stream hydrolyze at least some oligomeric sugars in the sugar stream into monomeric sugars thereby forming a cellulose sugar stream.

278. The method of claim 277, further comprising, prior to allowing, diluting the second stream to a lower sugar concentration.

279. The method of claim 277, further comprising, prior to allowing, increasing the acid concentration in the second stream.

280. The method of claim 279, wherein the acid concentration is increased to be more than 0.5%.

281. The method of claim 276, further comprising contacting the fourth stream with a strong acid cation exchanger to remove residual amines, thereby forming an amine-removed hydrolysate.

282. The method of claim 281, further comprising contacting the amine-removed hydrolysate with a weak base anion exchanger to form a neutralized hydrolysate.

283. The method of claim 276 or claim 281, further comprising further comprising evaporating the hydrolysate to form a concentrated hydrolysate.

284. The method of any of claims 276-283, further comprising fractionating the hydrolysate into a monomeric sugar stream and an oligomeric sugar stream.

285. The method of claim 284, further comprising purifying or concentrating the monomeric sugar stream.

286. The method of claim 273, further comprising

(iv) contacting the first stream with an alkaline solution thereby dissolving residual solid lignin in the cellulose pulp;

(v) separating the remainder cellulose pulp from the dissolved lignin thereby forming an aqueous solution comprising lignin;

(vi) adjusting the pH of an aqueous solution comprising lignin to an acidic pH;

(vii) contacting the acidic aqueous lignin solution with a lignin extraction solution comprising a limited-solubility solvent thereby forming a third stream comprising the lignin and the lignin extraction solution, and a fourth stream comprising water soluble impurities;

(viii) contacting the third stream with a strong acid cation exchanger to remove residual cations thereby obtaining a purified third stream; and

(ix) separating the limited-solubility solvent from the lignin thereby obtaining a high purity lignin composition.

287. The method of claim 286, wherein the separating is carried out by filtering.

288. The method of claim 286, wherein the separating step comprises precipitating the lignin by contacting the purified first stream with water.

289. The method of claim 288, wherein the purified third stream is contacted with hot water thereby flash evaporating the limited-solubility solvent.

290. The method of claim 286, wherein the separating step comprises evaporating the limited-solubility solvent from the lignin.

291. The method of claim 290, wherein the evaporating comprises spray drying.

292. A method comprising

(i) providing a fermentor; and

(ii) fermenting a medium comprising at least one member selected from the group consisting of a hemicellulose sugar mixture according to any one of claims 84 to 98; a xylose-enriched stream hemicellulose sugar mixture according to any one of claims 99-110; a xylose stream according to claim 70; a xylose-removed hemicellulose sugar mixture according to any one of claims 111-124; a mother liquor hemicellulose sugar mixture according to any one of claims 125-138; a high concentration C6 sugar mixture according to any one of claims 208 to 223, in the fermentor to produce a conversion product.

293. A method comprising:

(i) providing at least one member selected from the group consisting of a hemicellulose sugar mixture according to any one of claims 84 to 98; a xylose-enriched stream hemicellulose sugar mixture according to any one of claims 99-110; a xylose stream according to claim 70; a xylose-removed hemicellulose sugar mixture according to any one of claims 111-124; a mother liquor

hemicellulose sugar mixture according to any one of claims 125-138; a high concentration C6 sugar mixture according to any one of claims 208 to 223; and

(ii) converting sugars in the at least one member to a conversion product using a chemical process.

294. A method according to claim 292 or claim 293, wherein the conversion product includes at least one member selected from the group consisting of alcohols, carboxylic acids, amino acids, monomers for the polymer industry and proteins.

295. A method according to claim 292 or claim 293, comprising processing the conversion product to produce a consumer product selected from the group consisting of detergent, polyethylene-based products, polypropylene-based products, polyolefm- based products, polylactic acid (polylactide)-based products, polyhydroxyalkanoate- based products and polyacrylic-based products.

296. A method according to claim 295, wherein the detergent comprises a sugar-based surfactant, a fatty acid-based surfactant, a fatty alcohol-based surfactant, or a cell-culture derived enzyme.

297. A method according to claim 295, wherein the polyacrylic-based products are selected the group consisting of plastics, floor polishes, carpets, paints, coatings, adhesives, dispersions, flocculants, elastomers, acrylic glass, absorbent articles, incontinence pads, sanitary napkins, feminine hygiene products and diapers.

298. A method according to claim 295, wherein the polyole fin-based products are selected from the group consisting of milk jugs, detergent bottles, margarine tubs, garbage containers, water pipes, absorbent articles, diapers, non-wovens, HDPE toys and HDPE detergent packagings.

299. A method according to claim 295, wherein the polypropylene-based products are selected from the group consisting of absorbent articles, diapers, and non- wovens.

300. A method according to claim 295, wherein the polylactic acid-based products are selected from the group consisting of packaging of agriculture products and of dairy products, plastic bottles, biodegradable products and disposables.

301. A method according to claim 295, wherein the polyhydroxyalkanoate-based products are selected from the group consisting of packaging of agriculture products, plastic bottles, coated

papers, molded or extruded articles, feminine hygiene products, tampon applicators, absorbent articles, disposable non-wovens, wipes, medical surgical garments, adhesives, elastomers, films, coatings, aqueous dispersants, fibers, intermediates of pharmaceuticals and binders.

302. A method according to claim 292 or claim 293, wherein the conversion product includes at least one member selected from the group consisting of ethanol, butanol, isobutanol, a fatty acid, a fatty acid ester, a fatty alcohol and biodiesel.

303. A method according to claim 302, comprising processing of the conversion product to produce at least one product selected from the group consisting of an isobutene condensation product, jet fuel, gasoline, gasohol, diesel fuel, drop-in fuel, diesel fuel additive and a precursor thereof.

304. A method according to claim 303, wherein the gasohol is ethanol-enriched gasoline or butanol-enriched gasoline.

305. A method according to claim 303, wherein the product is selected from the group consisting of diesel fuel, gasoline, jet fuel and drop-in fuels.

306. A consumer product, a precursor of a consumer product, or an ingredient of a consumer product produced from a conversion product according to claim 292 or claim 293.

307. A consumer product, a precursor of a consumer product, or an ingredient of a consumer product comprising at least one conversion product produced by a method according to claim 292 or claim 293, wherein the conversion product is selected from the group consisting of carboxylic and fatty acids, dicarboxylic acids, hydroxylcarboxylic acids, hydroxyl di-carboxylic acids, hydroxyl-fatty acids, methylglyoxal, mono-, di-, or poly-alcohols, alkanes, alkenes, aromatics, aldehydes, ketones, esters, biopolymers, proteins, peptides, amino acids, vitamins, antibiotics and pharmaceuticals.

308. A consumer product according to claim 307, wherein the product is ethanol-enriched gasoline, jet fuel, or biodiesel.

309. A consumer product, a precursor of a consumer product, or an ingredient of a consumer product according to claim 307, wherein the consumer product has a ratio of carbon-14 to carbon-12 of about 2.0×10^{-13} or greater.

310. A consumer product comprising an ingredient according to claim 306 and an additional ingredient produced from a raw material other than lignocellulosic material.

311. The consumer product according to claim 310, wherein the ingredient and the additional ingredient produced from a raw material other than lignocellulosic material are essentially of the same chemical composition.

312. A consumer product according to claim 306, comprising a marker molecule at a concentration of at least 100 ppb.

313. A consumer product according to claim 312, wherein the marker molecule is selected from the group consisting of furfural, hydroxymethylfurfural, products of furfural or hydroxymethylfurfural condensation, color compounds derived from sugar caramelization, levulinic acid, acetic acid, methanol, galacturonic acid and glycerol.

314. A method comprising:
(i) providing a composition according to any one of claims 248 to 256, and
(ii) converting at least a portion of lignin in the composition to a conversion product.

315. A method according to claim 314, wherein the converting comprises treating with hydrogen.

316. A method according to claim 314 or 315, comprising producing hydrogen from lignin.

317. A method according to claim 314, wherein the conversion product comprises at least one item selected from the group consisting of bio-oil, carboxylic and fatty acids, dicarboxylic acids, hydroxyl-carboxylic, hydroxyl di-carboxylic acids and hydroxyl-fatty acids, methylglyoxal, mono-, di- or poly-alcohols, alkanes, alkenes, aromatics, aldehydes, ketones, esters , phenols, toluenes, and xylenes.

318. A method according to claim 314, wherein the conversion product comprises a fuel or a fuel ingredient.

319. A method according to claim 314, wherein the conversion product comprises para-xylene.

320. A conversion product produced according to claim 314, a consumer product produced from the conversion product or a consumer product containing the conversion product as an ingredient or component.

321. A product according to claim 320, comprising at least one chemical selected from the group consisting of lignosulfonates, bio-oil, carboxylic and fatty acids, dicarboxylic acids, hydroxyl-carboxylic, hydroxyl di-carboxylic acids and hydroxyl-fatty acids, methylglyoxal, mono-, di- or poly-alcohols, alkanes, alkenes, aromatics, aldehydes, ketones, esters, biopolymers, proteins, peptides, amino acids, vitamins, antibiotics, paraxylene and pharmaceuticals.

322. A product according to claim 320, comprising para-xylene.

323. A product according to claim 320, wherein the product is selected from the group consisting of dispersants, emulsifiers, complexants, flocculants, agglomerants, pelletizing additives, resins, carbon fibers, active carbon, antioxidants, flame retardant, liquid fuel, aromatic chemicals, vanillin, adhesives, binders, absorbents, toxin binders, foams, coatings, films, rubbers and elastomers, sequestrants, fuels, and expanders.

324. A product according to claim 320, wherein the product is used in an area selected from the group consisting of food, feed, materials, agriculture, transportation and construction.

325. A product according to claim 320, wherein the product has a ratio of carbon-14 to carbon-12 of about 2.0×10^{-13} or greater.

326. A product comprising an ingredient according to claim 320 and an ingredient produced from a raw material other than lignocellulosic material.

327. A product according to claim 320, wherein the ingredient according to claim 320 and the ingredient produced from a raw material other than lignocellulosic material are essentially of the same chemical composition.

328. A product according to claim 320, comprising a marker molecule at a concentration of at least 100 ppb.

329. A product according to claim 328, wherein the marker molecule is selected from the group consisting of furfural and hydroxy-methyl furfural, products of their condensation, color compounds, acetic acid, methanol, galcturonic acid, glycerol, fatty acids and resin acids.