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# APPENDIX

## Appendix A The Standard Curve of Glucose, Xylose, and Arabinose

The unknown samples were identified by comparing retention time of the unknown sample with standard sample. The height and the area of a peak were proportional to the concentration of the corresponding component. A calibration curve was created using the standard samples. The concentration of the unknown samples was determined from the peak areas of the detected sample using equation obtained from the standard curve, showing below.

**Table A1** Peak areas and retention times of standard glucose

| Glucose Concentration (g/l) | Peak Area | Retention Time (min) |
|---|---|---|
| 2.0 | 546473.00 | 8.664 |
| 4.0 | 1121052.00 | 8.676 |
| 6.0 | 1686160.00 | 8.682 |
| 8.0 | 2153626.00 | 8.696 |
| 10.0 | 2874216.00 | 8.695 |

**Table A2** Peak areas and retention times of standard xylose

| Xylose Concentration (g/l) | Peak Area | Retention Time (min) |
|---|---|---|
| 2.0 | 439978 | 9.223 |
| 4.0 | 909471 | 9.235 |
| 6.0 | 1511707 | 9.242 |
| 8.0 | 1874468 | 9.256 |
| 10.0 | 2484732 | 9.256 |

**Table A3** Peak areas and retention times of standard arabinose

| Arabinose Concentration (g/l) | Peak Area | Retention Time (min) |
|---|---|---|
| 2.0 | 483316 | 10.111 |
| 4.0 | 1077865 | 10.125 |
| 6.0 | 1599291 | 10.133 |
| 8.0 | 2296682 | 10.149 |
| 10.0 | 2726393 | 10.143 |

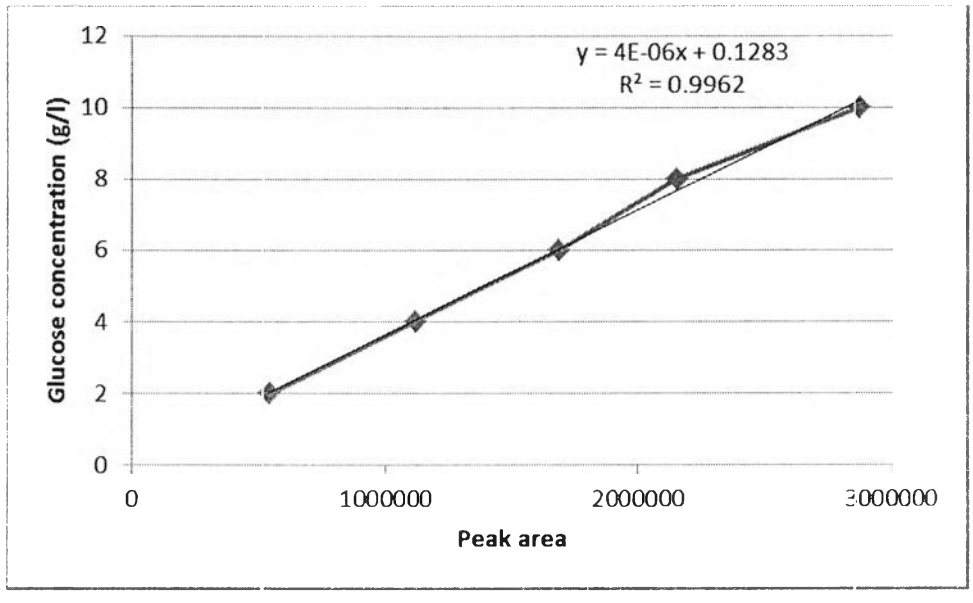


**Figure A1** Relationship between peak area and glucose concentration.

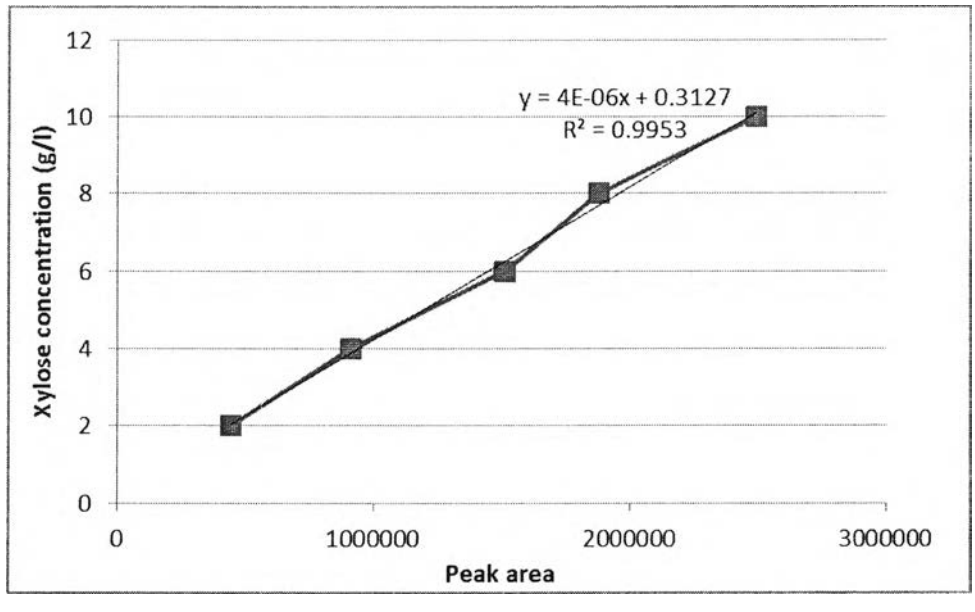


**Figure A2** Relationship between peak area and xylose concentration.

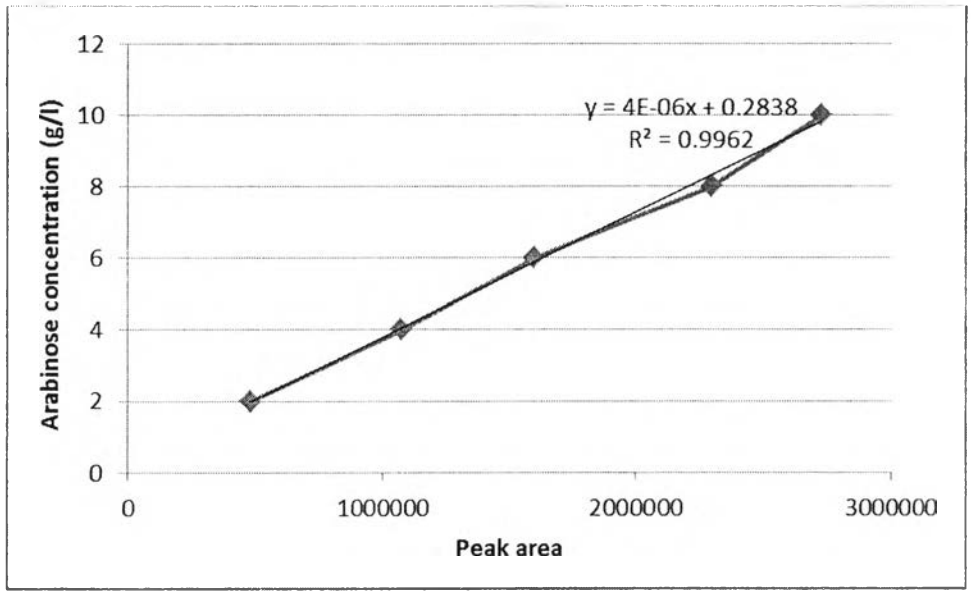


**Figure A3** Relationship between peak area and arabinose concentration.

Equation of standard glucose: y = 4E-06x

Equation of standard xylose: y = 4E-06x

Equation of standard arabinose: y = 4E-06x;

y = sugar concentration,

x = peak area

## Appendix B The Amount of Monomeric Sugar Yield from Different Reagent Types

**Table B1** Momomeric sugar yields of *Napier grass* hydrolyzed with 0.5 % (w/v) NaOH using 15:1 LSR under different times and temperatures (g sugar/100 g biomass)

| Temperature (°C) | Pretreatment Time (min) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|---|
| 40 | 5 | 2.20 ± 0.02 | 2.15± 0.05 | 0.35± 0.03 | 4.72± 0.03 |
| | 10 | 2.41± 0.04 | 3.38± 0.02 | 0.03± 0.02 | 5.84± 0.06 |
| | 15 | 2.92 ± 0.01 | 2.81± 0.03 | 0.10± 0.04 | 5.96± 0.13 |
| | 30 | 2.91 ± 0.05 | 2.88± 0.12 | 0.36± 0.05 | 6.15± 0.22 |
| | 60 | 3.02± 0.03 | 2.73± 0.03 | 0.36± 0.18 | 6.10± 0.12 |
| 60 | 5 | 2.27 ± 0.05 | 1.74± 0.03 | 0.21± 0.01 | 4.23± 0.09 |
| | 10 | 2.71± 0.02 | 2.30± 0.02 | 0.46± 0.05 | 5.48± 0.09 |
| | 15 | 2.63 ± 0.07 | 2.42± 0.10 | 0.38± 0.01 | 5.45± 0.18 |
| | 30 | 2.32 ± 0.07 | 2.29± 0.06 | 0.36± 0.00 | 4.98± 0.13 |
| | 60 | 2.21± 0.03 | 1.78± 0.07 | 0.90± 0.10 | 4.89± 0.20 |
| 80 | 5 | 1.14 ± 0.01 | 0.83 ± 0.05 | 0.46 ± 0.09 | 0.93 ± 0.15 |
| | 10 | 2.11 ± 0.13 | 1.93 ± 0.04 | 0.59 ± 0.01 | 1.19 ± 0.18 |
| | 15 | 1.45 ± 0.04 | 1.25 ± 0.05 | 0.81 ± 0.02 | 1.89 ± 0.11 |
| | 30 | 1.40 ± 0.07 | 1.14 ± 0.4 | 0.69 ± 0.03 | 2.46 ± 0.14 |
| | 60 | 1.17± 0.02 | 1.07± 0.03 | 0.61± 0.02 | 1.95 ± 0.07 |
| 100 | 5 | 0.71± 0.01 | 0.33± 0.00 | 0.46± 0.00 | 1.78± 0.01 |
| | 10 | 1.19± 0.01 | 1.05± 0.02 | 0.71± 0.03 | 3.04± 0.06 |
| | 15 | 1.25± 0.03 | 1.08± 0.02 | 0.75± 0.02 | 3.81± 0.07 |
| | 30 | 1.21± 0.04 | 1.15± 0.01 | 0.83± 0.05 | 3.21± 0.10 |

| | | | | | |
|---|---|---|---|---|---|
| | 60 | 1.16± 0.01 | 0.94± 0.01 | 0.47± 0.00 | 2.86± 0.02 |
| 120 | 5 | 1.14± 0.01 | 0.83± 0.05 | 0.09 ± 0.09 | 2.43± 0.15 |
| | 10 | 0.93± 0.05 | 0.93± 0.04 | 0.10 ± 0.08 | 2.57± 0.17 |
| | 15 | 1.02± 0.04 | 1.04± 0.04 | 0.66 ± 0.02 | 2.81± 0.10 |
| | 30 | 1.14± 0.02 | 0.89± 0.02 | 0.45 ± 0.01 | 2.86± 0.05 |
| | 60 | 0.67± 0.02 | 0.34± 0.01 | 0.06 ± 0.01 | 1.48± 0.04 |
| 140 | 5 | 1.14± 0.04 | 0.86± 0.04 | 0.78± 0.04 | 2.79± 0.12 |
| | 10 | 1.17± 0.02 | 0.92± 0.02 | 0.76± 0.02 | 2.86± 0.16 |
| | 15 | 1.20± 0.08 | 1.02± 0.01 | 0.75± 0.03 | 2.99± 0.12 |
| | 30 | 1.21 ±0.03 | 0.76± 0.00 | 1.15± 0.04 | 3.13± 0.07 |
| | 60 | 0.89± 0.03 | 0.69± 0.01 | 1.22± 0.00 | 2.78± 0.04 |
| 160 | 5 | 1.09± 0.03 | 0.99± 0.03 | 0.69± 0.08 | 2.79± 0.14 |
| | 10 | 0.82± 0.05 | 0.83± 0.04 | 0.82± 0.06 | 2.48± 0.16 |
| | 15 | 0.94± 0.06 | 0.76± 0.01 | 0.72± 0.03 | 2.99± 0.10 |
| | 30 | 1.02±0.02 | 0.86± 0.04 | 0.88± 0.01 | 3.13± 0.07 |
| | 60 | 0.68± 0.02 | 0.55± 0.02 | 0.86± 0.04 | 2.78± 0.08 |

Data are mean values ± S.D. of three replicates.

**Table B2** Monomeric sugar yields of NaOH-pretreated *Napier grass* using 15:1 LSR at 60 °C for 10 min with different NaOH concentrations (g sugar/100 g biomass)

| **Alkali Concentration (% w/v)** | **Glucose** | **Xylose** | **Arabinose** | **Total Monomeric Sugars** |
|---|---|---|---|---|
| 0.5 | 2.91 ± 0.05 | 2.88± 0.12 | 0.36± 0.05 | 6.15± 0.22 |
| 1.0 | 2.77± 0.03 | 2.33± 0.04 | 0.46± 0.02 | 5.57± 0.09 |
| 2.0 | 2.62± 0.04 | 1.88± 0.03 | 0.38± 0.01 | 4.88± 0.08 |
| 3.0 | 2.25± 0.05 | 1.63± 0.01 | 0.48± 0.01 | 4.37± 0.07 |

| | | | | |
|---|---|---|---|---|
| 4.0 | 1.97± 0.02 | 1.45± 0.04 | 0.46± 0.02 | 3.88± 0.08 |
| 5.0 | 1.95± 0.06 | 1.40± 0.03 | 0.47± 0.02 | 3.82± 0.11 |

Data are mean values ± S.D. of three replicates.

**Table B3** Monomeric sugar yields of *Napier grass*using 0.5 % (w/v) NaOHat 60 °C for 10 min with different LSRs (g/100 g biomass)

| Liquid to Solid Ratio (LSR) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 15:1 | 2.91 ± 0.05 | 2.88± 0.12 | 0.36± 0.050.67± 0.01 0.11± 0.01 | 6.15± 0.22 |
| 30:1 | 2.42± 0.01 | 1.07± 0.01 | | 3.55± 0.03 |
| 45:1 | 1.59± 0.01 | 0.67± 0.03 | | 2.38± 0.05 |

Data are mean values ± S.D. of three replicates.

**Table B4** Monomeric sugar yields of *Napier grass* hydrolyzed with 0.5 % (w/v) $NH_4OH$ using 15:1 LSR under different times and temperatures (g sugar/100 g biomass)

| Temperature (°C) | Pretreatment Time (min) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|---|
| 40 | 5 | 2.04 ± 0.02 | 2.15 ± 0.05 | 0.36 ± 0.02 | 4.72± 0.09 |
| | 10 | 2.24 ± 0.03 | 3.29 ± 0.04 | 0.03 ± 0.01 | 5.57± 0.18 |
| | 15 | 2.56 ± 0.02 | 3.04 ± 0.03 | 0.10 ± 0.02 | 5.70± 0.17 |
| | 30 | 2.88 ± 0.06 | 2.95 ± 0.05 | 0.36 ± 0.01 | 6.19± 0.12 |
| | 60 | 2.37± 0.05 | 3.42± 0.01 | 0.03± 0.03 | 5.82± 0.09 |

| | | | | | |
|---|---|---|---|---|---|
| 60 | 5 | 2.21 ± 0.02 | 2.68 ± 0.04 | 0.18 ± 0.00 | 5.08± 0.06 |
| | 10 | 2.03 ± 0.07 | 2.68 ± 0.08 | 0.49 ± 0.01 | 5.21± 0.16 |
| | 15 | 2.38 ± 0.07 | 2.85 ± 0.07 | 0.32 ± 0.01 | 5.56± 0.15 |
| | 30 | 2.14 ± 0.05 | 3.79 ± 0.02 | 0.03 ± 0.01 | 5.96± 0.08 |
| | 60 | 1.96± 0.05 | 1.48± 0.06 | 0.45± 0.03 | 3.90± 0.14 |
| 80 | 5 | 2.03 ± 0.01 | 2.52 ± 0.02 | 0.23 ± 0.00 | 4.79± 0.03 |
| | 10 | 1.87 ± 0.01 | 2.73 ± 0.01 | 0.52 ± 0.01 | 5.13± 0.03 |
| | 15 | 2.20 ± 0.10 | 2.37 ± 0.04 | 0.20 ± 0.01 | 4.77± 0.15 |
| | 30 | 1.96 ± 0.01 | 2.18 ± 0.02 | 0.26 ± 0.00 | 4.40± 0.03 |
| | 60 | 1.54± 0.02 | 1.79± 0.00 | 0.36± 0.02 | 3.71± 0.04 |
| 100 | 5 | 1.30± 0.06 | 1.27± 0.02 | 0.51± 0.03 | 3.09± 0.11 |
| | 10 | 1.57± 0.01 | 2.47± 0.01 | 0.84± 0.00 | 4.89± 0.02 |
| | 15 | 1.34± 0.01 | 1.69± 0.06 | 0.81± 0.06 | 3.85± 0.13 |
| | 30 | 1.20± 0.03 | 1.15± 0.08 | 0.84± 0.05 | 3.20± 0.16 |
| | 60 | 1.12± 0.02 | 1.16± 0.05 | 0.74± 0.10 | 3.02± 0.17 |
| 120 | 5 | 1.55± 0.01 | 1.83± 0.02 | 1.29± 0.01 | 4.67± 0.04 |
| | 10 | 1.48± 0.03 | 2.24± 0.05 | 0.66± 0.06 | 4.39± 0.14 |
| | 15 | 1.43± 0.01 | 2.01± 0.05 | 0.58± 0.06 | 4.03± 0.12 |
| | 30 | 1.16± 0.04 | 0.96± 0.06 | 0.50± 0.01 | 2.63± 0.111 |
| | 60 | 0.67± 0.02 | 0.34± 0.01 | 0.46± 0.01 | 1.48± 0.04 |
| 140 | 5 | 0.14 ± 0.00 | 0.02 ± 0.02 | 0.11 ± 0.01 | 0.28 ± 0.03 |
| | 10 | 1.10 ± 0.00 | 0.03 ± 0.02 | 0.14 ± 0.01 | 1.26 ± 0.03 |
| | 15 | 1.19 ± 0.03 | 0.07 ± 0.02 | 0.17 ± 0.01 | 1.42 ± 0.06 |
| | 30 | 1.32 ± 0.03 | 0.06 ± 0.04 | 0.09 ± 0.03 | 1.47 ± 0.10 |
| | 60 | 1.03 ± 0.02 | 0.04 ± 0.01 | 0.06 ± 0.00 | 1.13 ± 0.03 |
| 160 | 5 | 1.18± 0.02 | 1.09± 0.01 | 0.67± 0.02 | 2.94± 0.05 |
| | 10 | 0.88± 0.03 | 0.77± 0.02 | 0.62± 0.01 | 2.28± 0.06 |
| | 15 | 0.44± 0.13 | 0.46± 0.13 | 0.62± 0.18 | 1.53± 0.44 |

| | | | | | |
|---|---|---|---|---|---|
| | 30 | 0.44± 0.01 | 0.32± 0.02 | 0.65± 0.04 | 0.14± 0.07 |
| | 60 | 0.43± 0.05 | 0.32± 0.36 | 0.15± 0.02 | 0.90± 0.43 |

**Table B5** Monomeric sugar yields of $NH_4OH$-pretreated *Napier grass* using 15:1 LSR at 60 °C for 30 min with different $NH_4OH$ concentrations (g sugar/100 g biomass)

| Alkali Concentration (% w/v) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 0.5 | 2.88 ± 0.06 | 2.95 ± 0.05 | 0.36 ± 0.01 | 6.19± 0.12 |
| 1.0 | 2.49± 0.07 | 2.93± 0.03 | 0.71± 0.04 | 6.14± 0.14 |
| 2.0 | 2.04± 0.03 | 2.73± 0.05 | 0.71± 0.02 | 5.69± 0.10 |
| 3.0 | 2.11± 0.06 | 2.61± 0.04 | 0.42± 0.02 | 5.15± 0.12 |
| 4.0 | 2.15± 0.02 | 2.25± 0.02 | 0.25± 0.03 | 4.66± 0.07 |
| 5.0 | 2.09± 0.01 | 2.14± 0.01 | 0.35± 0.01 | 4.50± 0.03 |

Data are mean values ± S.D. of three replicates.

**Table B6** Monomeric sugar yields of *Napier grass* using 0.5 % (w/v) $NH_4OH$at 60 °C for 30 min with different LSRs (g/100 g biomass)

| Liquid to Solid Ratio (LSR) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 15:1 | 2.88 ± 0.06 | 2.95 ± 0.05 | 0.36 ± 0.01 | 6.19± 0.12 |
| 30:1 | 1.04± 0.02 | 1.77± 0.08 | 0.04± 0.01 | 2.85± 0.10 |
| 45:1 | 0.60± 0.02 | 0.84± 0.04 | 0.02± 0.01 | 1.48± 0.07 |

Data are mean values ± S.D. of three replicates.

**Table B7** Monomeric sugar yields of *Napier grass* hydrolyzed with 0.5 % (w/v) $H_2SO_4$ using 15:1 LSR under different times and temperatures (g sugar/100 g biomass)

| Temperature (°C) | Pretreatment Time (min) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|---|
| 60 | 5 | 1.98 ± 0.05 | 2.85± 0.08 | 0.05± 0.01 | 4.90± 0.13 |
| | 10 | 1.92± 0.01 | 2.87± 0.03 | 0.03± 0.01 | 4.83± 0.05 |
| | 15 | 1.81± 0.05 | 2.87± 0.07 | 0.41± 0.02 | 5.10± 0.13 |
| | 30 | 2.44± 0.02 | 3.77± 0.05 | 0.02± 0.01 | 6.24± 0.08 |
| | 60 | 1.88± 0.04 | 2.71± 0.06 | 0.14± 0.01 | 4.73± 0.11 |
| 80 | 5 | 2.06 ± 0.02 | 3.23 ± 0.04 | 1.03 ± 0.09 | 8.58± 0.15 |
| | 10 | 2.63 ± 0.08 | 3.75 ± 0.11 | 1.35 ± 0.08 | 9.10± 0.27 |
| | 15 | 2.21 ± 0.07 | 3.49 ± 0.10 | 2.06 ± 0.07 | 15.22± 0.24 |
| | 30 | 2.50 ± 0.02 | 3.57 ± 0.04 | 1.52± 0.10 | 17.29± 0.16 |
| | 60 | 2.59± 0.03 | 3.68± 0.10 | 1.26± 0.10 | 21.49± 0.23 |
| 100 | 5 | 2.01± 0.03 | 3.53± 0.09 | 3.04± 0.11 | 1.78± 0.23 |
| | 10 | 2.08± 0.03 | 3.39± 0.05 | 3.39± 007 | 3.04± 0.14 |
| | 15 | 2.41± 0.05 | 8.39± 0.48 | 4.42± 0.07 | 3.81± 0.59 |
| | 30 | 2.75± 0.02 | 10.42± 0.43 | 4.11± 0.05 | 3.21± 0.49 |
| | 60 | 2.77± 0.03 | 10.33± 0.13 | 8.39± 0.88 | 2.86± 1.05 |
| 120 | 5 | 2.37± 0.03 | 3.49± 0.04 | 1.80± 0.03 | 7.66± 0.10 |
| | 10 | 1.71± 0.03 | 3.55± 0.04 | 2.63± 0.39 | 7.90± 0.46 |
| | 15 | 2.09± 0.05 | 4.31± 0.17 | 3.06± 0.19 | 9.47± 0.43 |
| | 30 | 4.48± 0.02 | 15.08± 0.72 | 3.41± 0.18 | 22.99± 1.09 |
| | 60 | 3.40± 0.03 | 13.54± 1.34 | 3.23± 0.16 | 20.17± 1.82 |

| | | | | | |
|---|---|---|---|---|---|
| 140 | 5 | 2.72± 0.06 | 7.90± 0.19 | 2.77± 0.12 | 13.41± 0.36 |
| | 10 | 2.71± 0.04 | 8.98± 0.09 | 2.49± 0.12 | 14.19± 0.24 |
| | 15 | 3.58± 0.11 | 16.09± 0.45 | 3.01± 0.03 | 22.69± 0.59 |
| | 30 | 5.94 ± 0.28 | 16.48± 0.41 | 3.37± 0.06 | 25.79± 0.74 |
| | 60 | 5.07± 0.08 | 16.91± 0.41 | 3.48± 0.18 | 25.47± 0.66 |
| 160 | 5 | 3.42± 0.23 | 15.06± 0.66 | 4.81± 0.13 | 23.30±1.01 |
| | 10 | 5.12±0.12 | 16.41± 0.33 | 3.29± 0.08 | 24.82± 0.47 |
| | 15 | 5.92± 0.62 | 15.30±1.01 | 6.09± 0.39 | 27.32± 2.03 |
| | 30 | 4.47±1.30 | 15.88±4.61 | 5.47±1.58 | 25.84±7.48 |
| | 60 | 7.82± 0.16 | 13.87± 0.44 | 3.90± 0.65 | 25.59±1.25 |

Data are mean values ± S.D. of three replicates.

**Table B8** Monomeric sugar yields of $H_2SO_4$-pretreated *Napier grass* using 15:1 LSR at 160 °C for 15 min with different $H_2SO_4$concentrations (g sugar/100 g biomass)

| **Alkali Concentration (% w/v)** | **Glucose** | **Xylose** | **Arabinose** | **Total Monomeric Sugars** |
|---|---|---|---|---|
| 0.5 | 5.92± 0.62 | 15.30± 1.01 | 6.09± 0.39 | 27.32± 2.03 |
| 1.0 | 6.44± 0.62 | 20.21± 0.47 | 4.28± 0.14 | 30.93±1.24 |
| 2.0 | 5.65± 0.16 | 20.54± 0.32 | 3.53± 0.14 | 29.73± 0.63 |
| 3.0 | 4.98± 0.23 | 20.50± 0.74 | 4.11± 0.22 | 29.59± 1.20 |
| 4.0 | 5.31± 0.03 | 19.90± 0.27 | 4.27± 0.06 | 29.49± 0.37 |
| 5.0 | 5.21± 0.01 | 20.14± 0.03 | 3.27± 0.01 | 28.63± 0.05 |

Data are mean values ± S.D. of three replicates.

**Table B9** Monomeric sugar yields of *Napier grass* using 1.0 % (w/v) $H_2SO_4$at 160 °C for 15 min with different LSRs (g/100 g biomass)

| Liquid to Solid Ratio (LSR) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 15:1 | 6.44± 0.62 | 20.21± 0.47 | 4.28± 0.14 | 30.93±1.24 |
| 30:1 | 5.02± 1.78 | 7.28± 2.57 | 1.78± 0.62 | 14.08± 4.98 |
| 45:1 | 2.55± 0.28 | 5.68± 0.07 | 1.16± 0.10 | 9.39± 0.46 |

Data are mean values ± S.D. of three replicates.

**Table B10** Monomeric sugar yields of *Napier grass* hydrolyzed with 0.5 % (w/v) $H_3PO_4$ using 15:1 LSR under different times and temperatures (g sugar/100 g biomass)

| Temperature (°C) | Pretreatment Time (min) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|---|
| 60 | 5 | 2.39 ± 0.10 | 2.64± 0.06 | 0.19± 0.01 | 5.22 ± 0.18 |
| | 10 | 2.57± 0.41 | 2.89± 0.05 | 0.04± 0.01 | 5.50± 0.47 |
| | 15 | 3.49± 0.13 | 3.15± 0.13 | 0.14± 0.01 | 6.79± 0.27 |
| | 30 | 4.07 ± 0.32 | 3.46± 0.08 | 0.05± 0.00 | 7.60± 0.41 |
| | 60 | 1.18± 0.08 | 2.88± 0.03 | 0.02± 0.00 | 5.26± 0.11 |
| 80 | 5 | 1.62± 0.17 | 4.02 ± 0.05 | 0.57 ± 0.01 | 6.44± 0.23 |
| | 10 | 2.97 ± 0.29 | 4.75 ± 0.18 | 0.80 ± 0.02 | 8.52± 0.49 |
| | 15 | 4.22 ± 0.22 | 3.67 ± 0.04 | 3.07 ± 0.001 | 8.26± 0.29 |
| | 30 | 3.63 ± 0.13 | 3.49 ± 0.02 | 0.68 ± 0.05 | 7.81± 0.20 |
| | 60 | 2.13 ± 0.13 | 3.59± 0.02 | 0.99± 0.05 | 6.71± 0.20 |

| | | | | | |
|---|---|---|---|---|---|
| 100 | 5 | 0.31± 0.02 | 4.20± 0.04 | 2.10± 0.78 | 6.68± 0.84 |
| | 10 | 1.53± 0.07 | 3.67± 0.03 | 2.48± 0.02 | 7.69± 0.12 |
| | 15 | 2.41± 0.05 | 4.58± 0.04 | 3.14± 0.17 | 10.13± 0.26 |
| | 30 | 3.08± 0.05 | 4.58± 0.02 | 2.36± 0.12 | 10.03± 0.19 |
| | 60 | 0.00± 0.11 | 5.05 ± 0.12 | 2.97± 0.33 | 8.02± 0.57 |
| 120 | 5 | 0.00± 0.08 | 3.03± 0.06 | 1.64± 0.04 | 9.72± 0.17 |
| | 10 | 0.00± 0.06 | 4.45± 0.05 | 1.97± 0.08 | 10.09± 0.19 |
| | 15 | 3.19± 0.27 | 3.87± 0.06 | 2.25± 0.07 | 15.65± 0.40 |
| | 30 | 3.62± 0.23 | 6.51± 0.06 | 2.18± 0.07 | 18.86± 0.36 |
| | 60 | 2.73± 0.05 | 3.27± 0.07 | 0.76± 0.09 | 13.10± 0.22 |
| 140 | 5 | 3.00± 0.02 | 3.44± 0.12 | 1.76± 0.05 | 8.21± 0.20 |
| | 10 | 4.23± 0.26 | 3.97± 0.07 | 2.18± 0.02 | 10.97± 0.34 |
| | 15 | 5.46± 0.10 | 6.27± 0.52 | 3.07± 0.17 | 14.81± 0.79 |
| | 30 | 6.80± 0.12 | 13.63± 0.41 | 4.00± 0.23 | 24.44± 0.77 |
| | 60 | 4.26± 0.05 | 7.13± 0.36 | 2.56± 0.02 | 13.95± 0.43 |
| 160 | 5 | 3.78± 0.36 | 4.03±1.49 | 3.26± 0.08 | 11.08±1.93 |
| | 10 | 3.58±0.17 | 8.63± 0.03 | 2.77± 0.37 | 14.99± 0.58 |
| | 15 | 6.60± 0.04 | 12.83± 0.09 | 3.08± 0.18 | 23.23± 0.32 |
| | 30 | 4.24±0.13 | 11.12± 0.23 | 4.05± 0.02 | 19.43± 0.40 |
| | 60 | 7.15± 0.16 | 9.21±1.42 | 1.50± 0.38 | 17.88±1.97 |

Data are mean values ± S.D. of three replicates.

**Table B11** Monomeric sugar yields of $H_3PO_4$-pretreated *Napier grass* using 15:1 LSR at 140 °C for 15 min with different $H_3PO_4$ concentrations (g sugar/100 g biomass)

| Alkali Concentration (% w/v) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 0.5 | 6.80±0.1 | 13.63± | 4.00± | 24.44± 0.77 |
| 1.0 | 28.54± 0.01 | 0.4115.18± | 0.233.35± | 27.08± 0.14 |
| 2.0 | 0.22± 0.01 | 0.12 | 0.01 | 21.25± 0.04 |
| 3.0 | 0.22± 0.03 | 18.14± 0.01 | 2.89± 0.02 | 19.13± 0.08 |
| 4.0 | 0.22± 0.01 | 16.47± 0.03 | 2.43± 0.02 | 17.47± 1.79 |
| 5.0 | 1.16± 0.39 | 29.65± 0.01 | 7.65± 1.78 | 15.77± 0.91 |
| | | 12.14± 0.21 | 2.46± 0.30 | |

Data are mean values ± S.D. of three replicates.

**Table B12** Monomeric sugar yields of *Napier grass* using 1.0 % (w/v) $H_3PO_4$at 140 °C for 30 min with different LSRs (g/100 g biomass)

| Liquid to Solid Ratio (LSR) | Glucose | Xylose | Arabinose | Total Monomeric Sugars |
|---|---|---|---|---|
| 15:1 | 8.54± 0.01 | 15.18± 0.12 | 3.35± 0.01 | 27.08± 0.14 |
| 30:1 | 5.19± 0.02 | 6.07± 0.08 | 1.23± 0.01 | 12.49± 0.10 |
| 45:1 | 4.25± 0.02 | 4.99± 0.04 | 0.73± 0.01 | 9.98± 0.07 |

Data are mean values ± S.D. of three replicates.

## Appendix C %Weight loss and pH from different reagent types

**Table C1** %Weight loss and pH of *Napier grass* hydrolyzed with 0.5 % (w/v) NaOH using 15:1 LSR under different times and temperatures.

| Temperature (°C) | Pretreatment Time (min) | % weight loss | pH |
|---|---|---|---|
| 60 | 5 | 15.95± 0.09 | 11.7± 0.03 |
| | 10 | 17.66± 0.11 | 10.27± 0.06 |
| | 15 | 18.99± 0.13 | 10± 0.13 |
| | 30 | 22.06± 0.32 | 9.93± 0.08 |
| | 60 | 28.21± 0.41 | 9.69± 0.05 |
| 80 | 5 | 24.03± 0.12 | 11.08± 0.93 |
| | 10 | 26.74± 0.11 | 14.99± 0.58 |
| | 15 | 26.77± 0.13 | 23.23± 0.32 |
| | 30 | 27.32± 0.23 | 19.43± 0.40 |
| | 60 | 36.36± 0.12 | 17.88± 0.97 |
| 100 | 5 | 32.07± 0.21 | 9.20± 0.11 |
| | 10 | 32.38± 0.32 | 9.02± 0.12 |
| | 15 | 37.39± 0.22 | 8.94± 0.16 |
| | 30 | 38.18± 0.15 | 8.93± 0.01 |
| | 60 | 39.53± 0.18 | 8.80± 0.04 |
| 120 | 5 | 32.48± 0.31 | 9.08± 0.04 |
| | 10 | 42.32± 0.12 | 8.95± 0.02 |
| | 15 | 44.98± 0.42 | 8.8± 0.00 |
| | 30 | 50.04± 0.23 | 8.53± 0.01 |
| | 60 | 53.44± 0.29 | 8.14± 0.02 |

| | | | |
|---|---|---|---|
| 140 | 5 | 34.34± 0.20 | 9.01± 0.03 |
| | 10 | 42.13± 0.10 | 8.71± 0.06 |
| | 15 | 51.69± 0.13 | 8.69± 0.13 |
| | 30 | 54.19± 0.12 | 8.59± 0.08 |
| | 60 | 59.02± 0.41 | 8.14± 0.05 |
| 160 | 5 | 36.77± 0.03 | 8.99± 0.02 |
| | 10 | 45.21± 0.13 | 8.69± 0.01 |
| | 15 | 55.77± 0.17 | 8.58± 0.13 |
| | 30 | 57.66± 0.31 | 8.45± 0.12 |
| | 60 | 62.95± 0.15 | 8.11± 0.11 |

Data are mean values ± S.D. of three replicates.

**Table C2** %Weight loss and pH of *Napier grass* hydrolyzed with 0.5 % (w/v) $NH_4OH$ using 15:1 LSR under different times and temperatures.

| **Temperature (°C)** | **Pretreatment Time (min)** | **% weight loss** | **pH** |
|---|---|---|---|
| 60 | 5 | 16.76± 0.34 | 9.97± 0.13 |
| | 10 | 17.17± 0.14 | 9.91± 0.05 |
| | 15 | 18.13± 0.27 | 9.78± 0.13 |
| | 30 | 20.08± 0.14 | 9.78± 0.08 |
| | 60 | 20.25± 0.18 | 9.58± 0.11 |
| 80 | 5 | 19.94± 0.25 | 9.67± 0.15 |
| | 10 | 21.00± 0.16 | 9.4± 0.27 |
| | 15 | 22.90± 0.16 | 9.28± 0.24 |
| | 30 | 23.15± 0.31 | 8.92± 0.16 |
| | 60 | 27.59± 0.10 | 8.89± 0.23 |

| | | | |
|---|---|---|---|
| 100 | 5 | 20.97± 0.10 | 9.39± 0.15 |
| | 10 | 25.93± 0.13 | 9.2± 0.17 |
| | 15 | 27.63± 0.13 | 8.96± 0.10 |
| | 30 | 28.92± 0.13 | 8.88± 0.05 |
| | 60 | 30.16± 0.13 | 8.71± 0.04 |
| 120 | 5 | 23.06± 0.15 | 9.4± 0.10 |
| | 10 | 32.77± 0.17 | 9.23± 0.16 |
| | 15 | 36.78± 0.18 | 8.92± 0.03 |
| | 30 | 39.64± 0.24 | 8.71± 0.09 |
| | 60 | 40.66± 0.21 | 8.21± 0.82 |
| 140 | 5 | 30.39± 0.29 | 9.32± 0.16 |
| | 10 | 34.33± 0.21 | 8.88± 0.14 |
| | 15 | 37.96± 0.23 | 8.54± 0.19 |
| | 30 | 42.37± 0.22 | 8.39± 0.12 |
| | 60 | 43.74± 0.21 | 8.11± 0.32 |
| 160 | 5 | 32.90± 0.19 | 9.1±0.23 |
| | 10 | 36.08± 0.12 | 8.7± 0.47 |
| | 15 | 37.96± 0.24 | 8.49± 0.10 |
| | 30 | 42.37± 0.09 | 8.36±0.08 |
| | 60 | 43.74± 0.03 | 8.03±0.09 |

Data are mean values ± S.D. of three replicates.

**Table C3**% Weight loss and pH of *Napier grass* hydrolyzed with 0.5 % (w/v) $H_2SO_4$ using 15:1 LSR under different times and temperatures

| Temperature (°C) | Pretreatment Time (min) | % weight loss | pH |
|---|---|---|---|
| 60 | 5 | 15.91± 0.02 | 1.01± 0.15 |
| | 10 | 16.82± 0.10 | 1.03± 0.27 |
| | 15 | 17.10± 0.12 | 1.03± 0.24 |
| | 30 | 18.42± 0.20 | 1.11± 0.16 |
| | 60 | 18.81± 0.10 | 1.12± 0.23 |
| 80 | 5 | 19.54± 0.10 | 1.1± 0.23 |
| | 10 | 21.15± 0.13 | 1.11± 0.14 |
| | 15 | 21.94± 0.14 | 1.14± 0.59 |
| | 30 | 24.51± 0.10 | 1.17± 0.49 |
| | 60 | 28.58± 0.19 | 1.19± 1.05 |
| 100 | 5 | 32.63± 0.09 | 1.18± 0.10 |
| | 10 | 38.57± 0.13 | 1.19± 0.46 |
| | 15 | 39.27± 0.11 | 1.2± 0.43 |
| | 30 | 39.86± 0.10 | 1.21± 1.09 |
| | 60 | 40.20± 0.19 | 1.221.82 |
| 120 | 5 | 46.26± 0.09 | 1.1± 0.12 |
| | 10 | 51.32± 0.08 | 1.19± 0.23 |
| | 15 | 53.06± 0.07 | 1.21± 0.21 |
| | 30 | 57.96± 0.02 | 1.21± 0.14 |
| | 60 | 65.35± 0.19 | 1.23± 0.27 |

| | | | |
|---|---|---|---|
| 140 | 5 | 51.64± 0.13 | 1.32± 0.22 |
| | 10 | 58.33± 0.02 | 1.33± 0.15 |
| | 15 | 63.08± 0.04 | 1.33± 0.25 |
| | 30 | 66.18± 0.05 | 1.35± 0.41 |
| | 60 | 70.20± 0.19 | 1.36± 1.15 |
| 160 | 5 | 53.91± 0.34 | 1.39± 0.16 |
| | 10 | 60.82± 0.19 | 1.42± 0.34 |
| | 15 | 64.81± 0.12 | 1.45± 0.19 |
| | 30 | 68.15± 0.40 | 1.46± 0.24 |
| | 60 | 72.51± 0.10 | 1.48± 0.36 |

Data are mean values ± S.D. of three replicates.

**Table C4** %Weight loss and pH of *Napier grass* hydrolyzed with 0.5 % (w/v) $H_3PO_4$ using 15:1 LSR under different times and temperatures

| **Temperature (°C)** | **Pretreatment Time (min)** | **% weight loss** | **pH** |
|---|---|---|---|
| 60 | 5 | 14.74± 0.03 | 1.96± 0.04 |
| | 10 | 13.84± 0.23 | 2.01± 0.08 |
| | 15 | 16.70± 0.13 | 2.02± 0.07 |
| | 30 | 18.77± 0.14 | 2.02± 0.07 |
| | 60 | 20.20± 0.23 | 2.03± 0.09 |
| 80 | 5 | 16.73± 0.02 | 2.01± 0.05 |
| | 10 | 18.43± 0.14 | 2.01± 0.02 |
| | 15 | 18.59± 0.17 | 2.03± 0.17 |
| | 30 | 19.64± 0.12 | 2.04± 0.23 |

| | | | |
|---|---|---|---|
| | 60 | 25.71± 0.13 | 2.09± 0.02 |
| 100 | 5 | 23.60± 0.21 | 2.01± 0.08 |
| | 10 | 28.30± 0.12 | 2.07± 0.37 |
| | 15 | 28.87± 0.15 | 2.1± 0.18 |
| | 30 | 31.31± 0.21 | 2.12± 0.02 |
| | 60 | 31.89± 0.23 | 2.12± 0.38 |
| 120 | 5 | 46.26± 0.45 | 2.1± 0.04 |
| | 10 | 51.32± 0.21 | 2.13± 0.12 |
| | 15 | 53.06± 0.12 | 2.16± 0.16 |
| | 30 | 57.96± 0.41 | 2.16± 0.06 |
| | 60 | 65.35± 0.41 | 2.19± 0.04 |
| 140 | 5 | 24.64± 0.14 | 2.22± 0.03 |
| | 10 | 28.65± 0.18 | 2.24± 0.05 |
| | 15 | 29.97± 0.15 | 2.24± 0.13 |
| | 30 | 32.91± 0.21 | 2.26± 0.03 |
| | 60 | 46.14± 0.19 | 2.33± 0.08 |
| 160 | 5 | 35.84± 0.12 | 2.32± 0.06 |
| | 10 | 44.77± 0.24 | 2.34± 0.03 |
| | 15 | 48.43± 0.23 | 2.38± 0.10 |
| | 30 | 50.59± 0.45 | 2.4± 0.08 |
| | 60 | 54.71± 0.12 | 2.45± 0.07 |

Data are mean values ± S.D. of three replicates.

## Appendix D The Amount of $H_3PO_4$ at Different Conditions

**Table D1** The amount of $H_3PO_4$using 15:1 LSR at various temperaturesfor different pretreatment time (g/100g biomass).

| Temperature(°C) | Pretreatment Time (min) | Amount of H3PO4 |
|---|---|---|
| 60 | 30 | 5.33± 0.29 |
| 80 | 10 | 6.07± 0.06 |
| 100 | 30 | 6.33± 0.04 |
| 120 | 30 | 6.44± 0.01 |
| 140 | 30 | 6.68± 0.03 |
| 160 | 15 | 6.95± 0.05 |

Data are mean values ± S.D. of three replicates.

**Table D2** The amount of $H_3PO_4$ using 15:1 LSR at 140 °C for 30 min with different $H_3PO_4$ concentrations (g sugar/100 g biomass)

| Concentration (%w/v) | Amount of H3PO4 |
|---|---|
| 0.5 | 9.11± 0.02 |
| 1.0 | 13.50± 0.02 |
| 2.0 | 22.02± 0.02 |
| 3.0 | 38.87± 0.13 |
| 4.0 | 58.48± 0.07 |
| 5.0 | 62.11± 0.10 |

**Table D3** The amount of $H_3PO_4$ using 1.0 % (w/v) $H_3PO_4$ at 140 °C for 30 min with different LSRs (g/100 g biomass)

| Liquid to Solid Ratio (LSR) | Total Monomeric Sugars |
|---|---|
| 15:1 | 13.50± 0.13 |
| 30:1 | 13.54± 0.10 |
| 45:1 | 13.57± 0.07 |

Data are mean values ± S.D. of three replicates.

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2. Treeboobpha, S.; Luengnaruemitchai, A.; Chaisuwan, T.; and Wongkasemjit, S. (2012, April 24) Two-stage microwave/chemical pretreatment process of *Napier grass* for monomeric sugar production. Proceedings of 18th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.

**Presentations:**

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2. Treeboobpha, S.; Luengnaruemitchai, A.; Chaisuwan, T.; and Wongkasemjit, S. (2012, April 24) Two-stage microwave/chemical pretreatment process of *Napier grass* for monomeric sugar production. Proceedings of 18th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Bangkok, Thailand.