Electronic supplementary information

Title: Nitrogenous compounds produced by catalytic pyrolysis of cyanobacteria over metal loaded MCM-41 with vaporized methanol

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<table>
<thead>
<tr>
<th>Samples</th>
<th>( S_{\text{BET}} ) (m(^2)/g)</th>
<th>( V_{\text{total}} ) (mL/g)</th>
<th>Pore Diameter (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCM-41</td>
<td>1109.21</td>
<td>1.13</td>
<td>3.83</td>
</tr>
<tr>
<td>Al(_2)O(_3)/MCM-41</td>
<td>978.85</td>
<td>0.79</td>
<td>3.23</td>
</tr>
<tr>
<td>NiO/MCM-41</td>
<td>539.5</td>
<td>0.86</td>
<td>3.97</td>
</tr>
<tr>
<td>NiAl-LDO/MCM-41</td>
<td>796.76</td>
<td>0.72</td>
<td>3.62</td>
</tr>
<tr>
<td>NiAl-LDO</td>
<td>167.29</td>
<td>0.93</td>
<td>23.53</td>
</tr>
</tbody>
</table>

* From \( \text{N}_2 \) adsorption measurements (BET method).
<table>
<thead>
<tr>
<th></th>
<th>Peak position/℃</th>
<th>Peak area/(a.u.)</th>
<th>Total acid amount/(mmol.g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCM-41</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>NiO/MCM-41</td>
<td>246</td>
<td>148.84</td>
<td>0.27</td>
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<td>NiAl-LDO</td>
<td>230</td>
<td>258.22</td>
<td>0.52</td>
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<td>Al₂O₃/MCM-41</td>
<td>243</td>
<td>400.41</td>
<td>0.80</td>
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<tr>
<td>NiAl-LDO/MCM-41</td>
<td>231</td>
<td>696.23</td>
<td>1.27</td>
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Table S3 Chemical components in bio-oils by GC/MS at different conditions

<table>
<thead>
<tr>
<th>No.</th>
<th>Compounds</th>
<th>Molecular Formula</th>
<th>Relative content at different conditions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>None (N₃)</td>
</tr>
<tr>
<td>1</td>
<td>Undecane</td>
<td>C₁₁H₂₄</td>
<td>0.58</td>
</tr>
<tr>
<td>2</td>
<td>Tridecane</td>
<td>C₁₃H₂₈</td>
<td>1.22</td>
</tr>
<tr>
<td>3</td>
<td>Undecane, 2,6-dimethyl-</td>
<td>C₁₁H₂₆</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>2-Tetradecene, (E)-</td>
<td>C₁₄H₂₆</td>
<td>0.92</td>
</tr>
<tr>
<td>5</td>
<td>1-Tetradecene</td>
<td>C₁₄H₂₆</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Pentadecane</td>
<td>C₁₅H₃₂</td>
<td>1.4</td>
</tr>
<tr>
<td>7</td>
<td>2,6,10-Trimethyltridecane</td>
<td>C₁₈H₃₄</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>Hexadecane</td>
<td>C₁₆H₃₄</td>
<td>0.41</td>
</tr>
<tr>
<td>9</td>
<td>Heptadecane</td>
<td>C₁₇H₃₆</td>
<td>4.25</td>
</tr>
<tr>
<td>10</td>
<td>Cyclohexene, 4-(4-ethylcyclohexyl)-1-pentyl-</td>
<td>C₁₉H₃₆</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>Neophytadiene</td>
<td>C₂₀H₃₈</td>
<td>7.11</td>
</tr>
<tr>
<td>12</td>
<td>2-Hexadecene, 3,7,11,15-tetramethyl-</td>
<td>C₂₀H₄₀</td>
<td>5.29</td>
</tr>
<tr>
<td>13</td>
<td>1-Hexacosene</td>
<td>C₂₆H₅₂</td>
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<tr>
<td>14</td>
<td>1-Hexadecyne</td>
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<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>22.25</strong></td>
</tr>
<tr>
<td>15</td>
<td>Benzene, 1,3-dimethyl-</td>
<td>C₆H₁₀</td>
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<tr>
<td>16</td>
<td>Ethylbenzene</td>
<td>C₇H₁₄</td>
<td>0.51</td>
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<tr>
<td>17</td>
<td>Styrene</td>
<td>C₆H₈</td>
<td>0.91</td>
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<tr>
<td>18</td>
<td>Benzene, propyl-</td>
<td>C₆H₁₂</td>
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<tr>
<td>19</td>
<td>Benzene, 1-ethyl-3-methyl-</td>
<td>C₆H₁₈</td>
<td>0.49</td>
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<tr>
<td>20</td>
<td>Naphthalene, 1,2,3,4-tetrahydro-1,1,6-trimethyl-</td>
<td>C₁₃H₁₈</td>
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<tr>
<td>21</td>
<td>Benzene, 1-methoxy-4-methyl-</td>
<td>C₆H₁₀O</td>
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<tr>
<td>22</td>
<td>Phenol</td>
<td>C₆H₁₀O</td>
<td>10.14</td>
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<td>23</td>
<td>Phenol, 2-methyl-</td>
<td>C₆H₁₀O</td>
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<td>24</td>
<td>p-Cresol</td>
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<tr>
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<td>Phenol, 2,4-dimethyl-</td>
<td>C₇H₁₀O</td>
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<tr>
<td>26</td>
<td>Phenol, 4-ethyl-</td>
<td>C₇H₁₀O</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>20.72</strong></td>
</tr>
<tr>
<td>27</td>
<td>1H-Pyrole, 2,3-dimethyl-</td>
<td>C₆H₁₄N</td>
<td>1.66</td>
</tr>
<tr>
<td>28</td>
<td>Pyridine, 2,4-dimethyl-</td>
<td>C₇H₁₄N</td>
<td>0</td>
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<tr>
<td>29</td>
<td>1H-Pyrole, 2-methyl-</td>
<td>C₇H₁₄N</td>
<td>0.69</td>
</tr>
<tr>
<td>30</td>
<td>1H-Pyrole, 3-methyl-</td>
<td>C₇H₁₄N</td>
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<td>31</td>
<td>1H-Pyrole, 2-ethyl-4-methyl-</td>
<td>C₇H₁₄N</td>
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</tr>
<tr>
<td></td>
<td>Compound</td>
<td>Chemical Formula</td>
<td>C</td>
</tr>
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<td>---</td>
<td>---------------------------------------------------------------</td>
<td>------------------</td>
<td>---</td>
</tr>
<tr>
<td>32</td>
<td>1H-Pyrrole, 2,3,5-trimethyl-</td>
<td>C₈H₁₁N</td>
<td>0.83</td>
</tr>
<tr>
<td>33</td>
<td>Indole</td>
<td>C₆H₁₂N</td>
<td>11.83</td>
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<td>34</td>
<td>Indole, 3-methyl-</td>
<td>C₇H₁₄N</td>
<td>2.21</td>
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<tr>
<td>35</td>
<td>1H-Indole, 5-methyl-</td>
<td>C₈H₁₄N</td>
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<tr>
<td>36</td>
<td>1H-Indole, 4-methyl-</td>
<td>C₈H₁₄N</td>
<td>0</td>
</tr>
<tr>
<td>37</td>
<td>1H-Indole-3-propanoic acid</td>
<td>C₁₀H₁₄NO₂</td>
<td>0</td>
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<tr>
<td>38</td>
<td>Indolizine</td>
<td>C₈H₁₂N</td>
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<tr>
<td>39</td>
<td>Benzyl nitrite</td>
<td>C₈H₁₂N</td>
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<tr>
<td>40</td>
<td>Benzene, 1-isocynano-2-methyl-</td>
<td>C₈H₁₂N</td>
<td>2.66</td>
</tr>
<tr>
<td>41</td>
<td>Benzenepropanenitrile</td>
<td>C₉H₁₄N</td>
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<td>42</td>
<td>Oleanitrile</td>
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<td>43</td>
<td>Oleanitrile</td>
<td>C₁₈H₃₃N</td>
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<tr>
<td>44</td>
<td>Heptadecanenitrile</td>
<td>C₁₉H₃₅N</td>
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</tr>
<tr>
<td>45</td>
<td>Octadecanenitrile</td>
<td>C₂₀H₄₁N</td>
<td>0</td>
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<tr>
<td>46</td>
<td>9-Octadecenamide, (Z)-</td>
<td>C₁₉H₃₃NO</td>
<td>1.11</td>
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<tr>
<td>47</td>
<td>Hexadecanamide</td>
<td>C₂₀H₄₁NO</td>
<td>10.79</td>
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<tr>
<td>48</td>
<td>N-Methylsdocecnamide</td>
<td>C₁₉H₃₇NO</td>
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</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
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<td>48.46</td>
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<tr>
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<td><strong>Oxygenic compounds</strong></td>
<td></td>
<td>48.46</td>
</tr>
<tr>
<td>49</td>
<td>4-Methyl-dodec-3-en-1-ol</td>
<td>C₁₃H₂₅O</td>
<td>0.2</td>
</tr>
<tr>
<td>50</td>
<td>Phytol</td>
<td>C₂₀H₄₆O</td>
<td>1.4</td>
</tr>
<tr>
<td>51</td>
<td>4-Hydroxy-2,2,7,7-tetramethyl-octahydro-2H-dib</td>
<td>C₁₄H₂₅O₄</td>
<td>0.88</td>
</tr>
<tr>
<td>52</td>
<td>(R)-(−)-14-Methyl-8-hexadecyn-1-ol</td>
<td>C₁₉H₃₅O</td>
<td>0</td>
</tr>
<tr>
<td>53</td>
<td>2-Hydroxy-5-methoxybenzaldehyde, n-Hexadecanoic acid</td>
<td>C₁₉H₃₅O₃</td>
<td>0.83</td>
</tr>
<tr>
<td>54</td>
<td>Linoleic acid</td>
<td>C₁₀H₁₉O₂</td>
<td>2.93</td>
</tr>
<tr>
<td>55</td>
<td>2-Dodecen-1-yl(-)succinic anhydride</td>
<td>C₁₀H₁₉O₂</td>
<td>0</td>
</tr>
<tr>
<td>56</td>
<td>9,12-Octadecadienoic acid (Z,Z)-</td>
<td>C₁₀H₁₈O₂</td>
<td>0</td>
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<tr>
<td>57</td>
<td>2-Dodecen-1-yl(-)succinic anhydride</td>
<td>C₁₀H₁₈O₂</td>
<td>0</td>
</tr>
<tr>
<td>58</td>
<td>2(4H)-Benzofuranone,</td>
<td>C₁₀H₁₈O₂</td>
<td>0.69</td>
</tr>
<tr>
<td>59</td>
<td>Hexadecanoic acid, methyl ester</td>
<td>C₁₀H₁₈O₂</td>
<td>1.65</td>
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<tr>
<td></td>
<td><strong>Total</strong></td>
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<td>8.57</td>
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Fig. S1. XRD patterns of different catalysts
Fig. S2. Nitrogen adsorption-desorption isotherms of different catalysts
Fig. S3. NH$_3$-TPD curve of different catalysts