Supporting Information

Assessment of the toxicity and biodegradation of amino acid-based ionic liquids

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### Antimicrobial Screening Result

#### Table S1 Growth inhibition halo (cm) for the AAILs against the bacteria *B. subtilis*

| ILS            | ILS concentration (mol/L) | 0.0625 | 0.125 | 0.25 | 0.50 | 1.00  |
|----------------|---------------------------|--------|-------|------|------|-------|
| [C₄mim][Pro]  |                           | 0.00   | 0.70±0.00 | 0.80±0.00 | 0.93±0.06 | 1.17±0.06 |
| [C₄mim][Val]  |                           | 0.00   | 0.00   | 0.00 | 1.00±0.00 | 1.27±0.03  |
| [C₄mim][Gly]  |                           | 0.00   | 0.00   | 0.80±0.00 | 1.00±0.00 | 1.03±0.06  |
| [C₄mim][Cys]  |                           | 0.00   | 0.00   | 0.52±0.02 | 0.71±0.01 | 0.93±0.04  |
| [C₄mim][His]  |                           | 0.00   | 0.65±0.04 | 0.77±0.06 | 1.00±0.00 | 1.13±0.06  |
| [C₄mim][Phe]  |                           | 0.00   | 0.70±0.00 | 0.87±0.06 | 1.00±0.10 | 1.17±0.12  |
| [C₄mim][Asp]  |                           | 0.00   | 0.00   | 0.00 | 0.60±0.00 | 0.64±0.00  |
| [Cho][Gly]    |                           | 0.00   | 0.00   | 0.00 | 0.77±0.06 | 0.90±0.01  |
| [Cho][Pro]    |                           | 0.00   | 0.00   | 0.70±0.00 | 0.80±0.00 | 1.03±0.06  |
| [Cho][His]    |                           | 0.00   | 0.00   | 0.00 | 0.60±0.00 | 0.90±0.02  |
| [Cho][Phe]    |                           | 0.00   | 0.00   | 0.60±0.00 | 0.73±0.06 | 0.87±0.06  |
| [Cho][Asp]    |                           | 0.00   | 0.00   | 0.00 | 0.00   | 0.73±0.02  |
| [Cho][Cys]    |                           | 0.00   | 0.00   | 0.00 | 0.00   | 1.07±0.04  |
| [C₄mim][Cys]  |                           | 0.00   | 0.00   | 0.00 | 0.60±0.00 | 0.70±0.02  |
| [C₆mim][Cys]  |                           | 0.6±0.00 | 0.70±0.00 | 0.83±0.06 | 1.63±0.12 | 2.23±0.12  |
| [Pyr][Cys]    |                           | 0.00   | 0.00   | 0.00 | 0.6±0.00 | 0.90±0.10  |
| [Pip][Cys]    |                           | 0.00   | 0.00   | 0.00 | 0.00   | 0.60±0.02  |
| [N₂₂₂₂][Cys]  |                           | 0.00   | 0.00   | 0.00 | 0.00   | 0.70±0.02  |
| [N₄₄₄₄][Cys]  |                           | 0.00   | 0.70±0.00 | 0.93±0.06 | 0.97±0.06 | 1.33±0.06  |
| Controls      |                           | 0.00   | 0.00   | 0.00 | 0.00   | 0.00       |
Table S2 Growth inhibition halo (cm) for the AAILs against bacteria the \textit{R. solanacearum}

| ILS          | 0.0625 | 0.125 | 0.25  | 0.50  | 1.00   |
|--------------|--------|-------|-------|-------|--------|
| [C4mim][Pro] | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.80±0.00 | 1.07±0.06 |
| [C4mim][Val] | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.80±0.00 | 0.93±0.06 |
| [C4mim][Gly] | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.82±0.02 | 1.10±0.00 |
| [C4mim][Cys] | 0.00   | 0.00   | 0.00   | 0.70±0.00 | 1.80±0.02 |
| [C4mim][His] | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.87±0.06 | 1.10±0.00 |
| [C4mim][Phe] | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.80±0.00 | 0.97±0.06 |
| [C4mim][Asp] | 0.00   | 0.00   | 0.00   | 0.00   | 0.60±0.00 |
| [Cho][Gly]   | 0.00   | 0.00   | 0.60±0.00 | 0.70±0.00 | 0.80±0.02 |
| [Cho][Pro]   | 0.00   | 0.00   | 0.60±0.00 | 0.81±0.00 | 0.80±0.02 |
| [Cho][His]   | 0.00   | 0.00   | 0.00   | 0.00   | 0.60±0.02 |
| [Cho][Phe]   | 0.00   | 0.00   | 0.00   | 0.62±0.00 | 0.70±0.04 |
| [Cho][Asp]   | 0.00   | 0.00   | 0.00   | 0.00   | 0.12±0.01 |
| [Cho][Cys]   | 0.00   | 0.00   | 0.00   | 1.30±0.00 | 0.50±0.03 |
| [C4mim][Cys] | 0.00   | 0.00   | 0.00   | 0.60±0.00 | 1.47±0.06 |
| [C4mim][Cys] | 0.00   | 0.69±0.01 | 0.77±0.06 | 1.63±0.06 | 2.00±0.02 |
| [Pyr][Cys]   | 0.00   | 0.00   | 0.00   | 0.00   | 0.60±0.03 |
| [Pip][Cys]   | 0.00   | 0.00   | 0.00   | 0.00   | 1.00±0.02 |
| [N2,2,2,2][Cys] | 0.00 | 0.00   | 0.00   | 0.60±0.01 | 0.67±0.04 |
| [N4,4,4,4][Cys] | 0.00 | 0.00   | 0.70±0.00 | 0.87±0.06 | 1.20±0.03 |
| Controls     | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |
| AAILs          | AAILs concentration (mol/L) | 0.0625 | 0.125 | 0.25  | 0.50  | 1.00  |
|---------------|-----------------------------|--------|-------|-------|-------|-------|
| [C4mim][Pro]  | 0.00                        | 0.00   | 0.00  | 0.80±0.00 | 1.10±0.00 | 1.40±0.00 |
| [C4mim][Val]  | 0.00                        | 0.73±0.06 | 1.00±0.00 | 1.23±0.06 | 1.60±0.00 |
| [C4mim][Gly]  | 0.00                        | 0.00   | 0.90±0.00 | 1.17±0.06 | 1.53±0.06 |
| [C4mim][Cys]  | 0.00                        | 0.00   | 0.00   | 0.86±0.04 | 1.20±0.03 |
| [C4mim][His]  | 0.00                        | 0.00   | 0.83±0.06 | 1.23±0.06 | 1.47±0.06 |
| [C4mim][Phe]  | 0.00                        | 0.71±0.01 | 1.03±0.06 | 1.21±0.01 | 1.60±0.10 |
| [C4mim][Asp]  | 0.00                        | 0.00   | 0.00   | 0.70±0.00 | 0.97±0.06 |
| [Cho][Gly]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.83±0.06 |
| [Cho][Pro]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.70±0.02 |
| [Cho][His]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.80±0.03 |
| [Cho][Phe]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.70±0.02 |
| [Cho][Asp]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.20±0.02 |
| [Cho][Cys]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.40±0.03 |
| [C4mim][Cys]  | 0.00                        | 0.00   | 0.00   | 0.00   | 0.93±0.06 |
| [C4mim][Cys]  | 0.60±0.00                   | 0.90±0.00 | 1.20±0.00 | 1.47±0.06 | 1.70±0.02 |
| [Pyr][Cys]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.70±0.01 |
| [Pip][Cys]    | 0.00                        | 0.00   | 0.00   | 0.00   | 0.50±0.02 |
| [N2,2,2,2][Cys]| 0.00                        | 0.00   | 0.00   | 0.70±0.00 | 1.00±0.04 |
| [N4,4,4,4][Cys]| 0.00                        | 0.80±0.00 | 1.00±0.00 | 1.33±0.06 | 1.67±0.06 |
| Controls      | 0.00                        | 0.00   | 0.00   | 0.00   | 0.00   |
## Table S4. MIC and MBC values (in mM) of AAILs

| AAILs  | B. subtilis | R. solanacearum | E. coli | S. stipitis | S. cerevisiae | P. chrysosporium | T. sanguinea | C. subvermispora | F. lignosus | Fungi |
|--------|-------------|-----------------|--------|-------------|---------------|-----------------|--------------|----------------|-------------|-------|
|        | MIC | MBC | MIC | MBC | MIC | MBC | MIC | MBC | MIC | MBC | MIC | MBC | MIC | MBC | MIC | MBC |
| [C₅mim][Pro] | 15.63 | 31.3 | 62.5 | 62.5 | 23.4 | 31.3 | 23.4 | 250 | 31.3 | 62.5 | 15.6 | 15.6 | 23.4 | 23.4 | 46.9 | 62.5 | 93.8 | 375 |
| [C₅mim][Val] | 11.7 | 31.3 | 46.9 | 62.5 | 15.6 | 31.3 | 11.7 | 11.7 | 23.4 | 31.3 | 15.6 | 15.6 | 23.4 | 23.4 | 46.9 | 62.5 | 93.8 | 375 |
| [C₅mim][Gly] | 62.5 | 62.5 | 125 | 125 | 23.4 | 31.3 | 7.8 | 7.8 | 15.6 | 15.6 | 15.6 | 15.6 | 23.4 | 23.4 | 46.9 | 62.5 | 125 | 93.8 | 250 |
| [C₅mim][Cys] | 125 | 125 | 125 | 125 | 23.4 | 31.3 | 62.5 | 500 | 62.5 | 62.5 | 15.6 | 15.6 | 93.8 | 93.8 | 62.5 | 93.8 | 93.8 | 250 |
| [C₅mim][His] | 31.3 | 31.3 | 62.5 | 62.5 | 62.5 | 62.5 | 11.7 | 11.7 | 23.4 | 61.3 | 15.6 | 15.6 | 23.4 | 23.4 | 46.9 | 375 | 125 | 500 |
| [C₅mim][Phe] | 23.4 | 46.9 | 250 | 250 | 125 | 125 | 11.7 | 11.7 | 23.4 | 31.3 | 93.8 | 125 | 23.4 | 23.4 | 62.5 | 62.5 | 93.8 | 250 |
| [C₅mim][Asp] | 23.4 | 125 | 500 | 500 | 46.9 | 46.9 | 93.8 | 500 | 157.5 | 375 | 250 | 250 | 250 | 250 | 500 | 500 | 1000 | 1000 |
| [Cho][Gly] | 62.5 | 250 | 93.8 | 93.8 | 125 | 125 | 125 | 375 | 93.8 | 93.8 | 23.4 | 23.4 | 46.9 | 93.8 | 1000 | >1000 | 750 | >1000 |
| [Cho][Pro] | 46.9 | 62.5 | 187.5 | 250 | 125 | 125 | 93.8 | 187.5 | 125 | 187.5 | 46.9 | 62.5 | 46.9 | 62.5 | 750 | >1000 | 1000 | 1000 |
| [Cho][His] | 62.5 | 62.5 | 187.5 | 250 | 125 | 187.5 | 125 | 500 | 93.8 | 187.5 | 23.4 | 23.4 | 46.9 | 62.5 | 500 | 500 | 500 | 750 |
| [Cho][Phe] | 62.5 | 125 | 187.5 | 500 | 187.5 | 250 | 187.5 | 375 | 125 | 250 | 31.3 | 31.3 | 46.9 | 62.5 | 750 | 1000 | 1000 | >1000 |
| [Cho][Asp] | 750 | 750 | >1000 | >1000 | 750 | 1000 | 500 | 750 | 500 | 750 | 93.8 | 93.8 | 250 | 500 | >1000 | >1000 | >1000 | >1000 |
| [Cho][Cys] | 187.5 | 375 | 375 | 375 | 375 | 375 | 750 | >1000 | 500 | 1000 | 62.5 | 62.5 | 187.5 | 250 | 750 | 1000 | >1000 | >1000 |
| [C₅mim][Cys] | 62.5 | 125 | 250 | 250 | 31.3 | 31.3 | 93.8 | 500 | 93.8 | 125 | 15.6 | 15.6 | 62.5 | 62.5 | 375 | 500 | 500 | 750 |
| [C₅mim][Cy][S] | 125 | 125 | 62.5 | 125 | 15.6 | 31.3 | 7.8 | 15.6 | 31.3 | 31.3 | 15.6 | 15.6 | 15.6 | 15.6 | 15.6 | 23.4 | 31.3 | 31.3 |
| [Pyr][Cys] | 11.7 | 31.3 | 125 | 125 | 125 | 125 | 62.5 | 500 | 250 | 375 | 250 | 250 | 250 | 250 | 375 | 500 | 500 | 750 | 1000 |
| [Pyr][Cys] | 125 | 250 | 375 | 500 | 125 | 125 | 125 | 250 | 187.5 | 250 | 187.5 | 187.5 | 125 | 157.5 | 500 | >1000 | 750 | >1000 |
| [N₂3,1₇][Cys] | 11.7 | 15.6 | 187.5 | 500 | 62.5 | 93.8 | 62.5 | 125 | 93.8 | 250 | 31.3 | 31.3 | 62.5 | 62.5 | 750 | >1000 | 1000 | >1000 |
| [N₂3,1₇][Cys] | 15.6 | 62.5 | 46.9 | 46.9 | 15.6 | 31.3 | 7.8 | 7.8 | 15.6 | 15.6 | 15.6 | 15.6 | 15.6 | 15.6 | 15.6 | 46.9 | 46.9 | 62.5 | 375 |

**Toxicity standards**

- Green: MIC/MBC > 2 mM all strains, or up to solubility limit (preferred); Amber: MIC/MBC 0.25 – 2.0 mM (usable); Red: MIC/MBC < 0.25 mM (undesirable)
| AAILs     | AAILs concentration (mg/kg) |
|-----------|-----------------------------|
|           | 200            | 400            | 600            | 800            | 1000           |
| [C\text{mim}]|\text{[Pro]}  | -11.08±0.02   | 22.01±1.80    | -29.43±1.26   | -60.13±1.25    | -100±2.89      |
| [C\text{mim}]|\text{[Val]}  | 27.59±0.11    | 12.04±2.10    | -60.53±2.36   | -98.80±3.56    | -100±2.56      |
| [C\text{mim}]|\text{[Gly]}  | 81.83±4.58    | 27.59±1.2     | -72.49±5.6    | -82.46±2.53    | -100±3.59      |
| [C\text{mim}]|\text{[Cys]}  | -22.25±0.18   | 30.590±3.20   | -47.77±3.20   | -91.23±0.56    | -100±4.58      |
| [C\text{mim}]|\text{[His]}  | 57.10±0.26    | -8.29±1.50    | -41.39±2.36   | -79.27±0.89    | -90.83±3.52    |
| [C\text{mim}]|\text{[Phe]}  | -3.91±0.09    | -13.88±0.12   | -39.79±1.26   | -79.27±1.59    | -100±1.26      |
| [C\text{mim}]|\text{[Asp]}  | 4.90±0.40     | -24.71±1.21   | -38.6±2.61    | -79.53±3.56    | -100±1.59      |
| [\text{Cho}|\text{Gly]} | -9.49±0.11    | -16.27±1.32   | -13.08±0.26   | -29.03±1.24    | 70.65±1.45     |
| [\text{Cho}|\text{Pro]} | 57.89±4.5    | 20.02±0.12    | 4.07±0.23     | 15.23±0.26     | 2.87±0.23      |
| [\text{Cho}|\text{His]} | -4.70±0.02   | -19.06±0.15   | -33.01±1.31   | 9.65±0.23      | -19.06±0.16    |
| [\text{Cho}|\text{Phe]} | 53.91±0.15   | -14.67±0.28   | -13.48±0.15   | 10.45±0.25     | 13.24±0.15     |
| [\text{Cho}|\text{Asp]} | 864.51±8.90 | 848.96±7.80   | 946.65±3.65   | 445.85±3.46    | 37.56±0.26     |
| [\text{Cho}|\text{Cys]} | 34.37±1.20   | 25.2±2.23     | 13.64±0.23    | 29.19±4.56     | 2.07±0.03      |
| [C\text{mim}]|\text{[Cys]}  | 24.80±1.10    | 13.6±0.59     | 20.02±1.23    | -5.5±0.36      | -35.01±0.45    |
| [C\text{mim}]|\text{[Cys]}  | -72.09±5.80   | -100±5.20     | -100±3.56     | -100±2.15      | -100±4.59      |
| [\text{Pyr}|\text{Cys]} | 11.24±0.60   | 9.25±0.38     | -26.24±1.23   | -46.57±1.26    | -40.99±1.21    |
| [\text{Pip}|\text{Cys]} | 20.81±1.5    | -1.52±0.03    | -11.88±0.26   | -27.43±0.56    | -9.09±0.02     |
| [\text{N}_{2}\text{,2,2,2}\text{-}\text{Cys]} | 6.46±1.0     | -6.7±0.06     | -9.89±0.25    | -51.75±0.78    | -73.29±0.06    |
| [\text{N}_{4}\text{,4,4,4}\text{-}\text{Cys]} | -2.31±0.02   | -15.87±1.2    | -51.75±1.26   | -100±0.59      | -100±0.26      |
| [C\text{mim}]|\text{[Br]}   | -40.99±3.8    | -100±3.80     | -100±3.12     | -100±0.78      | -100±0.59      |
Table S6. The shoot inhibition (%) of rice seedling by adding ILs solution (Positive is representative for promoting growth conversely inhibition growth)

| AAILs        | AAILs concentration (mg/kg) | 200  | 400  | 600  | 800  | 1000 |
|--------------|----------------------------|------|------|------|------|------|
| [C4mim][Pro] |                            | -11.3±0.23 | 15.61±0.02 | -4.88±0.03 | -9.55±0.26 | -26.16±1.26 |
| [C4mim][Val] |                            | -3.66±0.03 | 3.62±0.03 | -8.17±0.12 | -20.42±0.24 | -17.97±1.23 |
| [C4mim][Gly] |                            | 11.65±0.02 | 12.03±0.29 | -1.13±0.23 | -17.97±0.01 | -30.52±1.26 |
| [C4mim][Cys] |                            | 0.02±0.10 | 16.74±0.36 | -4.12±0.05 | -18.89±0.03 | -22.71±1.78 |
| [C4mim][His] |                            | 17.85±0.03 | -1.00±0.01 | -8.17±0.09 | -14.68±0.12 | -25.08±1.26 |
| [C4mim][Phe] |                            | 11.11±0.02 | -7.17±0.02 | -2.43±0.03 | -7.02±0.03 | -17.58±1.23 |
| [C4mim][Asp] |                            | -2.29±0.01 | -12.68±0.09 | -2.99±0.09 | -23.12±0.03 | -30.98±0.04 |
| [Cho][Gly]   |                            | 0.70±0.02 | -2.46±0.01 | -11.62±0.04 | -12.46±0.01 | 1.93±0.02 |
| [Cho][Pro]   |                            | 7.06±0.01 | -1.18±0.02 | -6.11±0.07 | -10.54±0.56 | -7.41±0.23 |
| [Cho][His]   |                            | 1.47±0.02 | 10.78±0.05 | 5.07±0.02 | -0.06±0.03 | -1.21±0.03 |
| [Cho][Phe]   |                            | 18.00±1.24 | 10.68±0.04 | 10.96±0.14 | 15.40±0.07 | 1.16±0.07 |
| [Cho][Asp]   |                            | 24.20±0.06 | 24.08±0.06 | 32.15±1.26 | 24.20±0.26 | 20.14±0.05 |
| [Cho][Cys]   |                            | 12.79±0.08 | 19.58±0.24 | 13.79±0.78 | 20.22±0.32 | 13.10±0.02 |
| [C4mim][Cys] |                            | 3.84±0.06 | 5.13±0.07 | -2.20±0.06 | -2.82±0.32 | -4.96±0.23 |
| [C6mim][Cys] |                            | -15.98±0.07 | -40.71±0.29 | -92.42±1.45 | -94.95±2.89 | -97.47±0.15 |
| [Pyr][Cys]   |                            | 4.22±0.03 | -10.04±0.03 | -19.65±0.89 | -12.61±1.23 | -25.77±0.02 |
| [Pip][Cys]   |                            | 7.59±0.05 | -3.34±0.01 | 9.43±0.08 | 1.24±0.28 | -3.58±0.12 |
| [N2,2,2,2][Cys] |                        | 0.86±0.01 | 2.21±0.03 | -5.65±0.09 | -10.01±0.56 | -11.69±0.03 |
| [N4,4,4,4][Cys] |                        | 4.91±0.03 | -3.61±0.01 | -7.25±0.45 | -20.49±0.78 | -24.63±0.02 |
| [C4mim][Br]  |                            | -7.79±0.02 | -17.97±0.02 | -34.42±0.78 | -41.15±1.26 | -54.09±0.01 |
Table S7. The fresh weight inhibition (%) of rice seedling by adding ILs solution (Positive is representative for promoting growth conversely inhibition growth)

| AAILs               | 200       | 400       | 600       | 800       | 1000      |
|---------------------|-----------|-----------|-----------|-----------|-----------|
| [C₄mim][Pro]        | 0.00      | 0.00      | -6.90±0.06| -10.34±0.23| -17.24±0.06|
| [C₄mim][Val]       | 0.00      | -6.90±0.02| -10.34±0.05| -17.24±0.56| -20.69±0.26|
| [C₄mim][Gly]       | 13.79±0.03| -6.90±0.01| -20.69±0.09| -27.59±0.12| -29.31±0.37|
| [C₄mim][Cys]       | -10.34±0.03| 1.69±0.01 | -12.41±0.03| -24.14±0.26| -17.24±0.29|
| [C₄mim][His]       | 3.45±0.20 | -6.90±0.03 | -8.62±0.01 | -20.69±0.25| -17.24±0.15|
| [C₄mim][Phe]       | -6.90±0.23 | -10.34±0.08| -10.34±0.06| -24.14±0.24| -20.69±0.03|
| [C₄mim][Asp]       | 0.00      | 0.00      | 3.45±0.06  | 3.45±0.01  | 7.59±0.06  |
| [Cho][Gly]         | -1.72±0.12| -2.41±0.03| -3.45±0.04  | -3.45±0.03 | -17.24±0.05|
| [Cho][Pro]         | 0.00      | 0.00      | 3.45±0.09  | 3.45±0.01  | 7.59±0.06  |
| [Cho][His]         | 0.00      | -3.45±0.06| -4.83±0.05  | -6.21±0.56 | -6.90±0.15 |
| [Cho][Phe]         | 6.90±0.02 | 3.45±0.09  | 3.45±0.04  | 1.72±0.03  | -6.90±0.02 |
| [Cho][Asp]         | 0.00      | -3.45±0.01| -3.45±0.06  | -3.45±0.25 | -13.79±0.03|
| [Cho][Cys]         | 3.45±0.01 | 0.00      | -1.38±0.04  | -2.76±0.26 | -3.45±0.01 |
| [C₄mim][Cys]       | 48.28±0.03| 37.93±0.26| 34.48±0.01  | 24.14±0.23 | -3.45±0.03 |
| [C₄mim][Cys]       | -6.90±0.04| -20.69±0.56| -6.90±0.23  | -6.90±0.24 | -8.45±0.25 |
| [Pyr][Cys]         | 0.00±0.02 | -13.79±0.12| -13.79±0.56 | -20.69±0.56| -21.38±0.16|
| [Pip][Cys]         | -10.34±0.04| -27.59±0.13| -31.03±0.23 | -34.48±0.78| -34.48±0.12|
| [N₂,2,2,2][Cys]   | 3.45±0.02 | -10.34±0.03| -10.34±0.14 | -17.24±0.03| -20.69±0.02|
| [N₄,4,4,4][Cys]   | -10.34±0.03| -10.34±0.07| -10.34±0.56| -11.38±0.01| -13.79±0.01|
| [C₄mim][Br]       | -10.34±0.04| -24.14±0.08| -31.03±0.78 | -31.03±0.02| -31.03±0.02|
Characterization of the ionic liquids

All ILs were characterized by FT-IR spectroscopy and $^1$H NMR, then spectroscopic data of synthesized ILs were analyzed by
MestReNova LITE. The $^1$H NMR data obtained from Bruker BioSpin GmbH (400 MHz) using D$_2$O as solvents. All the results of FT-IR and $^1$H NMR proved that all synthesized ILs were target products.
[Cho][Asp]. $^1$H NMR (400 MHz, D$_2$O) δ: 2.52 – 2.73 (m, 2H, CH$_2$), 3.10 (s, 9H, CH$_3$, CH$_3$, CH$_3$), 3.41 – 3.43 (m, 2H, CH$_2$), 3.76 – 3.79 (q, $J$ = 12 Hz, 1H, CH-N). 3.94 – 3.97 (m, 2H, CH$_3$). IR: Error! = 3425, 2978, 1596, 1479, 1392, 1349, 1149, 1066, 908, 856 cm$^{-1}$. 

![NMR spectrum](image1)

![IR spectrum](image2)

![Absorbance spectrum](image3)
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[Cho][Phe]. $^1$H NMR (400 MHz, D$_2$O) δ: 2.73 – 2.78 (m, 2H, CH$_2$), 2.88 – 3.06 (m, 2H, CH$_2$), 3.06 (s, 9H, CH$_3$, CH$_3$, CH$_3$), 3.38 – 3.41 (m, 2H, CH$_2$), 3.93 (q, $J = 5.6$, 7.2 Hz, 1H, CH-N), 7.19 – 7.29 (m, 5H, C$_6$H$_5$). IR: 3463, 3050, 3028, 2940, 1565, 1483, 1405, 1342, 1083, 958 cm$^{-1}$. 

![Image of NMR spectrum]

![Image of IR spectrum]
[Cho][His]. $^1$H NMR (400 MHz, D$_2$O) δ: 2.69 – 2.87 (m, 2H, CH$_2$), 3.07 (s, 9H, CH$_3$, CH$_3$, CH$_3$), 3.36 – 3.40 (apparent q, $J = 16$ Hz, 3H, CH$_2$, CH-N), 3.92 – 3.95 (m, 2H, CH$_2$), 6.80 (s, 1H, =CH), 7.55 (s, 1H, =CH). IR: Error! = 3399, 2950, 1571, 1479, 1407, 1346, 1085, 956, 677 cm$^{-1}$. 

![NMR Spectrum of [Cho][His]](image1)

![IR Spectrum of [Cho][His]](image2)
[Cho][Gly]. \(^1\)H NMR (400 MHz, D₂O) \(\delta\): 3.13 – 3.14 (d, \(J = 4.0\) Hz, 11H, CH₃, CH₂, CH₃, CH₂), 3.44 – 3.46 (m, 2H, CH₂), 3.98 (s, 2H, CH₂-N). IR: Error! = 3444, 2978, 1577, 1483, 1400, 1081, 1046, 952, 650 cm\(^{-1}\).
$^1$H NMR (400 MHz, D$_2$O) $\delta$: 2.15 – 2.16 (m, 2H, CH$_2$), 3.12 (s, 9H, CH$_3$, CH$_3$, CH$_3$), 3.42 – 3.46 (m, 2H, CH$_2$), 3.54 – 3.60 (q, $J = 24$ Hz, 1H, CH-N), 3.95 – 3.98 (m, 2H, CH$_2$). IR: Error! = 3407, 2950, 1585, 1471, 1400, 1394, 1288, 1002, 670 cm$^{-1}$. 
[Cho][Pro]. $^1$H NMR (400 MHz, D$_2$O) δ: 1.69 – 1.74 (m, 4H, CH$_2$, CH$_3$), 3.02 – 3.05 (t, $J = 12$ Hz, 1H, CH-N), 3.11 (s, 9H, CH$_3$, CH$_3$), 3.42 – 3.46 (t, $J = 16$ Hz, 2H, CH$_2$-N), 3.53 – 3.55 (t, $J = 8.0$ Hz, 2H, CH$_3$), 3.95 – 3.99 (t, $J = 16$ Hz, 2H, CH$_2$). IR: Error! = 3444, 2971, 2869, 1581, 1477, 1419, 1386, 1081, 1078, 958 cm$^{-1}$. 

![NMR Spectrogram](image1)

![IR Spectrum](image2)
[C$_4$ mim][Val]. $^1$H NMR (400 MHz, D$_2$O) $\delta$: 0.75 – 0.77 (t, $J = 8.0$ Hz, 3H, CH$_3$), 0.81 – 0.84 (dd, $J = 12$ Hz, 6H, CH$_3$, CH$_3$), 1.17 – 1.23 (m, 2H, CH$_2$), 1.71 – 1.77 (m, 3H, CH, CH$_3$), 2.96 – 2.97 (m, $J = 4.0$ Hz, 1H, CH-N), 3.79 (s, 3H, CH$_3$), 4.08 – 4.10 (t, $J = 8.0$ Hz, 2H, CH$_2$), 4.10 – 4.11 (t, $J = 4.0$ Hz, 2H, CH$_2$), 7.33 – 7.38 (s, 3H, =CH, =CH, =CH). IR: Error! = 3430, 2958, 2875, 1571, 1457, 1392, 1322, 1164, 958, 620 cm$^{-1}$. 

![NMR spectrum](image1.png)

![IR spectrum](image2.png)
[C₄mim][Gly]. ¹H NMR (400 MHz, D₂O) δ: 0.84 – 0.88 (t, J = 16 Hz, 3H, CH₃), 1.23 – 1.26 (m, 2H, CH₂), 1.75 – 1.82 (m, 2H, CH₂), 3.14 (s, 2H, CH₂), 3.83 (s, 3H, CH₃), 4.11 – 4.15 (m, 2H, CH₂), 7.36 (s, 1H, =CH), 7.41 (s, 1H, =CH). IR: Error! = 3413, 2958, 2869, 1573, 1471, 1402, 1340, 1164, 956, 610 cm⁻¹.
$[^{\text{C}}_{4}\text{mim}][\text{Pro}]$. $^1$H NMR (400 MHz, D$_2$O) $\delta$: 0.83 – 0.86 ($t$, $J = 12$ Hz, 3H, CH$_3$), 1.20 – 1.25 (m, 2H, CH$_2$), 1.69 – 1.72 (m, 4H, CH$_2$, CH$_3$), 1.74 – 1.81 (m, 2H, CH$_2$), 3.03 – 3.06 ($t$, $J = 12$ Hz, 1H, CH-N), 3.52 – 3.58 (m, 2H, CH$_2$), 3.82 (s, 3H, CH$_3$), 4.10 – 4.14 ($t$, $J = 16$ Hz, 2H, CH$_2$), 7.37 (s, 1H, =CH), 7.42 (s, 1H, =CH). IR: Error! = 3425, 3112, 2956, 1629, 1571, 1425, 1342, 1301, 1164, 958, 650 cm$^{-1}$. 

![NMR spectrum](image1.png)

![IR spectrum](image2.png)
[C₄mim][Cys]. 'H NMR (400 MHz, D₂O) δ: 0.77 – 0.81 (t, J = 16 Hz, 3H, CH₃), 1.16 – 1.22 (q, J = 24 Hz, 2H, CH₂), 1.70 – 1.76 (m, 2H, CH₂), 2.56 – 2.86 (d, 2H, CH₂), 3.31 – 3.34 (t, J = 12 Hz, 1H, CH-N), 3.77 (s, 3H, CH(N)), 4.05 – 4.09 (t, J = 12 Hz, 2H, CH₂), 7.31 (s, 1H, =CH), 7.36 (s, 1H, =CH). IR: Error! = 3432, 3156, 2964, 1596, 1463, 1390, 1284, 1170, 1164, 662 cm⁻¹.
[C₄mim][Phe]. ¹H NMR (400 MHz, D₂O) δ: 0.84 – 0.88 (t, J = 16 Hz, 3H, CH₃), 1.22 – 1.27 (m, 2H, CH₂), 1.72 – 1.80 (m, 2H, CH₂), 2.75 – 2.80 (m, 2H, CH₂), 3.43 – 3.46 (t, J = 12 Hz, 1H, CH-N), 3.79 (s, 3H, CH₃), 4.07 – 4.11 (q, J = 16 Hz, 2H, CH₂), 7.20 – 7.30 (m, 5H, C₆H₅), 7.33 (s, 1H, =CH), 7.37 (s, 1H, =CH). IR: Error! = 3444, 3151, 2964, 2140, 1571, 1498, 1342, 1166, 755, 707, 624 cm⁻¹.
[C₄mim][Asp]. "H NMR (400 MHz, D₂O) δ: 0.84 – 0.88 (t, J = 16 Hz, 3H, CH₃), 1.22 – 1.29 (m, 2H, CH₂), 1.75 – 1.83 (m, 2H, CH₂), 2.58 – 2.64 (t, J = 24 Hz, 2H, CH₃), 3.83 (s, 3H, CH₃), 4.12 – 4.16 (t, J = 16 Hz, 2H, CH₂), 7.38 (s, 1H, =CH), 7.42 (s, 1H, =CH), 8.85 (s, 1H, =CH). IR: Error! = 3147, 2966, 1612, 1579, 1392, 1303, 1157, 1110, 968 cm⁻¹.
[C₄mim][His]. ¹H NMR (400 MHz, D₂O) δ: 0.83 – 0.86 (t, J = 12 Hz, 3H, CH₃), 1.21 – 1.26 (m, 2H, CH₂), 1.73 – 1.78 (m, 2H, CH₂), 2.75 – 2.88 (t, J = 8.0, 8.0 Hz, 2H, CH₂), 3.41 – 3.44 (t, J = 12 Hz, 1H, CH-N), 3.83 (s, 3H, CH₃), 4.09 – 4.12 (t, J = 12 Hz, 2H, CH₂), 6.84 (s, 1H, =CH), 7.34 (s, 1H, =CH), 7.39 (s, 1H, =CH), 7.59 (s, 1H, =CH). IR: Error! = 3425, 3156, 2964, 1565, 1463, 1340, 1166, 831, 748 cm⁻¹.
$[\text{C}_2\text{mim}][\text{Cys}]$. $^1\text{H}$ NMR (400 MHz, D$_2$O) $\delta$: 1.34 – 1.38 (t, $J = 12$ Hz, 3H, CH$_3$), 2.59 – 2.65 (t, $J = 24$ Hz, 2H, CH$_2$), 3.36 – 3.39 (d, 1H, CH-N), 3.75 (s, 3H, CH$_3$), 4.06 – 4.12 (q, $J = 24$ Hz, 2H, CH$_2$), 7.28 (s, 1H, =CH), 7.36 (s, 1H, =CH). IR: Error! = 3455, 2991, 1598, 1457, 1388, 1168, 962 cm$^{-1}$. 

![NMR spectrum of $[\text{C}_2\text{mim}][\text{Cys}]$.](image1)

![IR spectrum of $[\text{C}_2\text{mim}][\text{Cys}]$.](image2)
[C₆mim][Cys]. ¹H NMR (400 MHz, D₂O) δ: 0.75 – 0.77 (t, J = 8.0 Hz, 3H, CH₃), 0.80 – 0.84 (m, 6H, CH₂, CH₃, CH₂), 1.71 – 1.77 (m, 2H, CH₂), 2.95 – 2.96 (t, J = 4.0 Hz, 1H, CH-N), 3.80 (s, 3H, CH₃), 4.08 – 4.12 (m, 2H, CH₂), 7.34 – 7.20 (d, 2H, =CH, =CH). IR: Error! = 3455, 2991, 1598, 1457, 1388, 1168, 962 cm⁻¹.
[N_{2,2,2}][\text{Cys}].^{1} \text{H NMR (400 MHz, D}_2\text{O)} \delta: 0.80 – 0.89 (d, \text{ } J = 36 \text{ Hz}, 2\text{H, CH}_3), 1.18 – 1.22 (t, \text{ } J = 16 \text{ Hz}, 12\text{H, CH}_3, \text{ CH}_2, \text{ CH}_2, \text{ CH}_2, \text{ CH}_3, \text{ CH}_3), 3.02 – 3.03 (t, \text{ } J = 4.0 \text{ Hz}, 1\text{H, CH-N}), 3.16 – 3.22 (t, \text{ } J = 24 \text{ Hz}, 8\text{H, CH}_2, \text{ CH}_2, \text{ CH}_2, \text{ CH}_2, \text{ CH}_3, \text{ CH}_3), \text{ IR: } \text{Error!} = 3457, 2989, 1585, 1457, 1396, 1174, 1002, 786 \text{ cm}^{-1}. 
[N_{4,4,4,4}][Cys]. $^1$H NMR (400 MHz, D$_2$O) $\delta$: 0.82 – 0.86 (t, $J = 16$ Hz, 12H, CH$_3$, CH$_3$, CH$_3$, CH$_3$), 1.21 – 1.28 (m, 8H, CH$_2$, CH$_2$, CH$_2$), 1.50 – 1.58 (m, 8H, CH$_2$, CH$_2$, CH$_2$, CH$_2$), 2.71 – 2.90 (d, 2H, CH$_3$), 3.07 – 3.11 (t, $J = 16$ Hz, 8H, CH$_2$, CH$_2$, CH$_2$, CH$_2$), 3.47 – 3.54 (d, 1H, CH-N). IR: $\text{Error!} = 3430, 2960, 1575, 1463, 1334, 1172, 991$ cm$^{-1}$. 
[^Pyr][Cys]. $^1$H NMR (400 MHz, D$_2$O) $\delta$: 1.24 – 1.28 (t, $J = 16$ Hz, 3H, CH$_3$), 2.09 (m, 4H, CH$_2$, CH$_3$), 2.44 – 2.55 (m, 2H, CH$_2$), 2.90 (s, 3H, CH$_3$), 3.21 – 3.25 (t, $J = 16$ Hz, 1H, CH-N), 3.27 – 3.32 (q, $J = 20$ Hz, 2H, CH$_2$), 3.36 – 3.37 (m, 4H, CH$_2$, CH$_2$). IR: 3411, 2983, 1598, 1469, 1388, 1295, 1029, 995 cm$^{-1}$. 

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[Spectrum of [Pyro][Cys]](image)
[Pip][Cys]. $^1$H NMR (400 MHz, D$_2$O) δ: 1.23 – 1.25 (t, $J = 8.0$ Hz, 3H, CH$_3$), 1.54 – 1.59 (m, 2H, CH$_2$), 1.79 (m, 4H, CH$_2$, CH$_3$), 2.16 (d, 1H, CH-N), 2.91 (s, 3H, CH$_3$), 3.22 – 3.14 (m, 4H, CH$_2$, CH$_3$), 3.30 – 3.33 (m, 4H, CH$_2$, CH$_3$). IR: 3455, 2956, 1594, 1469, 1392, 1170, 944 cm$^{-1}$. 