Extraction and isolation of shikimic acid from *Ginkgo biloba* leaves utilizing an ionic liquid that dissolves cellulose

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Supplementary Information

1. Calibration curve by HPLC analysis of natural shikimic acid:

In order to prepare the calibration curve for shikimic acid, HPLC analysis of natural shikimic acid (0.04 µg/mL, 0.2 µg/mL, 1.0 µg/mL, and 5.0 µg/mL) was performed as shown in Figure S1 as the example under the condition described as main text. HPLC charts were acquired on a JASCO’s instrument (MD-2010 Plus, PU-2085 Plus, CO-2065 Plus). Since the obtained peak area of shikimic acid was 54040, 272025, 1453910, and 7803301, respectively, amount of shikimic acid could be plotted as shown in Figure S2. Consequently, the fitting for the plots gave an equation described as $y = 2 \times 10^6 x - 50967$ with $R^2 = 0.9998$ for the quantitative analysis of shikimic acid.

![Figure S1. HPLC chart of shikimic acid (1.0 µg/ml). The condition is described in main text.](image)
**Figure S2.** Calibration curve of shikimic acid based on the HPLC analysis.
2. HPLC analysis of extracted shikimic acid by MeOH:

When 0.005 mg of the extract (total: 293.9 mg) by methanol from 2.3848 g of *G. biloba* leaves was injected into the HPLC, the chart was obtained as Figure S3 under the condition described as main text. Since the peak area of shikimic acid was found to be 718488, the value was substituted for $y$ in the equation of $y = 2 \times 10^6 x - 50967$, resulting in estimation of amount of shikimic acid “$x$” as $3.8 \times 10^{-7}$ g. Ratio of contained shikimic acid in the extract was thus found to be 7.6% ($=3.8 \times 10^{-7} / 5 \times 10^{-6} \times 100$). Because total amount of shikimic acid in 293 mg of the extract was calculated to be 22 mg ($= 293.9 \times 7.6\%$), we found the extraction yield by methanol was to be 0.92% ($= 0.022\ g / 2.38848 \times 100$). Extraction yields by ethanol, H$_2$O, DMF, and ILs were calculated in the same procedures.

**Figure S3.** HPLC chart of extracted shikimic acid by methanol. The condition is described in main text.
3. SEM micrographs of *G. biloba* leaves:

SEM micrographs of *G. biloba* leaves before extraction (**Figure S4**), after extraction by methanol (**Figure S5**), and after IL (**Figure S6**) are shown, respectively. The micrographs were obtained by a Hitachi S-4500 equipment.
**Figure S4.** SEM micrographs of leaves before extraction at 10.0 k (up) and 70.0 k (bottom).
Figure S5. SEM micrographs of leaves after extraction by methanol at 10.0 k (up) and 70.0 k (bottom).
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**Figure S6.** SEM micrographs of leaves after extraction by ionic liquid 2 at 10.0 k (up) and 70.0 k (bottom).
4. $^1$H-NMR spectrum of the isolated shikimic acid:

Isolated shikimic acid from IL extracts by an anion-exchange resin was identified by $^1$H-NMR measurement which was acquired on a JEOL Lambda 300 spectrometer (Figure S7). The isolated shikimic acid: $^1$H-NMR (D$_2$O, 300 MHz) $\delta$ 2.25 (1H, m), 2.74 (1H, m), 3.80 (1H, m), 4.06 (1H, m), 4.47 (1H, m), 6.84 (1H, m).

Figure S7. $^1$H-NMR spectrum in D$_2$O of the isolated shikimic acid.