

Table S1. Chemical properties of different pesticide contaminants

| Type of contaminant | Contaminant (Pesticide)             | Acidity and alkalinity | Hydrophobicity     | Polarity and nonpolarity |
|---------------------|-------------------------------------|------------------------|--------------------|--------------------------|
| Herbicide           | oxyfluorfen                         | Acidic                 | Insoluble          | Nonpolarity              |
|                     | bentazone                           | Stable                 | Slightly soluble   | Nonpolarity              |
|                     | 4-chloro-2-methylphenoxyacetic acid | Alkalinity             | Insoluble          | Nonpolarity              |
|                     | atrazine                            | stable                 | Slightly soluble   | Nonpolarity              |
|                     | metolachlor                         | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | Sulfonylurea herbicides             | Acidic                 | Slightly soluble   | Polarity                 |
|                     | dicamba                             | Acidic                 | Soluble            | Polarity                 |
|                     | glyphosate                          | Acidic                 | Slightly soluble   | Polarity                 |
|                     | 2,4-dichlorophenoxyacetic acid      | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | trifluralin                         | Acidic                 | Insoluble          | Nonpolarity              |
|                     | diuron                              | Neutral                | Slightly soluble   | Nonpolarity              |
|                     | bispyribac-sodium                   | Acidic                 | Soluble            | Polarity                 |
|                     | fomesafen                           | Acidic                 | Soluble            | Polarity                 |
|                     | linuron                             | Acidic                 | Insoluble          | Nonpolarity              |
|                     | monuron                             | Acidic                 | Insoluble          | Nonpolarity              |
|                     | sulfentrazone                       | Acidic                 | Insoluble          | Nonpolarity              |
|                     | acetochlor                          | Acidic                 | Soluble            | Nonpolarity              |
|                     | fenoxaprop-ethyl                    | Acidic                 | Insoluble          | Nonpolarity              |
|                     | simazine                            | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | imazapic                            | Acidic                 | Readily soluble    | Polarity                 |
|                     | isoproturon                         | Stable                 | Slightly soluble   | Nonpolarity              |
|                     | aminocyclopyrachlor                 | Acidic<br>Stable       | Readily soluble    | Polarity                 |
|                     | clomazone                           | Acidic                 | Readily soluble    | Polarity                 |
|                     | carbofuran                          | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | Fipronil                            | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | ethiprole                           | Stable                 | Slightly soluble   | Nonpolarity              |
|                     | trichloroethylene                   | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | carbaryl                            | Acidic                 | Insoluble in water | Nonpolarity              |
| Insecticide         | metolachlor                         | Acidic                 | Readily soluble    | Polarity                 |
|                     | flubendiamide                       | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | imidacloprid                        | Neutral                | Slightly soluble   | Polarity                 |
|                     | dichlorvos                          | Acidic                 | Slightly soluble   | Nonpolarity              |
|                     | aldrin                              | Alkalinity             | Insoluble          | Nonpolarity              |
|                     | chlorpyrifos                        | Acidic                 | Insoluble          | Nonpolarity              |
|                     | thiacloprid                         | Acidic                 | Insoluble          | Nonpolarity              |
|                     | methyl isothiocyanate               | Acidic                 | Slightly soluble   | Nonpolarity              |
| Bactericide         | tebuconazole                        | Acidic                 | Slightly soluble   | Nonpolarity              |

**Table S2.** Comparison of biochar and modified biochar on adsorption capacity and removal rate.

| Raw material                           | Pyrolysis temperature<br>°C | Contaminant  | Biochar    |   |  |  |                       | Modification method   | Modified Biochar |   |  |  |                       | Reference |
|--|-----------------------------|--|------------|---|--|--|-----------------------|---|------------------|---|--|--|-----------------------|-----------|
|  |                             |  | pH         | Specific surface area<br>(m <sup>2</sup> ·g <sup>-1</sup> ) | Total pore volume<br>(cm <sup>3</sup> ·g <sup>-1</sup> ) | Maximum adsorption capacity<br>(mg·g <sup>-1</sup> ) | Maximum removal rate% |   | pH               | Specific surface area<br>(m <sup>2</sup> ·g <sup>-1</sup> ) | Total pore volume<br>(cm <sup>3</sup> ·g <sup>-1</sup> ) | Maximum adsorption capacity<br>(mg·g <sup>-1</sup> ) | Maximum removal rate% |           |
| walnut shell                           | 700                         | metolachlor (herbicide)                            | 7          | 158.67  | 0.22   | 72.99  | 57%                   | illite FeCl <sub>3</sub>  | 7                | 232.77  | 0.29   | 126.72   | 95%                   | [49]      |
| oil palm empty fruit bunch             | 300                         | imazapic (herbicide)                               | 7.14       | 1.46  | —  | increase by 8 %                                      | —                     | chitosan  | 8.14             | 1.19  | —  | increase by 75 %                                     | —                     | [50]      |
| pinus radiata shavings                 | 450                         | isoproturon (herbicide)                            | —          | 166   | 0.0474   | 73.03  | 26.18%                | Al-oxide  | —                | 219   | 0.0681   | 146.054  | 56.72%                | [51]      |
| <i>Moringa oleifera</i> Lam. seed husk | 300                         | atrazine (herbicide)                               | —          | 1.52  | 0.0210   | —  | —                     | nitric acid   | —                | 5.77  | 0.0409   | 10.321   | 33.03%                | [52]      |
| phragmite powders                      | 500                         | glyphosate (herbicide)                             | —          | 8.3   | 0.04   | 200  | 73.42%                | nano CuFe <sub>2</sub> O <sub>4</sub>   | —                | 189.6   | 0.12   | 269.4  | 98.9%                 | [53]      |
| rice husk                              | 700                         | carbofuran (insecticide)                           | 9.87       | 236.74  | 0.05   | 132.87   | 13.29%                | steam activated Ni(NO <sub>3</sub> ) <sub>2</sub> FeCl <sub>3</sub> ZnCl <sub>2</sub> | 10.12            | 251.47  | 0.083  | 160.77   | 16.08%                | [54]      |
| corn stalk                             | 600                         | atrazine (herbicide)                               | 10         | 20.51   | —  | 95.93  | 47.97%                |   | 10               | 14.26   | —  | 143.15   | 71.58%                | [55]      |
| corn straw                             | 300                         | atrazine (herbicide)                               | —          | 6.678   | —  | 31.51  | 38%                   | H <sub>3</sub> PO <sub>4</sub>  | —                | 638.1   | —  | 79.6   | 96%                   | [56]      |
| corn straw                             | 500                         | atrazine (herbicide)                               | 7          | 32.85   | 0.0148   | 1.94   | 60.11%                | KOH   | 7                | 59.23   | 0.0231   | 2.84   | 88%                   | [59]      |
| rice straw                             | 600                         | imidacloprid (insecticide)                         | 8.82       | 220.2   | 0.646  | 0.04   | 77.8%                 | H <sub>3</sub> PO <sub>4</sub>  | 6.93             | 192.3   | 0.161  | 0.05   | 89.5%                 | [60]      |
| corn stalk                             | 600                         | 2,4-dichlorophenoxyacetic acid (2,4-D) (herbicide) | 3.83 ±0.21 | 523.04  | 0.658  | 8.54   | 14.23%                | K <sub>2</sub> CO <sub>3</sub> H <sub>2</sub> SO <sub>4</sub> HNO <sub>3</sub>        | 2.38 ±0.01       | 691.28  | 0.943  | 22.84  | 38.07%                | [61]      |
| tea waste                              | 500                         | imidacloprid (insecticide)                         | 7±0.2      | —   | —  | 3.82   | 62.9%                 | Chitosan AgNO <sub>3</sub>  | 7±0.2            | —   | —  | 5.643  | 93%                   | [64]      |