

**Table S1. Characteristics of biochars and experimental conditions reported in the studies included in this review.**

|     | Feedstock                               | Pyrolysis temperature (°C) | Modification                                                                                | Dose/application rate         | Reference            |
|-----|-----------------------------------------|----------------------------|---------------------------------------------------------------------------------------------|-------------------------------|----------------------|
| 1.  | Swine manure                            | 300 and 700                | NR                                                                                          | 30 g/kg soil (3%, w/w)        | Dai et al. [19]      |
| 2.  | Rice straw                              | 400, 500, 600              | NR                                                                                          | 0.01 g biochar per experiment | Wang et al. [20]     |
| 3.  | Grass, wood                             | 200,300,400, 500,600,700   |                                                                                             | 1 or 4 g/L                    | Klüpfel et al. [21]  |
| 4.  | Pine wood chips                         | 620                        | Particle-size fractionation: <0.5, 1–2, and <4 mm                                           | 1% and 6% (w/w)               | Prodana et al. [22]  |
| 5.  | Cd-enriched rice straw                  | 300, 400, 500, 600         | Separation into macro-, colloidal-, and nano-sized fractions                                | NR                            | Gu et al. [25]       |
| 6.  | Maize straw and peanut hulls            | NR                         | NR                                                                                          | 7,800 kg/ha                   | Ma et al. [26]       |
| 7.  | Maize and wheat straw                   | 450                        | NR                                                                                          | 20 and 40 t dw/ha             | Jílková et al. [27]  |
| 8.  | Corn straw                              | 450                        | NR                                                                                          | 10, 20, 30 t/ha               | Yang et al. [28]     |
| 9.  | Cottonseed husk (30%) + rice husk (70%) | 400                        | NR                                                                                          | 30, 60, 90 Mg/ha              | Ding et al. [29]     |
| 10. | Wheat straw                             | 350-550                    | NR                                                                                          | 10, 20, 40 t/ha               | Bian et al. [33]     |
| 11. | Lychee branches (pruning waste)         | 500                        | NR                                                                                          | 2.5%, 5%, 10%                 | Jun et al. [34]      |
| 12. | Orange peels                            | 240                        | Yes-NaOH treatment + HNO <sub>3</sub> neutralization/dialysis; subsequent functionalization | NR                            | Iannazzo et al. [42] |

|     |                                                                                                       |                                        |                                                                      |                                                                                                   |                               |
|-----|-------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------|
| 13. | <i>Lolium perenne</i> (perennial ryegrass) shoots                                                     | 400                                    | NR                                                                   | 108 mg/45 g soil or loess                                                                         | Kuzyakov et al. [45]          |
| 14. | Corn cob                                                                                              | 230, 369, 416, 562, 600, 796           | NR                                                                   | 0.12% or 1.2% dry weight (4 or 40 t/ha), followed by addition of 2.3% dw (78 t ha <sup>-1</sup> ) | Budai et al. [46]             |
| 15. | <i>Miscanthus giganteus</i> straw                                                                     | 230, 235, 369, 385, 416, 503, 600, 682 | NR                                                                   | 0.12% or 1.2% dry weight (4 or 40 t/ha), followed by addition of 2.3% dw (78 t ha <sup>-1</sup> ) | Budai et al. [46]             |
| 16. | Wheat straw, rice husk                                                                                | 550                                    | NR                                                                   | 0, 5, 10, 15, 20% (w/w)                                                                           | Elliston & Oliver et al. [48] |
| 17. | <i>Fraxinus excelsior</i> , <i>Quercus robur</i> and <i>Fagus sylvatica</i> trunks and large branches | 450                                    | NR                                                                   | 2% (w/w)                                                                                          | Xing et al. [49]              |
| 18. | Pine (woody feedstock)                                                                                | 300                                    | NR                                                                   | 5, 10, 20% (v/v); coarse biochar also at 10% (v/v)                                                | Ravi et al. [51]              |
| 19. | <i>Schima superba</i> litter, <i>Cunninghamia lanceolata</i> litter                                   | 350, 550, 750                          | NR                                                                   | 20 g/kg soil                                                                                      | Lu et al. [52]                |
| 20. | Maize ( <i>Zea mays</i> ) stover, Switchgrass ( <i>Panicum virgatum</i> ),                            | 850                                    | Air-cooled; sieved <2 mm or 2-4 mm; water-doused mixed-size material | 1, 10% (w/w)                                                                                      | Clay et al. [53]              |

|     |                                                  |          |                                                                   |                                             |                                        |
|-----|--------------------------------------------------|----------|-------------------------------------------------------------------|---------------------------------------------|----------------------------------------|
|     | Ponderosa pine ( <i>Pinus ponderosa</i> )        |          |                                                                   |                                             |                                        |
| 21. | Cow bones                                        | 500, 800 | NR                                                                | 2.5, 5, 10% (w/w)                           | Azeem et al. [64]                      |
| 22. | Pig carcass, <i>Platanus orientalis</i> branches | 650      | NR                                                                | 0.5, 1, 2, 4% (w/w)                         | Chen et al. [87]                       |
| 23. | Wheat straw                                      | ~450     | NR                                                                | 5% and 15% (w/w or w/v)                     | Cui et al. [91]                        |
| 24. | Maple residues ( <i>Acer pseudoplatanus</i> )    | 560      | NR                                                                | 10%, 20% of total pot mass                  | Farhangi-Abriz & Torabian et al. [104] |
| 25. | Orange and potato waste                          | 325 ± 5  | Washing with distilled water (deashing)                           | 0.75% (w/w)                                 | Anwar et al. [106]                     |
| 26. | Wood/wood charcoal                               | NR       | Wood vinegar compound liquid (CWVC; charcoal:wood vinegar = 4:1)  | 1, 3, 5% of diet                            | Mekbungwan et al. [111]                |
| 27. | Broadleaf tree wood                              | 300-450  | Wood vinegar adsorbed onto amorphous charcoal carbon powder (1:4) | 10, 30 g/kg diet                            | Mekbungwan et al. [112]                |
| 28. | Maize straw                                      | 450-500  | NR                                                                | 1.3% (w/w)                                  | Tan et al. [121]                       |
| 29. | Alder wood chips                                 | 550      | BMDG (butyrate mono-/diacylglycerides) absorbed onto biochar      | 0.25 mg/mL biochar; BMDG-Biochar 0.75 mg/mL | Fei et al. [124]                       |
| 30. | Beech wood chips, Oak wood chips                 | 600      | NR                                                                | 3 mg/mL biochar-aqueous extract             | Amin et al. [130]                      |
| 31. | Date seeds                                       | 550      | AgNPs combined with biochar                                       | Biochar: IC50; AgNPs: 3 µg/mL               | Abu Hajleh et al. [134]                |

|     |                                                |          |                                                                                                       |                                                  |                         |
|-----|------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------|-------------------------|
| 32. | Willow, sewage sludge, rice husk, oilseed rape | 450-750  | Ball milling to produce nanobiochar                                                                   | NR                                               | Rackiewicz et al. [136] |
| 33. | Tobacco stems                                  | 500      | Ball milling to produce nano-biochar                                                                  | NR                                               | Dong et al. [138]       |
| 34. | Corn straw                                     | 900      | Ag loading during carbonization; subsequent incorporation into porous PVA gel                         | 0.2, 0.3, 0.4, 0.5, 0.6, 0.8, 1.0 g/L p-PVA/C-Ag | Zhao et al. [148]       |
| 35. | Fish scales                                    | 300      | AgNP loading; incorporation into PVA/SA gel beads                                                     | 0.5, 1.0, 1.5, 2.0, 2.5, 3 g/L                   | Xie et al. [150]        |
| 36. | Fish scales                                    | NR       | Nanosilver (AgNP) loading onto fish-scale biochar                                                     | 0.1 g F/C-Ag per well                            | Zhang & He et al. [151] |
| 37. | Corn straw                                     | 500      | Magnetic Fe <sub>3</sub> O <sub>4</sub> loading followed by quaternary phosphonium salt (QPS) loading | 20, 50, 100, 200 mg/L                            | Fu et al. [152]         |
| 38. | Solid digestate                                | NR       | Fe nanoparticle (Fe NP) impregnation                                                                  | 1.0 g/L                                          | Fu et al. [153]         |
| 39. | Mango tree branches/ wood                      | 550      | NR                                                                                                    | 1.5% and 3% of diet (w/w)                        | Emam et al. [170]       |
| 40. | Apple tree wood                                | 650      | NR                                                                                                    | 3% of diet (w/w)                                 | Zhang et al. [171]      |
| 41. | Wood                                           | 300, 700 | NR                                                                                                    | 1% (w/v)                                         | Masiello et al. [182]   |
| 42. | Excess activated sludge                        | 600      | Mg modification; Mg-Fe double-oxide loading                                                           | NR                                               | Zhang et al. [206]      |