**Table S1**. Experimental conditions and products for the oxidationa,b of SBP in water solution at 33 g/L concentration, irradiated and not irradiated with simulated solar light, in the absence and presence of added hydrogen peroxide at 2-3 H2O2/C mole ratio, with and without pH controlc,d. Data for pristine SBP at day 0 and recovered soluble and insoluble products at day 14e:weight (WY, w/w %), and C (CMY) and N (NMY) molar (mol/mol%) yields relative to pristine SBPf, and organic C and N w/w % contentg in recovered materials**.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatmentb** | **pHc** | **KOHd** | **H+/C,d** | **Producte** | **Yields (Y)f** | **Content %g** | **C/N w/w** |
| **grams** | **eq/mol** | **WY** | **CMY**  | **NMY**  | **N**  | **C** |
| **Nr.** | **type** |
| 0 | None | 10 |  |  | SBP |  |  |  | 4.14 | 35.83 | 8.7 |
| 1 | D0 | 9 |  |  | soluble | 73.9 | 79.3 | 80 | 4.50 | 38.69 | 8.6 |
|  |  |  |  |  | insoluble | 3.8 | 2.9 | 3.3 | 3.58 | 28.8 | 7.9 |
|  |  |  |  |  | total | 77.7 | 82.2 | 83.3 |  |  |  |
| 2 | D2  | 5.3 |  |  | soluble | 71.2 | 58.2 | 111 | 6.47 | 29.41 | 4.5 |
|  |  |  |  |  | insoluble | 7.2 | 4.4 | 3.1 | 1.81 | 21.9 | 12.1 |
| 3 | D3 | 4.9 |  |  | soluble | 54.8 | 36.8 | 95 | 7.17 | 23.84 | 3.4 |
|  |  |  |  |  | insoluble | 12.4 | 7.8 | 8.4 | 2.80 | 22.96 | 8.2 |
| 4 | L0 | 9 |  |  | soluble | 85.2 | 91.8 | 91 | 4.44 | 38.77 | 8.8 |
|  |  |  |  |  | insoluble | 3.4 | 2.9 | 3.4 | 4.10 | 30.34 | 7.4 |
| 5 | L2  | 4.9 |  |  | soluble | 65.4 | 53.9 | 109 | 6.91 | 29.68 | 4.3 |
|  |  |  |  |  | insoluble | 13.8 | 8.9 | 8.4 | 2.51 | 23.3 | 9.3 |
| 6 | L3 | 5.1 |  |  | soluble | 51.4 | 35.1 | 96 | 7.70 | 24.47 | 3.2 |
|  |  |  |  |  | insoluble | 15.4 | 9.4 | 6.9 | 1.86 | 22.1 | 11.9 |
| 7 | D0 | 10 | 2 | 0.24 | soluble | 88.5 | 100 | 88 | 2.93 | 27.89 | 10.2 |
|  |  |  |  |  | insoluble | 4.3 | 3.8 | 3.6 | 2.50 | 19.20 | 9.1 |
| 8 | D2  | 10 | 2.8 | 0.33 | soluble | 97.4 | 94.1 | 77 | 2.10 | 19.09 | 10.6 |
|  |  |  |  |  | insoluble | 4.4 | 3.9 | 1.7 | 1.06 | 19.72 | 19.3 |
| 9 | D3 | 10 | 3.3 | 0.40 | soluble | 97.7 | 90.1 | 70 | 1.77 | 16.71 | 11.2 |
|  |  |  |  |  | insoluble | 4.8 | 4.7 | 4.1 | 2.10 | 20.65 | 10.0 |
| 10 | L0  | 10 | 2 | 0.24 | soluble | 95.0 | 100 | 92 | 2.87 | 27.08 | 10.1 |
|  |  |  |  |  | insoluble | 5.3 | 4.3 | 3.7 | 2.07 | 16.44 | 10.1 |
| 11 | L2  | 10 | 2.9 | 0.35 | soluble | 95.9 | 84.7 | 67 | 1.82 | 17.06 | 11.0 |
|  |  |  |  |  | insoluble | 4.9 | 4.4 | 3.2 | 1.72 | 19.76 | 11.9 |
| 12 | L3 | 10 | 3.3 | 0.40 | soluble | 107 | 98.4 | 74 | 1.74 | 16.92 | 11.5 |
|  |  |  |  |  | insoluble | 5.2 | 4.8 | 3.5 | 1.71 | 19.21 | 11.6 |

aSee section 4 for details. b Nr (treatment number), D (dark, no irradiation); L (simulated solar light irradiation); Di and Li, i = 0, 2-3 H2O2/C mole ratio. cFinal pH after 14 days treatment; starting pH was 10 at day 0 for all treatments. dAdded KOH (g) to keep pH 10 constant and corresponding acid equivalents produced per pristine organic C mole (H+/C eq/mol). e Pristine SBP at day 0, and recovered soluble and insoluble product at day 14). fWY, CMY and NMY (% weight, molar C and N yields, respectively, relative to pristine SBP). gWeight % content of C and N in product. Data for treatment 0-none are for the pristine SBP solution at day 0

**Table S2**. C mole % recoveriesa accounted for by molecular weight fractions (MWF)b isolated by sequential membrane ultrafiltration in the SBP treatmentsc listed in Table S1.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| MWFb | 1-D0 | 2-D2 | 3-D3 | 4-L0 | 5-L2 | 6-L3 | 7-D0 | 8-D2 | 9-D3 | 10-L0 | 11-L2 | 12-L3 |
| R750 | 4.2 | 13.5 |  | 4.0 |  |  | 30.0 | 7.9 | 12.6 | 0.5 | 4.3 | 10.0 |
| R150 | 46.0 | 20.1 | 1.0 | 1.9 | 5.0 | 0.7 | 6.5 | 8.6 |  | 0.5 |  |  |
| R50 |  |  | 0.6 |  |  |  | 1.3 | 0.5 |  | 14.2 | 5.7 |  |
| R20 |  |  | 0.8 | 68.7 |  | 0.9 | 11.6 | 6.6 | 3.0 | 33.5 |  | 12.1 |
| R5 |  |  |  | 0.1 |  | 2.0 |  |  |  |  |  | 2.7 |
| R0.2 |  |  | 7.2 | 0.1 | 41.3 |  | 11.7 | 16.0 | 16.0 | 17.8 | 1.2 | 19 |
| P0.2 | 28.3 | 28.6 | 26.9 | 10.4 | 3.4 | 26.0 | 14.8 | 24.7 | 30.1 | 11.4 | 34.7 | 22.2 |
| P0.2+R0.2d | 36 | 46 | 93 | 12.3 | 89.9 | 87.8 | 34.9 | 63.2 | 74.7 | 37.4 | 78.2 | 62.4 |

aData are referred to the carbon in the pristine SBP yielding the products in the different treatments in Table S1. bRi (i=750-0.2) retentates and P0.2 permeate fractions containing molecules in the following molecular weight ranges: over 750 kDa for R750, from 750 to 150 kDa for R150, from 150 to 100 kDa for R100, from 100 to 50 kDa for R50, from 50 to 30 kDa for R30, from 30 to 20 kDa for R20, from 20 to 5 kDa for R5, from 5 to 0.2 kDa for R0.2, below 0.2 kDa for P0.2. cTreatments identified as in Table 1. d Total C recovered with the R0.2 and P0.2 fractions as % of total C recovered with all fractions.

**Table S3**. Chemical composition and property data for molecular weight fractions of SBPox described in Table 1 and above subsections 2.1-2.3: C and N content (w/w %), C/N w/w ratio, and surface tension (, mN m-1) and colour for aqueous solutions containing 2 g L-1 added products.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treatment****Nr-typea** | **Fraction** | **C, %**  | **N, %**  | **C/N**  |  **, mN m-1** | **Color** |
| 1-D0 | R750 | 33.9 | 3.73 | 9.1 |  |  |
|  | R150 | 41.5 | 4.93 | 8.4 | 69.0±0.047 | Dark brown |
|  | P0.2 | 38.9 | 4.67 | 8.3 |  |  |
| 2-D 2  | R750 | 25.1 | 2.12 | 11.9 |  |  |
|  | R150 | 35.3 | 5.35 | 6.6 | 65.0±0.54 | Dark brown |
|  | P0.2 | 50.7 | 5.07 | 10.0 |  |  |
| 3-D3 | R150 | 44.2 | 5.59 | 7.9 |  |  |
|  | R50 | 39.0 | 7.75 | 8.2 |  |  |
|  | R20 | 44.3 | 5.14 | 8.6 |  |  |
|  | R0.2 | 27.3 | 5.21 | 5.2 |  |  |
|  | P0.2 | 22.4 | 6.73 | 3.3 |  |  |
| 4-L0 | R750 | 38.84 | 4.62 | 8.4 |  |  |
|  | R150 | 37.71 | 4.45 | 8.5 |  |  |
|  | R20 | 39.80 | 4.70 | 8.5 | 55.6±1.7 | Beige |
|  | R5 | 31.07 | 3.77 | 8.2 |  |  |
|  | R0.2 | 32.54 | 4.16 | 7.8 |  |  |
|  | P0.2 | 21.8 | 1.97 | 11.1 |  |  |
| 5-L2 | R150 | 36.5 | 5.33 | 6.9 |  |  |
|  | R0.2 | 27.3 | 4.14 | 6.6 |  |  |
|  | P0.2 | 20.4 | 1.51 | 13.6 |  |  |
| 6-L3 | R150 | 37.95 | 4.07 | 9.3 |  |  |
|  | R20 | 14.26 | 0.56 | 25.7 |  |  |
|  | R5 | 24.1 | 4.30 | 5.6 |  |  |
|  | P0.2 | 21.4 | 4.84 | 4.4 |  |  |
| 7-D0 | R750 | 38.1 | 4.41 | 8.7 | 63.9±0.48 | Dark brown |
|  | R150 | 37.9 | 4.56 | 8.3 | 65.2±0.049 | Dark brown |
|  | R50 | 34.6 | 4.08 | 8.5 |  |  |
|  | R20 | 40.3 | 4.90 | 8.2 |  |  |
|  | R0.2 | 38.2 | 4.67 | 8.2 |  |  |
|  | P0.2 | 14.2 | 0.59 | 25.0 |  |  |
| 8-D2 | R750 | 31.4 | 3.36 | 9.4 |  |  |
|  | R150 | 35.2 | 4.52 | 7.8 |  |  |
|  | R50 | 27.4 | 2.91 | 9.4 |  |  |
|  | R20 | 38.0 | 5.22 | 7.3 |  |  |
|  | R0.2 | 33.9 | 4.29 | 7.9 |  |  |
|  | P0.2 | 13.3 | 0.68 | 19.7 |  |  |
| 9-D3 | R750 | 32.1 | 3.75 | 8.6 | 52.4±0.16 |  |
|  | R20 | 32.4 | 4.24 | 7.6 |  |  |
|  | R0.2 | 33.0 | 4.34 | 7.6 |  |  |
|  | P0.2 | 13.2 | 0.79 | 17.3 |  |  |
| 10-L0 | R750 | 22.1 | 2.09 | 10.6 |  |  |
|  | R150 | 30.7 | 3.46 | 9.0 |  |  |
|  | R50 | 39.9 | 4.75 | 8.4 | 63.1±0.005 |  |
|  | R20 | 39.2 | 4.69 | 8.4 | 64.0±0.45 |  |
|  | R0.2 | 36.5 | 4.30 | 8.5 |  |  |
|  | P0.2 | 10.1 | 0.31 | 32.4 |  |  |
| 11-L2 | R750 | 26.3 | 2.52 | 10.5 |  |  |
|  | R50 | 31.3 | 3.92 | 8.0 |  |  |
|  | R0.2 | 34.6 | 4.27 | 8.2 |  |  |
|  | P0.2 | 15.0 | 1.11 | 13.5 |  |  |
| 12-L3 | R750 | 26.0 | 2.71 | 9.6 | 53.5±0.068 |  |
|  | R20 | 34.3 | 4.39 | 7.8 |  |  |
|  | R5 | 30.1 | 4.17 | 7.2 |  |  |
|  | R0.2 | 31.6 | 4.04 | 7.8 |  |  |
|  | P0.2 | 10.5 | 0.64 | 16.7 |  |  |
| 13-D0 | R750 | 42.4 | 6.13 | 6.9 | 54.1±0.22 | Light brown |
|  | R20 | 44.2 | 6.70 | 6.6 |  |  |
|  | R0.2 | 36.6 | 6.86 | 5.3 |  |  |
|  | P0.2 | 16.3 | 1.85 | 8.8 |  |  |
| 14-D0.5  | R20 | 41.9 | 4.57 | 9.2 | 45.9±0.056 | Yellow |
|  | R0.2 | 38.3 | 7.76 | 5.0 |  |  |
|  | P0.2 | 16.5 | 1.70 | 9.7 |  |  |
| 15-L0 | R750 | 41.2 | 6.12 | 6.7 | 55.0±.0.008 | Brown |
|  | R150 | 39.9 | 6.66 | 6.0 | 57.4±0.01 | Yellow |
|  | R20 | 8.71 | 0.66 | 13.3 |  |  |
|  | P0.2 | 10.3 | 0.21 | 49.0 |  |  |
| 16-L0.5 | R150 | 38.8 | 5.23 | 7.5 | 48.8±0.20 | Pale yellow |
|  | R20 | 40.3 | 5.53 | 7.3 | 48.3±0.029 | Brown |
|  | R5 | 33.7 | 4.95 | 6.8 |  |  |
|  | P0.2 | 19.9 | 2.25 | 8.9 |  |  |
| 17-D0.1 | R750 | 43.1 | 5.25 | 8.2 | 51.0±0.12 | Light brown |
|  | R150 | 42.5 | 7.22 | 5.9 |  |  |
|  | R50 | 41.9 | 7.13 | 5.9 | 59.0±0.83 | Brown |
|  | R5 | 40.2 | 7.08 | 5.7 |  |  |
|  | P0.2 | 22.1 | 2.99 | 7.4 |  |  |
| 18-D0.25  | R750 | 41.3 | 5.11 | 8.1 | 49.4±0.12 | Beige |
|  | R150 | 37.6 | 9.31 | 4.0 | 54.6±0.89 | Pale Yellow |
|  | R50 | 41.8 | 8.56 | 4.9 | 64.1±0.17 | Brown |
|  | R20 | 41.4 | 7.75 | 5.3 |  |  |
|  | R0.2 | 15.2 | 0.49 | 31.2 |  |  |
|  | P0.2 | 19.9 | 2.58 | 7.7 |  |  |
| 19-D0.5 | R750 | 43.1 | 3.97 | 10.9 | 47.1±0.018 | Pale yellow |
|  | R150 | 42.0 | 6.46 | 6.5 | 62.7±0.50 | Light browm |
|  | R50 | 40.8 | 7.28 | 5.6 | 60.1±0.035 | Beige |
|  | R0.2 | 14.5 | 0.73 | 20.1 |  |  |
|  | P0.2 | 10.7 | 0.55 | 19.4 |  |  |

aLegends for treatments and fractions as in Table 1 and 3, and in Figure 1. Abbreviations for treatment 13 through 19 not reported in Table 1 have the same meaning: i.e.the treatment number followed by D or L indicates in the absence or presence of irradiation, respectively; the number after D and L indicats the added H2O2/C mole ratio.

**Table S4.** Surface tension values (mN m-1) in Table 4 and Figure 2 and mean values for50, 5060, 60 groups.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Treata** | **Rib** |  **** | **Rib** |  **** | **Rib** |  **** |
| 1-D0 | R150 | 69.0 |  |  |  |  |
| 2-D0 | R150 | 65.0 |  |  |  |  |
| 4-L0 |  |  | R20 | 55.6 |  |  |
| 7-D0 | R750 | 63.9 |  |  |  |  |
| 7-D0 | R150 | 65.2 |  |  |  |  |
| 9-D3 |  |  | R750 | 52.4 |  |  |
| 10-L0 | R50 | 63.1 |  |  |  |  |
| 10-L0 | R20 | 64.0 |  |  |  |  |
| 12-L3 |  |  | R750 | 53.5 |  |  |
| 13-D0 |  |  | R750 | 54.1 |  |  |
| 14-D0.5 |  |  |  |  | R20 | 45.9 |
| 15-L0 |  |  | R750 | 55.0 |  |  |
| 15-L0 |  |  | R150 | 57.4 |  |  |
| 16-L0.5 |  |  |  |  | R150 | 48.8 |
| 16-L0.5 |  |  |  |  | R20 | 48.3 |
| 17-D0.1 |  |  | R750 | 51.0 |  |  |
| 17-D0.1 |  |  | R50 | 59.0 |  |  |
| 18-D0.25 | R50 | 64.1 | R150 | 54.6 | R750 | 49.4 |
| 19-D0.5 | R150 | 62.7 |  |  | R750 | 47.1 |
| 19-D0.5 | R50 | 60.1 |  |  |  |  |
| Nc |  | 9 |  | 9 |  | 5 |
| Meand |  | 64.1 a |  | 54.7 b |  | 47.9 c |
| Stdd |  | 2.4 |  | 2.6 |  | 1.4 |

aTreatment and bRetentate (Table 1 and 4). cNumber of data points. dValues with different letters are significantly different at P *<*0.01 level; e.g., a > b > c. eStandard deviation.