

*Research article*

## **Removal of cobalt and copper from aqueous solutions with sulfonated fruit waste**

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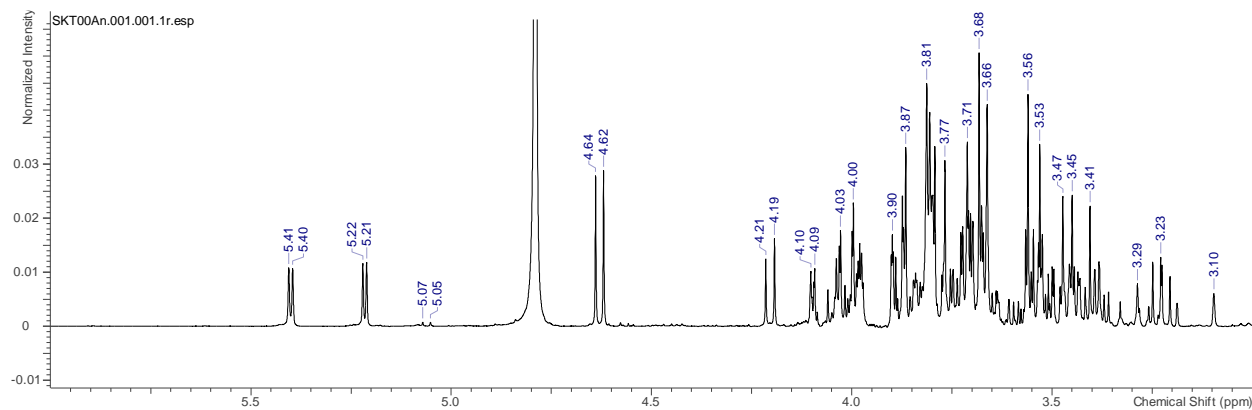
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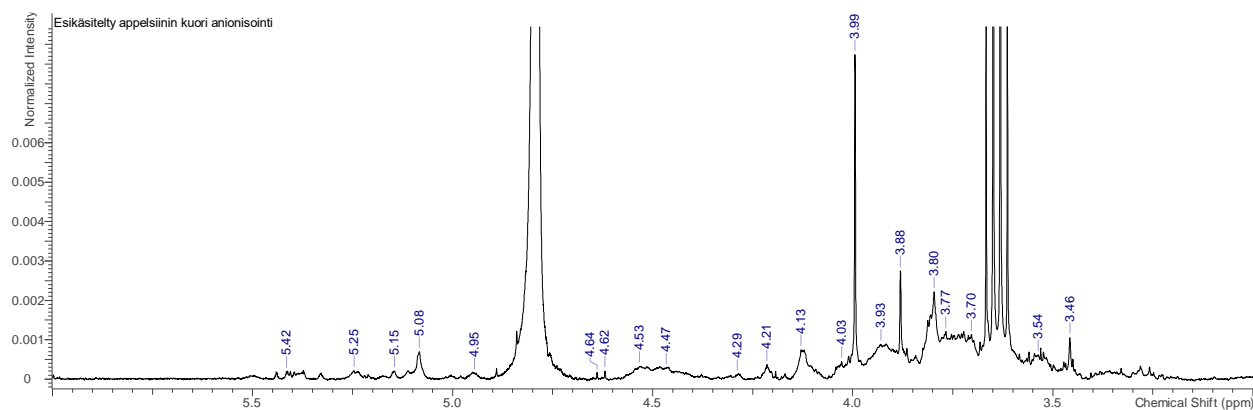
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## **Supplementary**

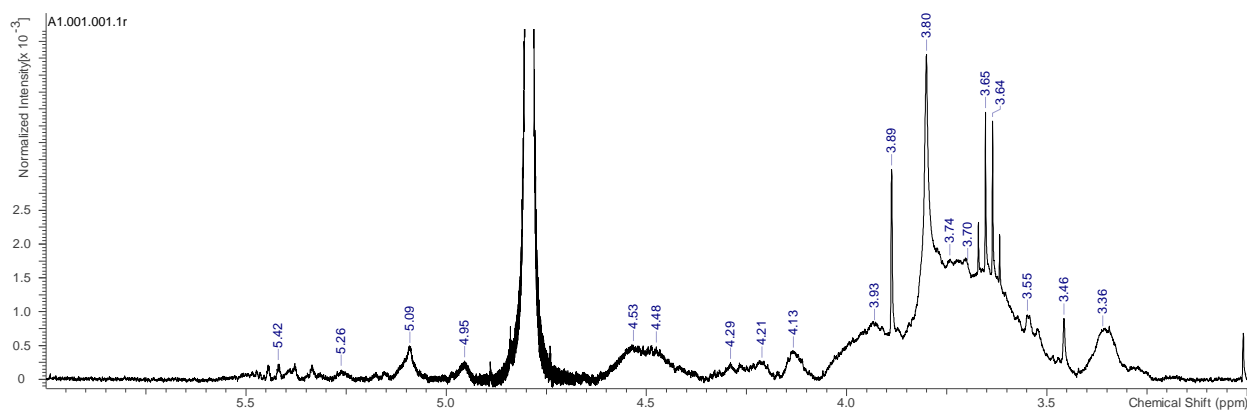
$^1\text{H}$  NMR spectra of the orange peel waste sulfonation reaction products as well as the spectrum of unmodified and pretreated orange peel waste:



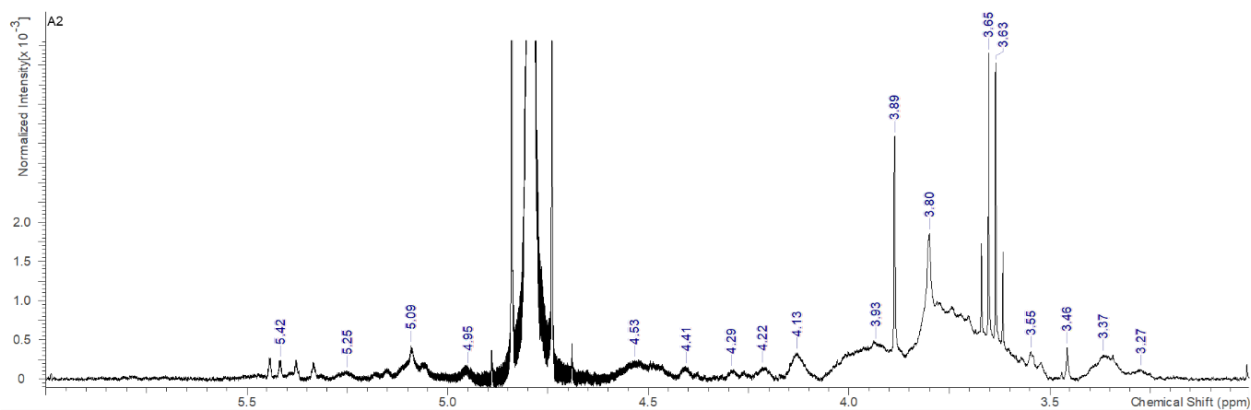
**Figure S1.**  $^1\text{H}$  NMR spectrum of unmodified orange peel waste.



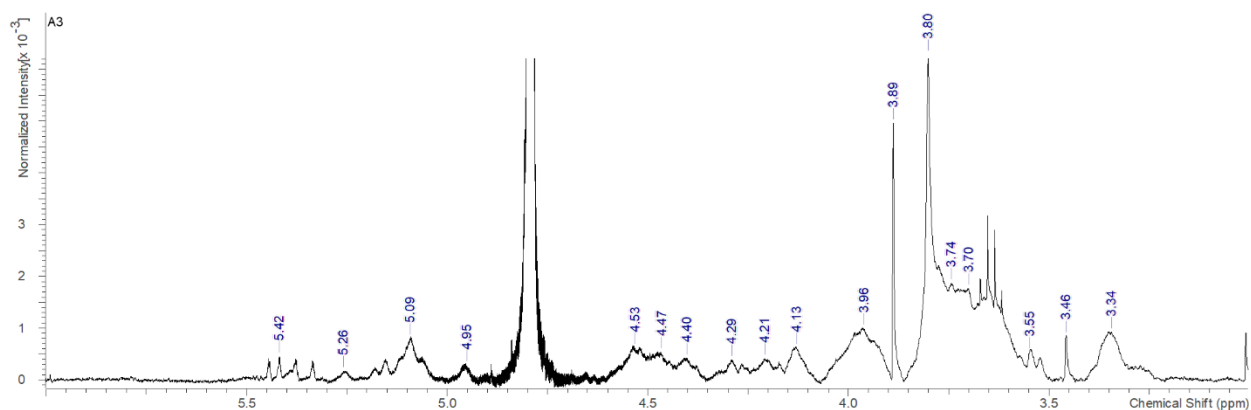
**Figure S2.**  $^1\text{H}$  NMR spectrum of orange peel waste pretreated in ionic liquid.



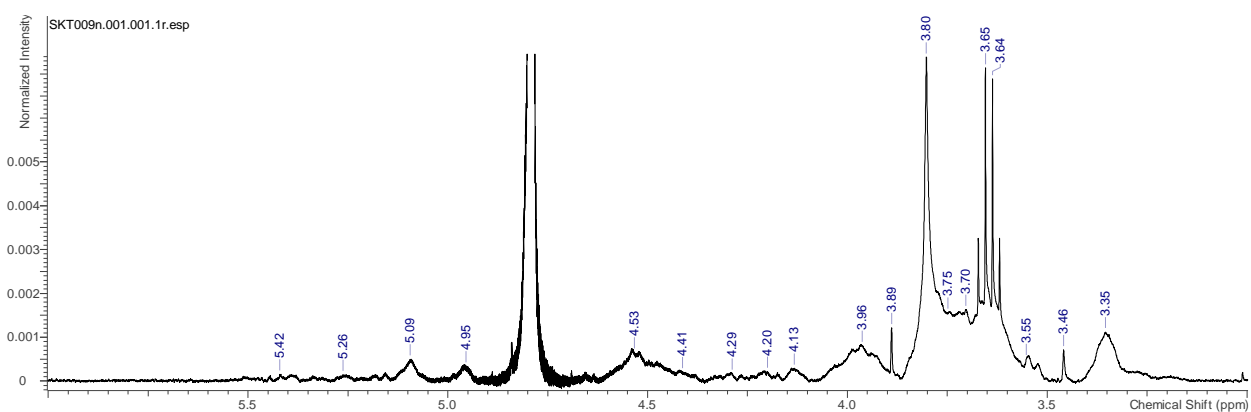
**Figure S3.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 1.5:1, 60 min, 30 °C).



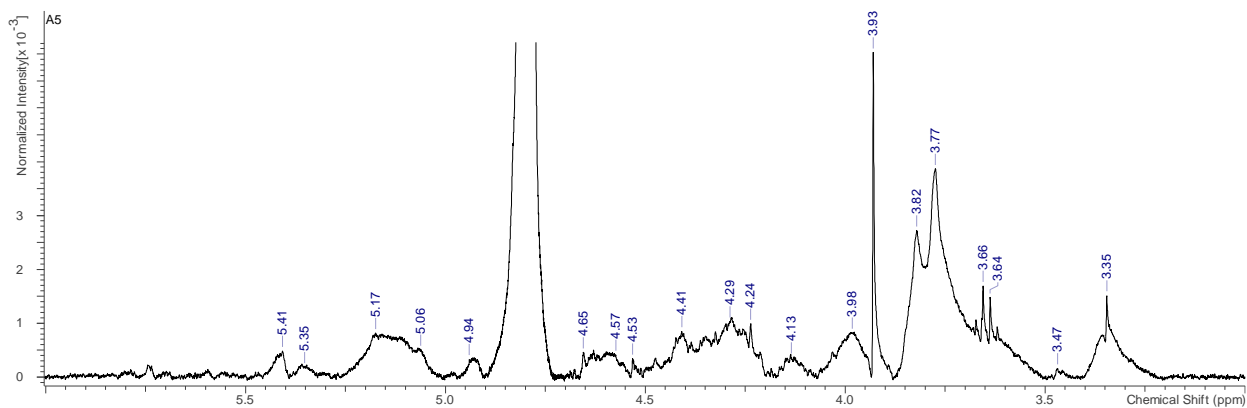
**Figure S4.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 1.5:1, 120 min, 30 °C).



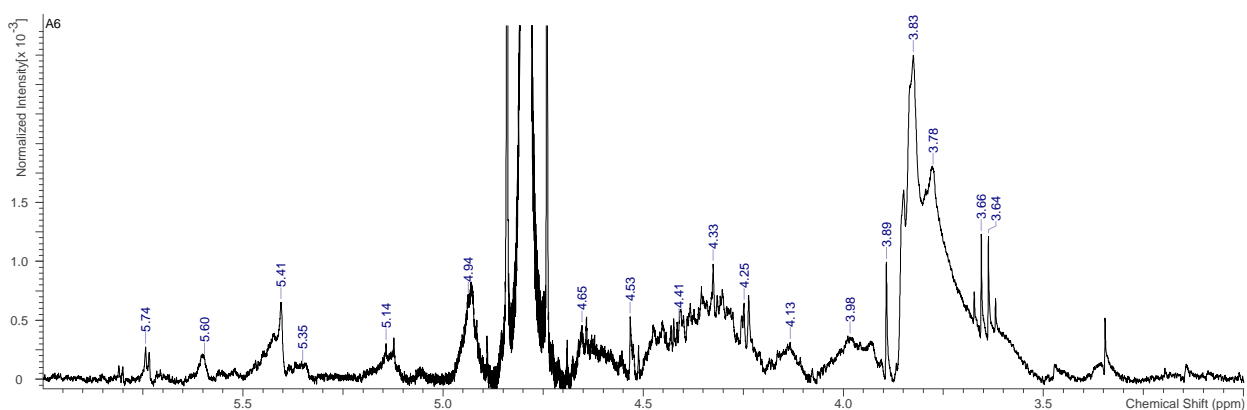
**Figure S5.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 1.5:1, 60 min, 70 °C).



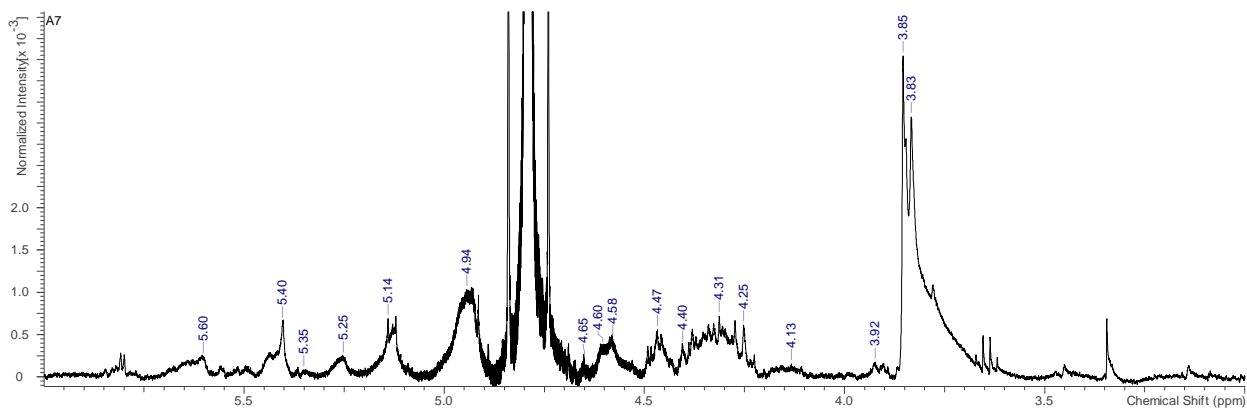
**Figure S6.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 1.5:1, 120 min, 70 °C).



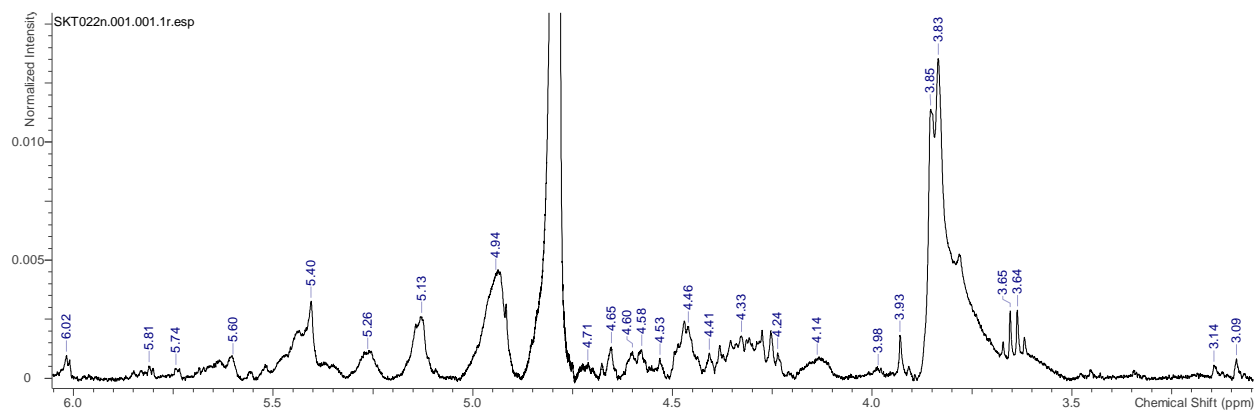
**Figure S7.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 5:1, 60 min, 30 °C).



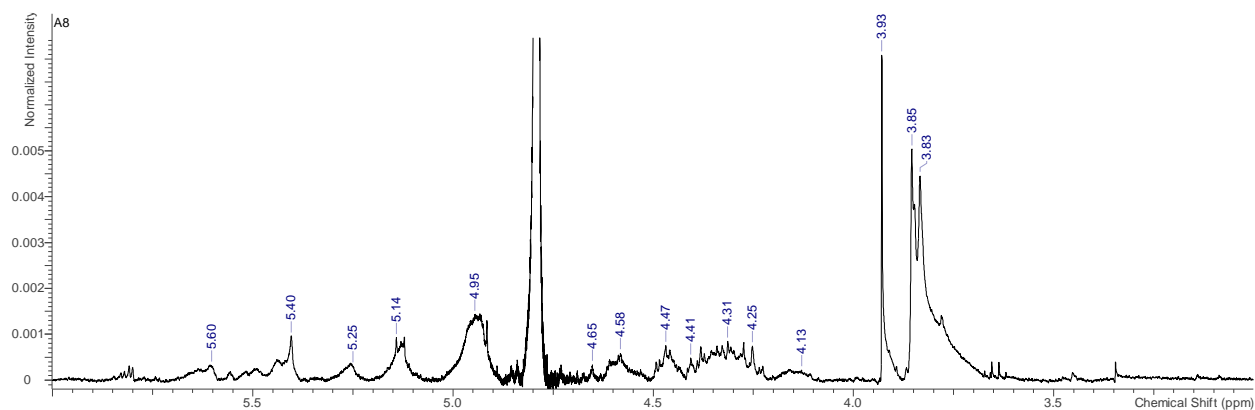
**Figure S8.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 5:1, 120 min, 30 °C).



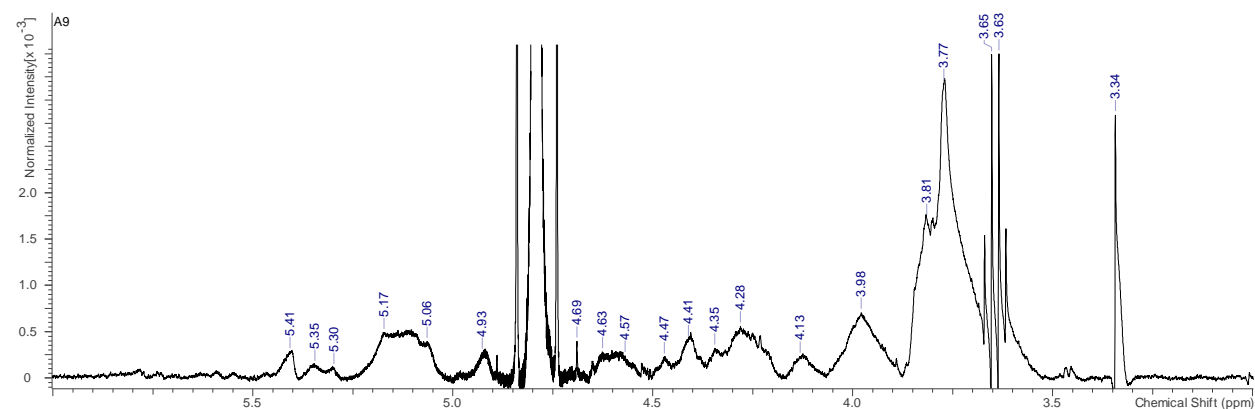
**Figure S9.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 5:1, 60 min, 70 °C).



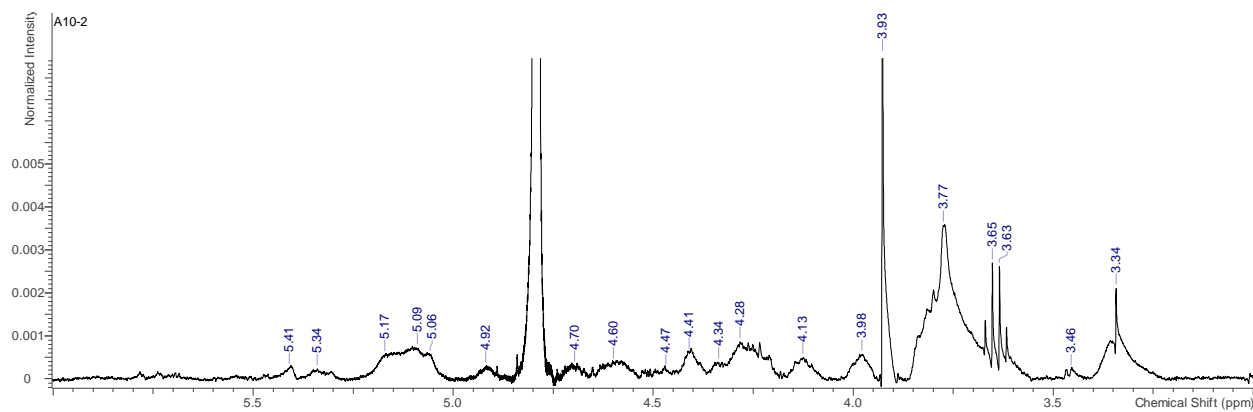
**Figure S10.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 5:1, 60 min, 70 °C). Reaction was scaled-up 8 times.



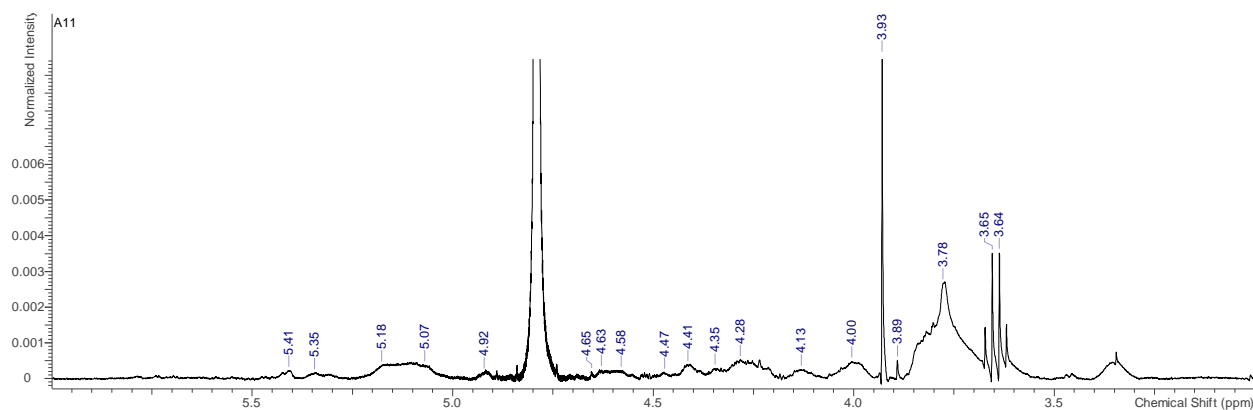
**Figure S11.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 5:1, 120 min, 70 °C).



**Figure S12.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 3.25:1, 90 min, 50 °C).



**Figure S13.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 3.25:1, 90 min, 50 °C). Same reaction as in Figure S12 repeated.



**Figure S14.**  $^1\text{H}$  NMR spectrum of sulfonated orange peel waste (reagent to AGU 3.25:1, 90 min, 50 °C). Same reaction as in Figures S12 and S13 repeated.



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