Supporting information

**Surface Activity of Humic Acid and Its Sub-fractions from Forest Soil**

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Figure captions

**Figure S1.** Relationships between CMC and percentage of alkyl C, O-alkyl C, aromatic C and carbonyl C base on 13C NMR of HA and its sub-fractions: CMC vs. alkyl C (┄), CMC vs. O-alkyl C (┄), CMC vs. aromatic C (┄), CMC vs. carbonyl C (┄).

**Figure S2.** Effect of concentration on Zeta potential for HA.

**Figure S3.** Intensity-base PSDs of HA and its sub-fractions (a. HA1; b. HA2; c. HA3; d. HA4; e. HA5; f. HA6; g. HA).

**Figure S4.** Volume-base PSDs of HA and its sub-fractions (a. HA1; b. HA2; c. HA3; d. HA4; e. HA5; f. HA6; g. HA).

Figure S5. Gaussian peak distribution of Number PSDs for six HA sub-fractions at concentrations of 2000 mg·L-1, pH = 6.86 (■ HA1; ■ HA2; ■ HA3; ■ HA4; ■ HA5; ■ HA6).

Table captions

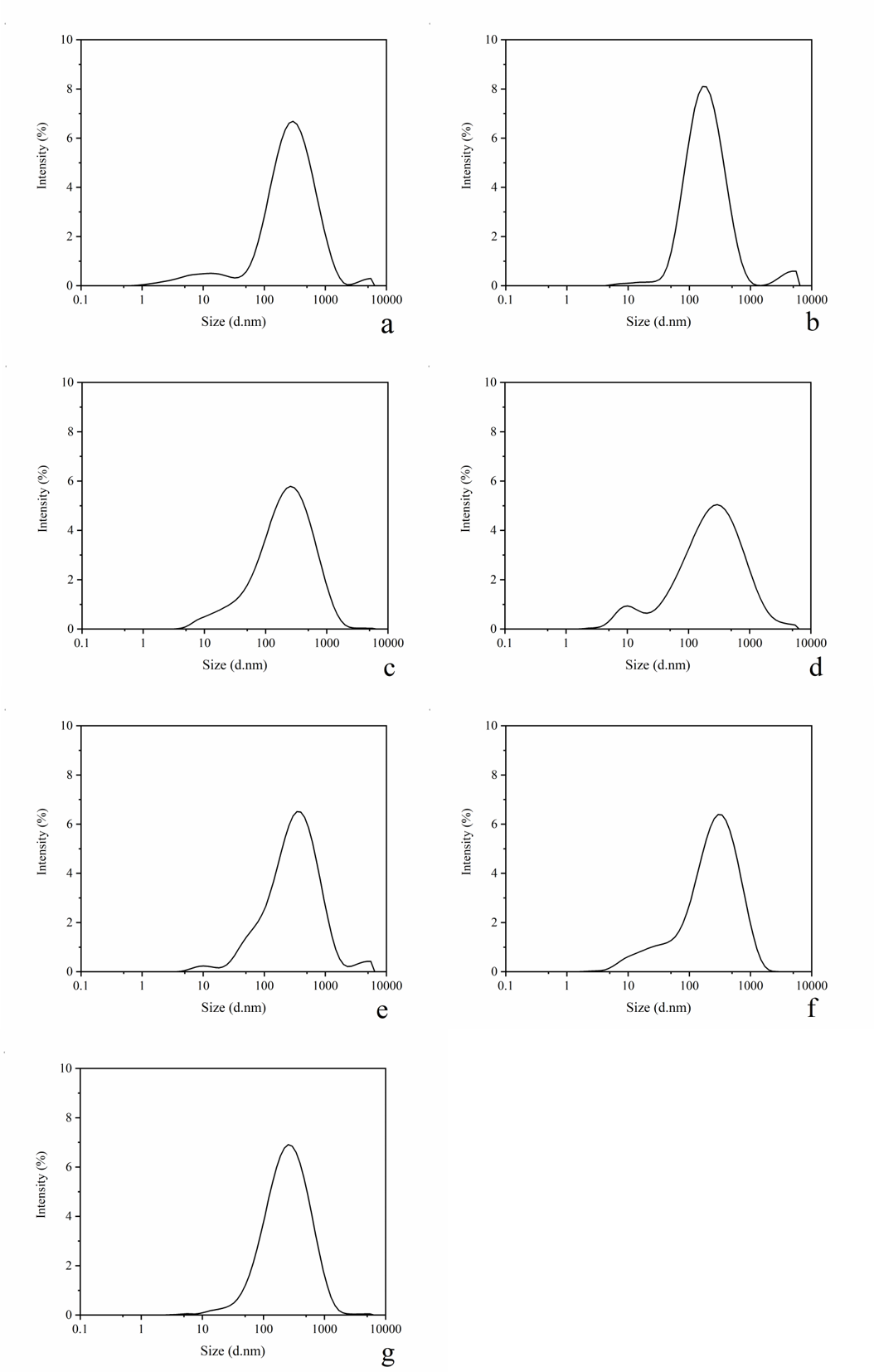
**Table S1.** Multiple linear equations obtained by previous researchers.



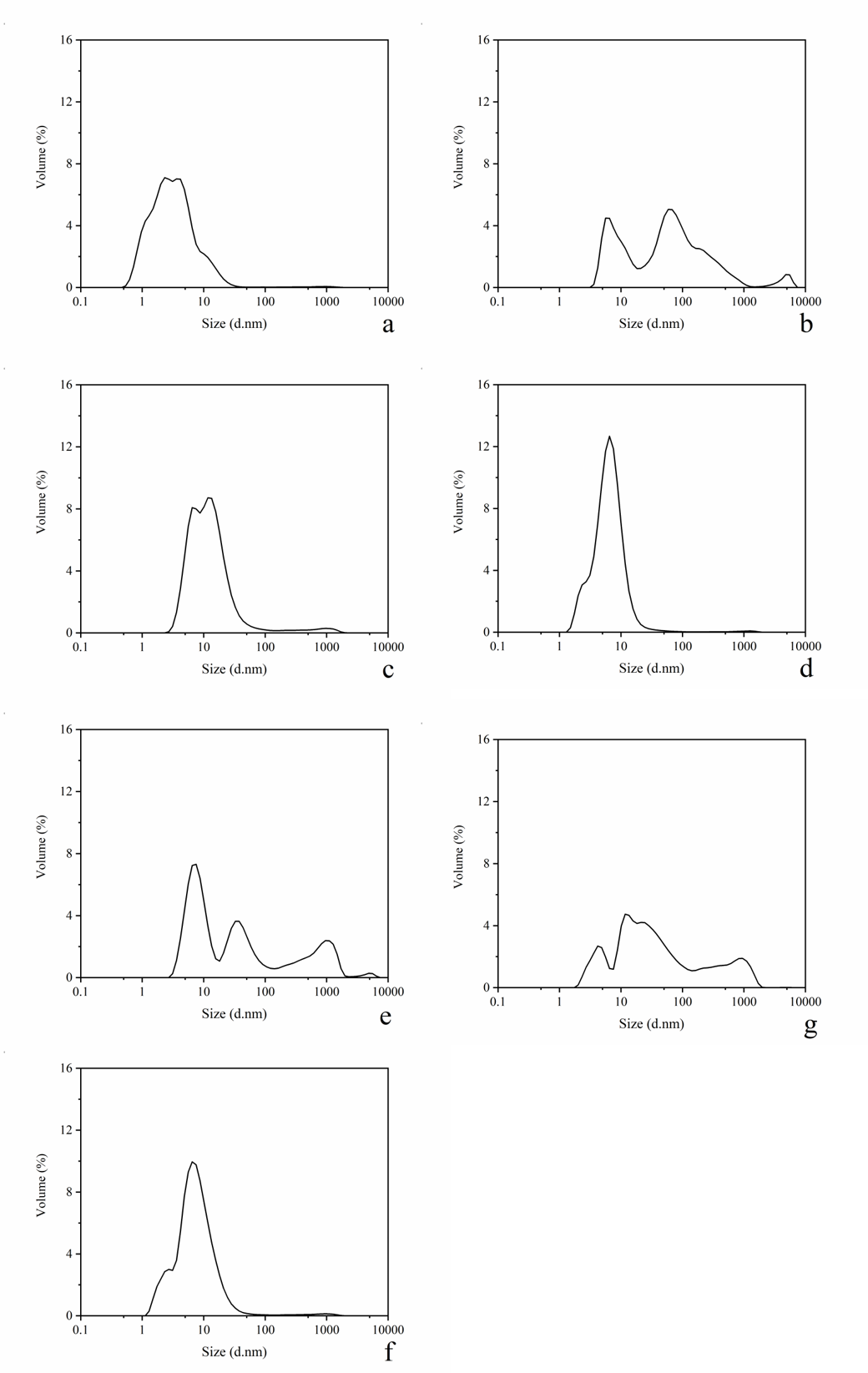
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**Figure S2.** Effect of concentration on Zeta potential for HA.



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Figure S5. Gaussian peak distribution of Number PSDs for six HA sub-fractions at concentrations of 2000 mg·L-1, pH = 6.86 (■ HA1; ■ HA2; ■ HA3; ■ HA4; ■ HA5; ■ HA6).

**Table S1.** Multiple linear equations obtained by previous researchers

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Equation | n | R2 | *p* | ref |
| S1 | CMC = 24.6–0.189×alkyl-C–2.64(N+S) | 6 | 0.770 | <0.1 | Quadri, et al. [1] |
| S2 | CMC = 12,246–56.19×alkyl-C–0.532×MW | 7 | 0.900 | <0.05 | Adani, et al. [2] |
| S3 | CMC = 8565–(22.1×H)–(146×alkyl-C)–(176×aromatic-C)+1877×HB/HI | 13 | 0.878 | <0.0001 | Salati, et al. [3] |

References

1. Quadri, G.; Chen, X.; Jawitz, J. W.; Tambone, F.; Genevini, P.; Faoro, F.; Adani, F., Biobased surfactant-like molecules from organic wastes: the effect of waste composition and composting process on surfactant properties and on the ability to solubilize tetrachloroethene (PCE). *Environmental Science & Technology* **2008,** *42*, (7), 2618-2623. https://doi.org/10.1021/es702144t.

2. Adani, F.; Tambone, F.; Davoli, E.; Scaglia, B., Surfactant properties and tetrachloroethene (PCE) solubilisation ability of humic acid-like substances extracted from maize plant and from organic wastes: A comparative study. *Chemosphere* **2010,** *78*, (8), 1017-1022. https://doi.org/10.1016/j.chemosphere.2009.11.039.

3. Salati, S.; Papa, G.; Adani, F., Perspective on the use of humic acids from biomass as natural surfactants for industrial applications. *Biotechnology Advances* **2011,** *29*, (6), 913-22. https://doi.org/10.1016/j.biotechadv.2011.07.012.