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The role of humic acid in stabilizing fullerene (C_{60}) suspension

Key words: Fullerene, Humic acid (HA), Colloidal stability, Natural organic matter (NOM), Nanomaterial

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- With its widespread production and usage, C_{60} is inevitably released into the aquatic environment and may thus threaten aquatic organisms and human health as well through food chains

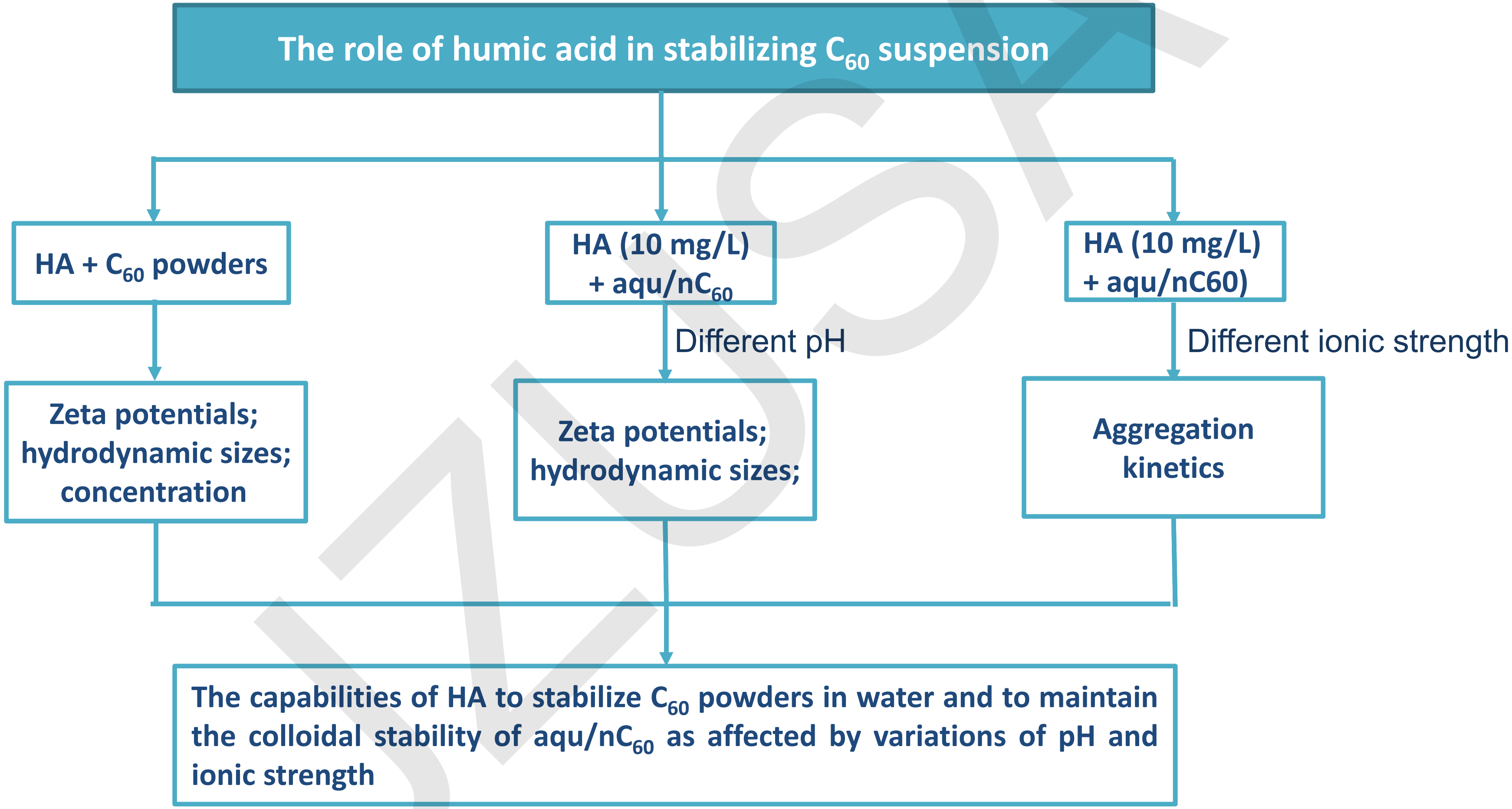
- It is essential to take into account the interactions between NOM (HA as a model NOM) and nC_{60} when elucidating the behavior of nC_{60} in natural water bodies.

- Environmental conditions (e.g., water quality parameters) may have profound effects on the interaction between HA and nC_{60}, which has not been well examined.

- Water quality parameters such as ionic strength and pH can likely have a significant effect on the colloidal stability of nC_{60} in the presence of HA, which merits further investigation.

- The changes in zeta potentials and hydrodynamic sizes of the C_{60} powders and the nC_{60} suspension (aqu/nC_{60}) under various pHs and the impact of ionic strength on the aggregation kinetics of the aqu/nC_{60} in the absence and presence of HA were specifically examined to investigate the capabilities of HA to disperse and stabilize C_{60} powders in water and to maintain the colloidal stability of aqu/nC_{60} as affected by variations of pH and ionic strength.

METHOD



The role of humic acid in stabilizing C_{60} suspension
HA + C_{60} powders
HA (10 mg/L) + aqu/nC_{60}
HA (10 mg/L) + aqu/nC60)
Different pH
Different ionic strength
Zeta potentials; hydrodynamic sizes; concentration
Zeta potentials; hydrodynamic sizes;
Aggregation kinetics
The capabilities of HA to stabilize C_{60} powders in water and to maintain the colloidal stability of aqu/nC_{60} as affected by variations of pH and ionic strength

RESULTS AND CONLUSIONS

- The electronegativity of C_{60} powders in the presence of HA increased with increasing the HA concentration and the hydrodynamic sizes decreased with increasing the HA concentration, suggesting that HA could disperse the C_{60} powders to some degree in water. However, concentration of the C_{60}-HA suspensions decreased with increasing settling time, indicating HA was unable to stably suspend C_{60} powders.

- The aqu/nC_{60} could remain stable at pH>4 but was destabilized at lower pH ratings. However, the colloidal stability of aqu/n C_{60} in the presence of HA was insensitive to pH from 3 to 11, owing to the HA adsorption on the nC_{60} and its increased electrosteric repulsions among the nC_{60} aggregates.

- The colloidal stability of aqu/nC_{60} with and without HA decreased as we increased the valence and concentration of the added cations. The HA was found to mitigate the destabilization effect of Na^{+} on the colloidal stability of aqu/nC_{60} by increasing the critical coagulation concentration (CCC) of Na^{+}, while it lowered the CCCs of Ca^{2+} and La^{3+} probably owing to the bridging effect of nC_{60} with the HA aggregates formed through the intermolecular bridging of the HA macromolecules via cation complexation at high concentrations of cations with high valences.

- In conclusion, the C_{60} powders could be dispersed to some degree but hardly be stably suspended in the presence of HA. Low pH and high ionic strength would affect the colloidal stability of aqu/nC60. Big aggregates formed at pH <4, owing to the screening of surface charges of the aqu/nC_{60} at such low pHs. However, the colloidal stability of aqu/nC_{60} in the presence of HA was insensitive to pH from 3 to 11. It was supposed that HA could adsorb on the surfaces of nC_{60} and the surface-bound HA increased surface electronegativity of the nC_{60} and thereby mitigated the aggregation through electrosteric repulsion at low pHs. Cation valence and concentration had a profound effect on the destabilization of the aqu/nC60 suspension. The CCCs of Na^{+}, Ca^{2+} and La^{3+} in the presence and absence of HA were exponentially decreased with the increase in cationic valence. The presence of HA could mitigate the impact of Na^{+} on the colloidal stability of aqu/nC_{60}, but enhanced the destabilization effect of Ca^{2+} and La^{3+} on the aqu/C_{60}.