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Communication

A rapid method for the detection of humic acid based on the poly(thymine)-templated copper nanoparticles

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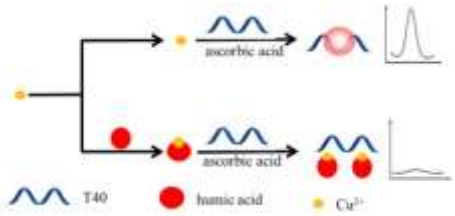
Graphical Abstract



A label-free fluorescent method for sensitive detection of humic acid based on poly(thymine)-templated copper nanoparticles is reported.

ABSTRACT
This work described a new method for the detection of humic acid (HA) based on the poly(thymine) (poly T)-templated copper nanoparticles (CuNPs). Without the presence of HA, the formation of poly T-templated CuNPs could take place, resulting in strong fluorescence emission peaks at 610 nm (upon excitation at 340 nm). On the other hand, when HA was present, strong interaction between HA and Cu^{2+} took place, which then hampered the effective formation of fluorescent CuNPs, leading to the decrease in fluorescence intensity. Furthermore, under the optimal experimental conditions, the method exhibited a high specificity to HA with a detection limit of 0.4 mg/L. This work has demonstrated a low-cost and convenient method that could be accomplished within 10 min. The method could provide a simple, rapid, and sensitive fluorescent platform for the detection of HA.

Keywords:
Label-free
Humic acid
Fluorescence
Copper nanoparticle
Cost-effective

Small organic acids presented in soil and water are those released by plant roots and microorganisms. In addition, they can be decomposition products of natural organic matter (NOM), which plays a very important role in purifying water pollutions and migrating metal ions and organic compounds [1,2]. As the major component of NOM, humic substances, a type of brown or black compound, are reduced by the animal and plant following microbial decomposition and chemical processes [3,4]. The content of humic substances in total NOM is in the range of 50% to 80% in all the soil and water. Humic acid (HA), as a major component of the humic substances, contributes its vital properties to global carbon and nitrogen cycling, the regulation of the mobility, fate of plant nutrients, and environmental contaminants, as well as transformation of trace heavy metals [5]. Because HA contains phenol hydroxide, quinone, and carboxyl functional groups, it can interact with the halogens in drinking water treatment to produce halogenated carcinogens such as chloroform and bromoform [6]. Thus, it is essential to develop a highly sensitive analytical method to determine HA content in water samples.

Numerous analytical instruments and approaches have been applied for HA analysis, including electrochemical methods [7,8], chromatography [9,10], oxygen consumption measurement, flow injection chemiluminescence, UV and fluorometric methods [11]. These methods can help determine concentration of HA in water. For example, Qu and co-workers reported a low-cost method in detection of the HA by using flow-through chemiluminescence. This method however not only needs the special instrumentations but also has cumbersome operational process [12]. Michaowski *et al*., reported a methodology for the determination of HA by flow