



Development of a Colorimetric Sensor for Uric Acid Detection Based on the In situ Formation of a Silver Shell on Gold Nanoparticles

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ABSTRACT

Introduction: Uric acid is one of the primary antioxidant substances in human body fluids. Physiological and pathophysiological conditions may affect the uric acid level in human body. Therefore, the biological monitoring of uric acid is of great importance, and diverse analytical methods, including chromatography, electrochemistry, and spectroscopy methods, have been employed for this purpose. Among these approaches, colorimetric methods have gained attention due to their promising properties. Colorimetric methods are also the preferred choice for biological analysis due to their simplicity, cost-effectiveness, and the possibility of visual detection. In this study, we developed a colorimetric sensor to detect uric acid.

Methods and Materials: Gold nanoparticles (AuNPs) were prepared using standard citrate reduction methods, such as HAuCl₄ and trisodium citrate. For uric acid measurement, 500 μ L of AuNP, 75 μ L buffer (glycine; pH 11.5), an appropriate volume of uric acid standard or sample solution and 400 μ L of AgNO₃ (0.02 M) were added to the test tube, and the resulting mixture was diluted to 2 ml with deionized water. After 10 min incubation at 50 °C, the absorption spectrum of each solution was measured.

Results: The appearance of the specific SPR peak of AuNPs in 520 nm confirmed the formation of AuNPs. The size of spherical AuNPs was determined to be about 15 nm by transmission electron microscopy (TEM) imaging. The applicability of AuNPs was tested to establish a colorimetric sensor for uric acid monitoring based on the in situ formation of an Ag shell on the AuNP by adding uric acid to the experimental solution containing AuNPs and Ag⁺. In the presence of uric acid as a reducing agent, Ag⁺ can be reduced to Ag⁰ on the surface of AuNPs, resulting in Au@AgNPs with a more intense SPR peak. Moreover, a slight blue shift in the SPR peak position of AuNPs was observed at the higher concentration of uric acid, resulting in color variation of the solution from red to orange. This assertion was confirmed with TEM imaging and EDS analysis, which verified the formation of Au@AgNPs.

Conclusion and Discussion: We indicated that the increased SPR peak intensity of AuNPs was proportional to the uric acid concentration. A logarithmic relationship exists between increasing SPR peak intensity of AuNPs and uric acid concentration in the 0.1-10 μ M range. Based on this observation, we established a colorimetric sensor to determine uric acid with a detection limit of 40 nM. The colorimetric sensor was applied to measure uric acid in human urine samples with acceptable results.

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