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**Albumin capped carbon-gold (C-Au) nanocomposite as an optical sensor for the detection of Arsenic(III)**

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**Highlights**

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We have developed BSA capped C-Au composite for the detection of As(III).

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Detection As(III) is confirmed on the [photoluminescence](https://www.sciencedirect.com/topics/materials-science/photoluminescence) quenching of BSA-C-Au composites.

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The developed method can detect the As(III) concentration as low as 0.004 ppb.

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This method can be applied to detect both drinking water and sedimentary As(III).

**Abstract**

A sensitive arsenic (III) (As(III)) detection method based on the fluorescence quenching system using bovine serum albumin (BSA) capped carbon-gold composite (C-Au-BSA) was developed. BSA could attach to the surface of C-Au composite and increase the [photoluminescence](https://www.sciencedirect.com/topics/physics-and-astronomy/photoluminescence) (PL) efficiency, As(III) could combine with BSA and remove it from C-Au composite to decrease the PL efficiency. A linear relationship was observed between (As(III)) concentration and PL quenching at low concentrations (5–50 ppb - for drinking and bore water detection) and high concentrations (100–800 ppb - sedimentary arsenic) of the metal. The limit of detection was more superior (low conc; R2 = 0.96 with sensitivity 0.004 ppb, high conc; R2 = 0.98 with sensitivity 0.0002) when compared to other techniques. Thus, this method can be applied to determine low levels as well as sedimentary levels of As(III).

**Introduction**

Arsenic (As(III)) is ranked first amongst the known toxicants and its contamination in drinking water is a major and serious global problem. It is known to be a poison, a co-carcinogen, and even in lower concentrations has been shown to be susceptible to brain, pitutary and cognitive dysfunction [1,2]. The most serious concern about arsenic is that it can cross the placenta and induce delayed growth and neural tube defects [[3], [4], [5]]. World Health Organization (WHO) has suggested worried that the maximum contamination limit (MCL) for arsenic in drinking water should be 10 ppb. It exists mainly in organic (As(III) and As(V)), and inorganic As(III) forms, however, inorganic As(III) is more stable in the environment. In our body, As(V) can be converted to As(III) by a few reducing agents including vitamin C, therefore, rapid and sensitive analytical methods to detect it in food products, drinking water and the environment are very urgently needed [6].

The present study demonstrates the detection of As(III) from contaminated sources both low as well as high concentrations using carbon nano dots (C-dots) coated gold nanoparticles (Au NPs) in combination with bovine serum albumin (BSA). In general, AuNPs can be synthesized using plant extracts and other biological methods, however, here C-dots were used as reducing and stabilizing agent for the synthesis of AuNPs [[7], [8], [9]]. This method involves two steps namely synthesis of carbon-gold (C-Au) composite followed by capping of BSA on it to form C-Au-BSA complex. In this complex, C-Au and BSA act as the energy donor and the energy acceptor, respectively. The photoluminescence (PL) spectra of this complex (C-Au-BSA) vary in the presence of As (III) and hence can be used to detect the amount of this metal. In this optical sensor, BSA acts as the sensing material. The proposed method can be used to detect the As(III) at low and high concentrations. The possible mechanism of the sensing is also discussed.

**Section snippets**

**Materials**

All the chemicals were of analytical grade and purchased from (Merck, Mumbai and Sigma, Chennai). HeLa cells were purchased from NCCS, Pune, India and were maintained in DMEM medium. Water was collected from the borewell, Velachery (12.9760° N, 80.2212° E), Chennai, India.

*Synthesis of C-dots*: C-dot were synthesized using our previous protocol [10]. In brief, 500 g of *Citrullus lanatus* pulp was added to 500 ml of double distilled (DD) water and ground. The pulp was filtered twice using Whatman

**Results and discussion**

A strong optical absorption in the UV region typically at 280 nm is observed indicating the formation of C-dots (Fig. 1). This is due to the carbon core and is ascribed to π-π\* transition of the aromatic C−C bonds associated with C-dots [11]. These C-dots are used here as the reducing and stabilizing agent for the synthesis of C-Au composite. The formation of the C-Au composite is visually confirmed as the color of the reaction mixture changes from yellow to ruby red. Also, the sharp surface

**Conclusion**

We have investigated the reducing and capping capabilities of *Citrullus lanatus* derived C-dots for the synthesis of the C-Au composite. These composite are capped with the BSA to from C-Au-BSA complex in which BSA acts as the sensing material for the detection of As(III). The PL intensity of C-Au-BSA complex reduces significantly on treatment with As(III) and exhibits a linear behavior at two sets of concentrations (5–50 and 100–800 ppb) of As(III). The developed method can detect As(III) as

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**Conflicts of interest**

Author's declared that they have no interest of conflicts and approved the content of the manuscript.

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