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A novel green technology: Synthesis and characterization of Ag/TiO_2 nanocomposites using *Padina tetrastromatica* (seaweed) extract

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ABSTRACT

Green synthesis of nanoparticles from plants is a field showing growth and popularity in recent times due to eco-friendliness, cost-effectiveness and minimal use of toxic chemicals for synthesis. In the current work, the *Padina tetrastromatica* extract has been employed for the synthesis of Ag/TiO_2 nanocomposites. All the synthesized particles were characterized accordingly, using X-ray diffraction, Fourier trans-form infra-red spectroscopy, Scanning electron microscopy and energy dispersive X-ray analysis. Aqueous extract of seaweed acts a as reducing and capping agent in the formation of nanocomposites. Green synthesized Ag/TiO_2 nanocomposites were of anatase phase and average particles size was 25 ± 4 nm. Biological method for synthesis of nanocomposites using seaweed extract has been recommended as an alternative to physical and chemical methods.

1. Introduction

Green nanotechnology is developing as a rapidly growing field and significant division of nanotechnology. Gold, silver, zinc oxide, platinum, and palladium nanoparticles have been synthesized via green chemistry and eco-friendly approach in the last decade [1]. Green synthesis of nanoparticles employing biological materials could be an enhanced alternative to costly physical methods and toxic chemicals [2]. Plants [3–5], microorganisms [6] algae [7] and/or their extracts provide a biological synthesis route for several metallic nanoparticles which are more cost-effective and allow a controlled synthesis with well-defined size and shape [8]. Previously, green nanocomposites have been synthesized using renewable natural oils [9] and epoxidized Soy bean oil [10]. *Padina tetrastromatica* (brown algae) belongs to Dictyotaceae family and is pre-dominantly present in the coastal areas of India [11]. Mohsin et al. [11] have reported the anti-inflammatory and antioxidant potential of polysaccharides isolated from *P. tetrastromatica*. *Padina* mediated silver nanoparticles have photocatalytic activity and they degraded Congo red and Direct brown 95 [12]. The aim of the present study is to synthesize and characterize Ag/TiO_2 nanocomposites using aqueous extract of seaweed (*P. tetrastromatica*) by green chemistry approach.

2. Materials and methods

2.1. Collection of seaweed and preparation of aqueous extract

Fresh and healthy *P. tetrastromatica* Hauck (BSI/SRC/5/23/2010-11/Tech. 1413) (Brown Seaweed) were collected from Mandapam coastal region (78°8′E, 9°17′N), in Gulf of Mannar, Tamil Nadu, South India. Samples were brought to laboratory in polythene bags and cleaned thoroughly with fresh water to remove adhering debris and associated biota. Samples were cleaned using brush and distilled water for the removal of epiphytes. After cleaning, the samples were dried in shade at room temperature for about a week. 25 g of brown seaweed samples were cut into fine pieces and boiled with 100 mL of sterile double distilled water for 5 mins. The crude extract was then passed through filter paper (Whatman No. 42, Maidstone, England) and the filtrate was stored at 4 °C for further use.

2.2. Green synthesis and characterization of seaweed mediated nanocomposites

The precursor solution was prepared by continuous stirring of 5 mL of titanium (IV) isopropoxide and 50 mL of ethanol for 1 h. To this 1 mM $AgNO_3$ solution with 30 mL of seaweed extract was added drop wise under continuous stirring for 1 h. The control sample: 1 mM $AgNO_3$ solution with 30 mL of water was added drop wise under continuous stirring for 1 h. The mixture of solution obtained was calcinated initially at 110 °C for 1 h and later at

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