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Green synthesis, spectroscopic investigation and photocatalytic activity of lead nanoparticles

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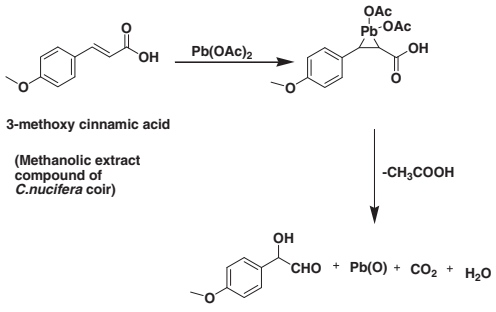
HIGHLIGHTS

- *Cocos nucifera* was utilized for the production of colloidal PbNPs.
- Antibacterial study was evaluated for PbNPs.
- Photocatalytic property was done with malachite green using PbNPs.

GRAPHICAL ABSTRACT

The present study indicates that colloidal lead nanoparticles can be achieved via agricultural waste *cocos nucifera*. Synthesized PbNPs having potent activity and utilized for the photocatalytic activity.



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ABSTRACT

Most of researcher focused their research towards synthesize of nanoparticles by the method of applied chemical method which was one of the costliest method. We have focused cheapest and simplest method for the synthesizing of lead nanoparticles (Pb-NPs) using *cocos nucifera* L extract. The methanolic extract of *cocos nucifera* L was efficiently used as a reducing agent for synthesizing Pb-NPs. On treatment of lead acetate with *cocos nucifera* coir extracts, stable Pb-NPs were formed. The synthesized Pb-NPs were further confirmed by UV–visible spectroscopy, X-ray diffraction (XRD), Transmission electron microscope (TEM) and Energy Dispersive (EDAX) analysis. The secondary metabolites present in methanolic extract which can mainly act as a reducing and capping agents for the formation of Pb-NPs were identified by GC–MS. Anti-microbial activity for Pb-NPs against four pathogenic strain's such as *Staphylococcus aureus*, *Escheria coli, Staphylococcus epidermis and Bacillus subtilis.* Result states that Pb-NPs size was 47 nm and also shows good activity against *S. aureus*. Further we report on photocatalytic absorption of malachite green dye processed in short UV wavelength at 254 nm. UV spectral analysis showed peak absorbance at 613 nm with special reference to the excitation of surfaces plasmon vibration by Pb-NPs.

Introduction

During recent decade, major researchers focused their research towards nanotechnology and its applications all over the globe [1]. Metal nanoparticles have gained more attention and play a major role in day by day due to its vast of area of application like development of biosensors etc., [2]. Due to their higher potency most of the researcher focused towards greener synthesis of metal nanoparticles [3–5]. Metallic nanoparticles are mainly synthesized by various physical and chemical methods such as reduction of metal salts, evaporation method, sonochemical decomposition and metal evaporation [6]. Metal and metal oxide nanoparticles having

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optical, electronic, magnetic and catalytic properties. It will vary based upon the size and shape of the nanoparticles. Lead nanoparticles (Pb-NPs) have a vital role in electronic devices especially on sensors. Also it can be used as a type 1 superconductors with superconducting temperature of T = 72 K [7]. Pb-NPs synthesis have been reported by various methods such has reverse micelles, UV-light reduction, reduction of lead and palladium salts and also recently synthesized by tetrazolium based ionic liquids [8]. Lead is a metal mostly toxic to environment and also for human health; particularly it targets the nervous system for humans. So to avoid this metal deficiency most of researchers processing adsorption study [9]. Our work design is focused on Pb-NPs preparation and its catalytic study towards malachite green.

Coconut coir dust (*C. nucifera*) was one of waste material in coconut fining industries which can be stated has fluffy particles of less weight. The major constituents of coir dust were tannin's and lignin's and also it was reported to be composed particles of pentosan, cellulose and furfural [10]. Main advantage of the coir is availability, cost, and applied to produce coir mattress, foam, decorating industries. These materials cannot use in industries directly rather to avoid pollution either it will be dumped or incinerated. We can collect this type of fluffy materials and we can use it for our needful purposes. This coconut coir dust used in various countries like an absorbent due to it contains of hemicelluloses's and pectin's. It can also use as media for growth of some ornamental plants [11]. Here we have chosen low cost and efficient method to synthesize Pb-NPs using *cocos nucifera* L (Coir dust).

Recently major issue was environmental pollutants due to some microbial agents it poses a major threat to public health anyhow many microorganisms are now developed their resistance against antimicrobial agents. Metal nanoparticles showed special interest to act against microorganisms for exploring bactericidal effect of nanoparticles and also with anti-microbial coating of nanoparticles can used in various applications mainly in waste water treatment, food processing industries etc., [12].

Mostly synthetic organic dyes were used in textile industry. The effluents removed from textile industries and printing industries will contain some of the toxic substance which was harmful to the environment and also it causes severe damages to human beings [13]. We choose malachite green because it causes carcinogenic effect to the human beings.

This report is discussing about easy, simple, fast and low cost preparation *i.e.* Green synthesis of Pb-NPs. Further, we studied the anti-microbial and degradation effect of malachite green in the presence of Pb-NPs is reported.

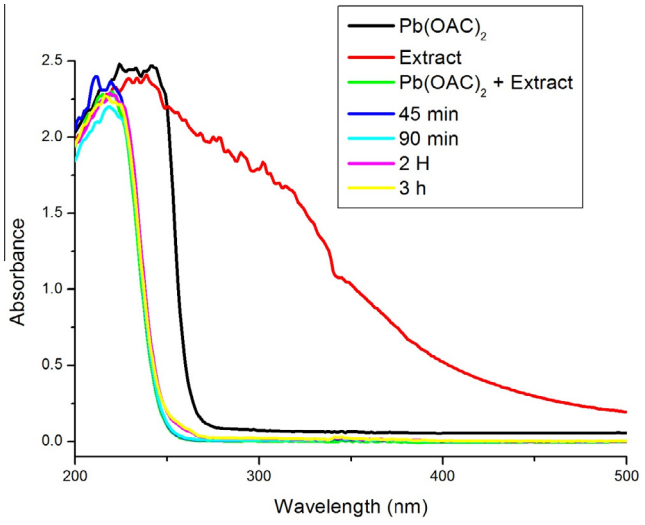

Fig. 1. UV–visible spectra of methanolic extract at different time interval.

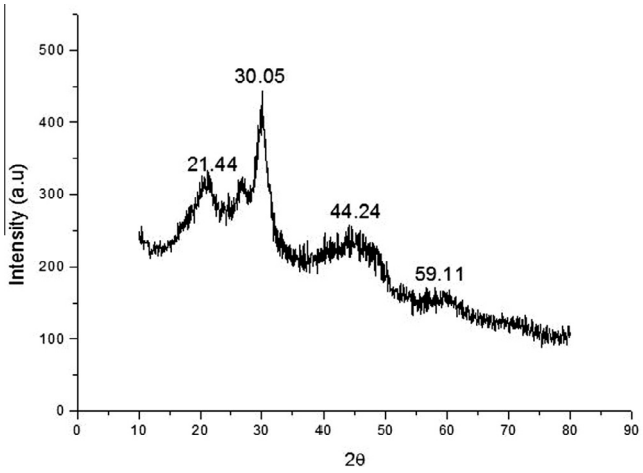

Fig. 2. XRD pattern of Pb-NPs.

Experimental section

Plant collection and materials

Cocos Nucifera L was collected in Gudiyatham (12.9397°N, 78.8644°E), Vellore District, Tamil Nadu, India. The taxonomic identification and authentication was done from Botanical Survey of India, Coimbatore, Tamil Nadu. The identified plant specimen No: BSI/SRC/5/23/2013–14/Tech 1118 was registered and kept for further reference.

Methanol purchased from Sisco Research Laboratories (SRL-India), Lead acetate from (Central Drug House, Bombay-India), Muller Hinton Agar from Hi-Media Laboratories and for throughout experimental process we used double distilled water. Malachite Green procured from Sigma Aldrich, Bombay, India.

C. nucifera methanolic extracts preparation

The Collected *Cocos Nucifera* L was taken and sieved into fine powder. About 300 g powder was packed in musk-in cloth and it was placed in Soxhlet apparatus for extraction. First it was fully ruined with pet-ether for removal of hydrocarbons and then extracted using 500 mL of methanol. Collected fractions were condensed by distillation. One cycle of condensation gives 30 mg of methanolic residue.

Synthesis of lead nanoparticles

About 100 mL of 1 mM Lead acetate solution was prepared using double distilled water. About 20 mg of methanolic residue was dissolved in 20 mL of double distilled water. 20 mL of methanolic extract was mixed with 80 mL of Lead acetate solution and kept for continuous stirring at room temperature. The process was monitored by UV–visible spectrometry.

Characterization

The plant mediated bio-reduction of Pb $(OAC)_2$ suspended solutions was monitored by UV- visible spectroscopy (Schimadzu UV-Visible spectrophotometer, model UV-1800). Further characterization was done using, XRD-analysis (Advance Powder X-ray diffractometer, Bruker, Germany, model D8), TEM Transmission