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SUSTAINABLE UTILIZATION OF BIOWASTES TOWARDS THE GREEN SYNTHESIS OF SILVER NANOPARTICLES AND ITS UTILITY IN THE NAKED EYE DETECTION OF METALS COUPLED WITH ITS LARVICIDAL PROPERTIES

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ABSTRACT

Green synthesis of nanoparticles has become a prominent area of interest in the field of nano science and technology, as it is a non toxic, economically viable and green approach. In the present work we have developed an ecofriendly and zero cost approach for the green synthesis of silver nanoparticles using cashew nut peel. The well known characteristic phenomenon of surface Plasmon resonance (SPR) has been exploited towards the characterization of the green synthesized nanoparticles. The nanoparticles were characterized by UV spectroscopy and the behavior of these particles towards naked eye detection of metal ions were observed. The sensitivity of the nanoparticles towards the detection of metal ions were carefully monitored by the shift in the SPR band. Moreover the larvicidal potential of these green synthesized silver nanoparticles were evaluated as per WHO standards. Such a route of green synthesis of silver nanoparticles is economically feasible as well as environment friendly and also capable of rapid synthesis of nanoparticles at ambient conditions.

I. INTRODUCTION

Green synthesis of silver nanoparticles by using biomaterials has recently attracted considerable attention due to their biodegradability, non- toxicity, and cost effectiveness. Greener syntheses of nanoparticles also provides advancement over other methods as they are simple, one step, cost-effective, environment friendly and relatively reproducible and often results in more stable materials [1].

The Kollam district of Kerala state is well known for its cashew industry and is also named as the Cashew Capital of the World. Kollam is the largest processed cashew exporter in the world. As of 2011 there were more than 600 cashew processing units in the city. About 800,000 tones of raw cashews are imported to the city for processing every year and 80% of India's export quality cashew kernels are prepared in Kollam [2, 3].

According to the statistics by the Cashew Export Promotion Council of India (CEPCI) in 2013–14, India exported 113,620 metric tones of cashew shipments and generated equivalent amount of cashew peelings. Our present study is on the utilization of cashew peel for the synthesis of noble nanoparticles with wider applications in different fields which would otherwise appear as waste in and around the processing centers.

Chemosensors that are broadly employed in heavy metal ion detection have considerably gained attention because these metals play imperative roles in living systems and have a brutally toxic impact on the environment [1, 2]. Because of its widespread distribution in air, water and soil and since it is a toxic element that exists in metallic, inorganic, and organic forms, mercury is regarded as one of the most dangerous metals that pose a serious threat to humanity. It can cause several developmental delays and health problems that can damage the brain, nervous system, kidneys, and endocrine system [3]. Therefore, it is vital to be able to detect and measure the level of Hg2+ in both environmental and biological samples under aqueous conditions. The usual synthetic pathway for nanoparticles preparation was substituted by a novel green one pot synthesis using plant extracts. Hitherto ample literature is available in the synthesis of silver due to its wide range of industrial applications [4-14]. But the current work focuses on the utilization of a waste from cashew processing units to noble nanoparticles with its applications in development of chemosensors for mercury detection and its anti-larvicidal properties against mosquito larva.

II. MATERIAL AND METHODS

Preparation of Silver Nanoparticles

Cashew nut peels were collected from a cashew Processing unit in Kollam District. 1 molar solution of AgNO3 solution was prepared in 250 ml double distilled water. 5gm of cashew peel waste was boiled in 25ml double distilled water at 100^0C for 10 minutes. The extract is filtered. 5ml of the extract was added to 50ml 1M $AgNO_3$ solution. 1 mM solution of $HgCl_2$, $Pb(NO_3)^2$,$NiSO_4$,$CdSO_4$ were prepared. 2ml of fresh unmodified green synthesized silver nanoparticles was mixed with 2ml of each of these metal solutions and colour change was observed.

Mosquito larval Toxicity Test

Aedes aegypti larvae were collected from premises of Amrita University, Kollam , Kerala and were reared in plastic trays in tap water. They were maintained at 27°C.The larvae were fed with 10% sucrose solution. Bioassays were performed with the fourth instar stage of *A. aegypti* following the WHO guidelines [15].Various concentrations of cashew peel extracts (1, 2, 3, 4, 5 mg/L) were taken in glass beakers containing 100 mL of double-distilled water. For mortality studies, 20 larvae were introduced in the beaker. At each tested concentration, four trials were made and each trial consists of four replicates and a control (aqueous cashew peel extracts) were tested for anti–larval effects. The larval mortalities were assessed to determine the acute toxicities on 4th instar larvae of *A. aegypti* at intervals of 1, 3, 6, 12, 16 and 24 hours of exposure. The number of dead larvae was counted from the 1st hour of exposure, and the percentage of mortality was reported from the average of four replicates. The larval mortality data were counted and corrected by the formula of Abbott [16].

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III. RESULTS AND DISCUSSION

The nanoparticles were prepared using cashew peel. The bioreduction of silver nitrate into zero valent metallic nanoparticles was monitored using a UV visible spectrometer and the strong surface Plasmon resonance characteristic of silver nanoparticles confirm the presence of nano silver in the medium. Figures 1-2 depicts the SPR band of nano silver prepared using the biowastes materials.

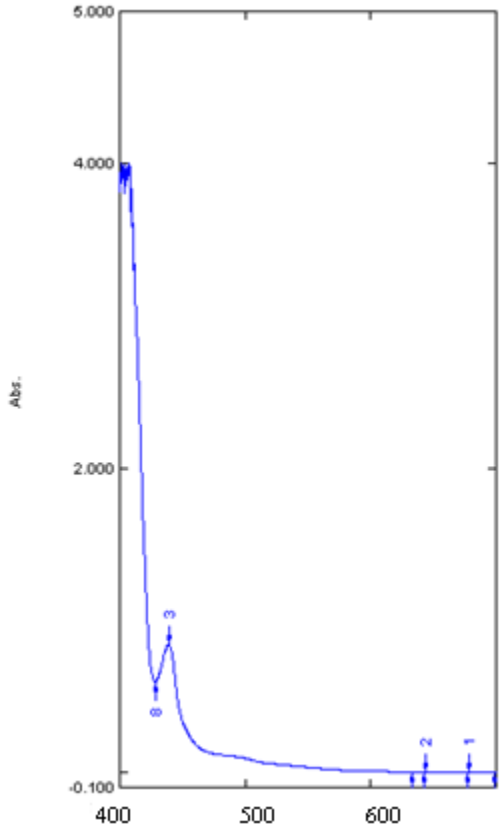

Fig. 1: The UV spectrum of silver nanoparticles prepared using cashew peel extract.

Mosquito larval Toxicity Test

The percentage mortality rate of the mosquito larvae after exposure to various concentration of the green synthesized nano particles using cashew peel extract is shown in figure 3. It can be seen that at lower concentrations the larvae requires greater time of exposure for mortality but on increasing the concentration it is seen that higher mortality rate is observed at lower exposure times. The best results are obtained with higher concentrations of nano silver and immediate mortality is observed as compared to control. This reveals the effectiveness of the material to be utilized as potential eco friendly cost effective mosquito destructive material. This is obviously due to the inherent ability of nanoparticles to penetrate through the cell membrane of the larva which eventually leads to cell death.

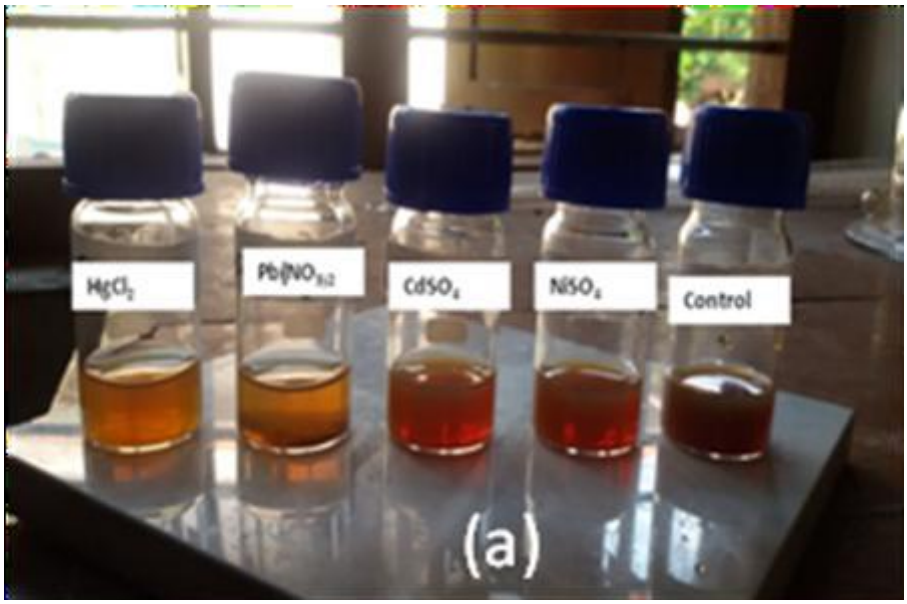

Fig 2:Colour change of the silver nanoparticles prepared using (a) cashew peel with different metal salt solutions

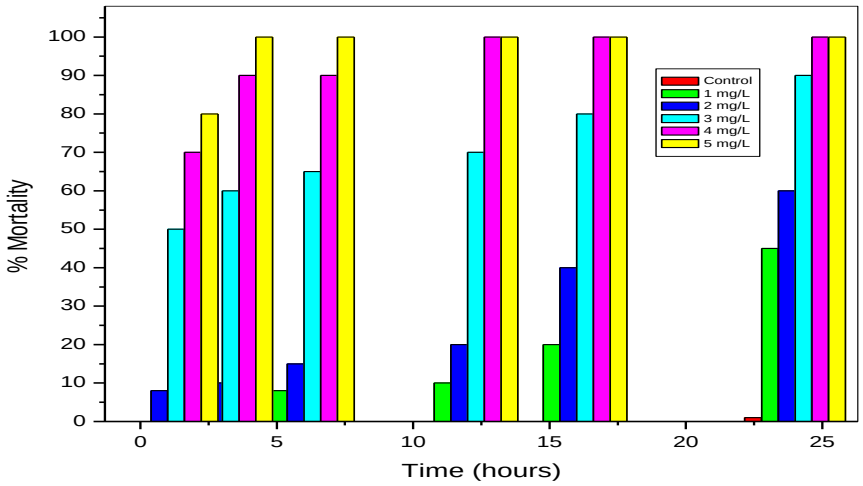

Fig. 3. Percentage mortality of mosquito larvae after exposure to different concentrations of nano silver prepared using cashew peel extract

IV. CONCLUSION

The present work depicts a novel approach towards the synthesis of silver nanoparticles using a green synthetic pathway enabling the use of cashew peel otherwise it will be considered as a waste material from the cashew processing units. Moreover the work also attempts towards the naked eye detection of heavy metals like mercury in a cost effective manner. In this manner the approach is surely a novel method towards the effective

utilization of waste materials. Moreover we have turned biowastes into useful nanomaterials which can be employed in an array of applications in the upcoming era of nano technology.

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