



Green Synthesis and Characterisation of Mucuna Pruriens Mediated Titanium Dioxide Nanoparticles Using Transmission Electron Microscope

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Nanoscience and nanotechnology are the investigation and utilization of minuscule things and can be used over the different science fields, for instance, biology, chemistry, physical science, material science, and designing. In spite of the fact that advanced innovation requests the improvement of nanotechnologies in multidisciplinary science, including the creation of nanoparticles (NPs), it goes back from the Before-Christ time. Nanoparticles can be combined utilizing numerous techniques like physical, substance or organic, otherwise called green synthesis. Titanium dioxide (TiO₂) semiconductor nanoparticles are one sort of significant and promising photocatalysts in photocatalysis as a result of their extraordinary optical and electronic properties. Mucuna pruriens, broadly known as velvet bean or cowhage is a leguminous plant that has been utilized for quite a long time in Ayurvedic medication.

Aim: The main aim of the present study is to evaluate the green synthesis and characterisation of Mucuna pruriens mediated titanium dioxide nanoparticles using transmission electron microscope.

Materials and Methods: The titanium dioxide was synthesised using the seed extract of *Mucuna pruriens*. Analytical tools like UV-Visible spectrophotometer and Transmission Electron microscope were used to understand the surface chemistry of the TiO₂ nanoparticles.

Results: UV-vis spectroscopic analysis of TiO₂ nanoparticles synthesized using *Mucuna pruriens* showed the peak at 280 nm and confirms the TiO₂ nanoparticles formation. Under transmission electron microscopes, the nanoparticles were spherical and some were in undefined shapes. The average size of the nanoparticles was 25-76 nm.

Conclusion: The present study concludes that the TiO₂ nanoparticles synthesised showed spherical shape.

Keywords: Titanium dioxide nanoparticles; Mucuna pruriens; green synthesis; characterisation; Transmission electron microscope; UV- Spectrophotometer.

1. INTRODUCTION

Nanoscience and nanotechnology are the investigation and utilization of minuscule things and can be used over the different science fields, for instance, biology, chemistry, physical science, material science, and designing. In spite of the fact that advanced innovation requests the improvement of nanotechnologies in multidisciplinary science, including the creation of nanoparticles (NPs), it goes back from the Before-Christ time. Nanoparticles can be combined utilizing numerous techniques like physical, substance or organic, otherwise called green synthesis. Green synthesis incorporates utilization of microorganisms like organisms, yeast (eukaryotes) or microbes, actinomycetes (prokaryotes); utilization of plant concentrates or proteins or utilization of formats like DNA, films, infections and diatoms [1,2]. A few of the current cycles of nanoparticle age utilize harmful synthetics either as lessening specialists for metals or as settling specialists to stop agglomeration of the nanoparticles [3]. Disregarding the way that synthetic and actual techniques may successfully make unadulterated, all around portrayed nanoparticles, these are expensive and perhaps perilous to the climate [4,5]. As an option in contrast to noxious and expensive actual methodologies for amalgamation of, utilizing microorganisms, plants and green growth will help a ton [6]. Additionally, the noxious nature of the side-effect would be less when contrasted with other manufactured strategies [7]. The utility of plant-based phytochemicals by and large [8,9] blend and designing of Nano-phytomedicine is the relationship between plant science and nanotechnology that gives a naturally green way to deal with nanotechnology alluded to as green nanotechnology [10,11,12]. Phytochemicals show synergistic impact in the decrease of gold salt into its nano phytomedicine [13,14].

Titanium dioxide (TiO₂) semiconductor nanoparticles are one sort of significant and promising photocatalysts in photocatalysis as a result of their extraordinary optical and electronic properties [15,16]. Ultrafine TiO₂ is utilized in sunscreens because of its capacity to obstruct UV radiation while staying straightforward on the skin (Shanmugam Rajeshkumar *et al.*, 2021). It is in rutile precious stone construction and covered with silica or/and alumina to forestall photocatalytic marvels [17]. The wellbeing dangers of ultrafine TiO₂ from dermal openness on flawless skin are viewed as amazingly low, and it is viewed as more secure than different substances utilized for UV insurance [18].

Mucuna pruriens, broadly known as velvet bean or cowhage is a leguminous plant that has been utilized for quite a long time in Ayurvedic medication [19]. It is a vivacious yearly climbing vegetable initially from southern China and eastern India, where it was all at once generally developed as a green vegetable yield [20]. It is perhaps the most mainstream green yields presently known in the jungles; velvet beans have incredible potential as both food and feed as proposed by encounters around the world [21]. The velvet bean has been customarily utilized as a food source by certain ethnic gatherings in various nations [22]. It is developed in Asia, America, Africa, and the Pacific Islands, where its units are utilized as a vegetable for human utilization, and its young leaves are utilized as creature grain [23,24,25,26,27].

The plant's seeds contain approximately 3.1–6.1 percent L-DOPA, as well as serotonin, nicotine, and bufotenine. One examination utilizing 36 examples of seeds found no tryptamines present [28]. *M. pruriens* var. *pruriens* has the most noteworthy substance of L-dopa [29]. A normal of 52.11% debasement of L-dopa into harming quinones and responsive oxygen species was

found in seeds of *M. pruriens* assortments [30,31]. Our team has extensive knowledge and research experience that has translate into high quality publications [32-38,26,39-44] The main aim of the present study is to evaluate the green synthesis and characterisation of *Mucuna pruriens* mediated titanium dioxide nanoparticles using transmission electron microscope.

2. MATERIALS AND METHODS

Titanium isopropoxide 97% (Aldrich) diluted in isopropyl alcohol 99.5% (Merck) was used as a starting solution, where TiO₂ nanoparticles were precipitated on the addition of alkaline distilled water (pH 8). The molar ratio of alkoxide:alcohol:water was fixed at 5:3:1. The as-prepared precipitate was washed using distilled water, centrifuged and heated at temperatures ranging from 200 to 1100 °C.

2.1 UV-vis Spectrophotometer

The bioreduction of pure TiO₂ is monitored using UV-vis spectroscopy at regular intervals. During the reduction, 0.1 ml of samples was taken and diluted several times with millipore water. After dilution, it was centrifuged at 800 rpm for 5 min. The supernatant was scanned using a UV-300 spectrophotometer (UNICAM, York Street, Cambridge, Cambridgeshire) for a UV-vis 1601 Shimadzu spectrophotometer (Kyoto, Japan), operated at a resolution of 420 nm.

2.2 Transmission Electron Microscopy

Transmission electron microscopy (TEM) analysis of the sample was done using a Philips CM 200 instrument (Philips, Amsterdam, The Netherlands) operated at an accelerating voltage of 200 kV with a resolution of 0.23 nm. A drop of the solution was placed on a carbon-coated copper grid and later exposed to infrared light (45 min) for solvent evaporation.

3. RESULTS AND DISCUSSION

During the nanoparticles formation the solution was analysed for its surface plasmon resonance using UV-vis spectrophotometer. The nanoparticles were analysed for its morphology using transmission electron microscopes.

3.1 UV-vis Spectrophotometer

The reduction of aqueous titanium ions by *M. Pruriens* seed extract mediated synthesis of TiO₂ NPs was identified in this study. UV-vis spectral analysis was used to confirm the formation of TiO₂ NPs in aqueous solution. The reduction of titanium ions and generation of TiO₂ NPs were completed after an overnight incubation at room temperature, according to the results. The reduction of titanium ions was indicated by the formation of a light green colour. For the seed extract solution exposed to TiO₂ NPs, the

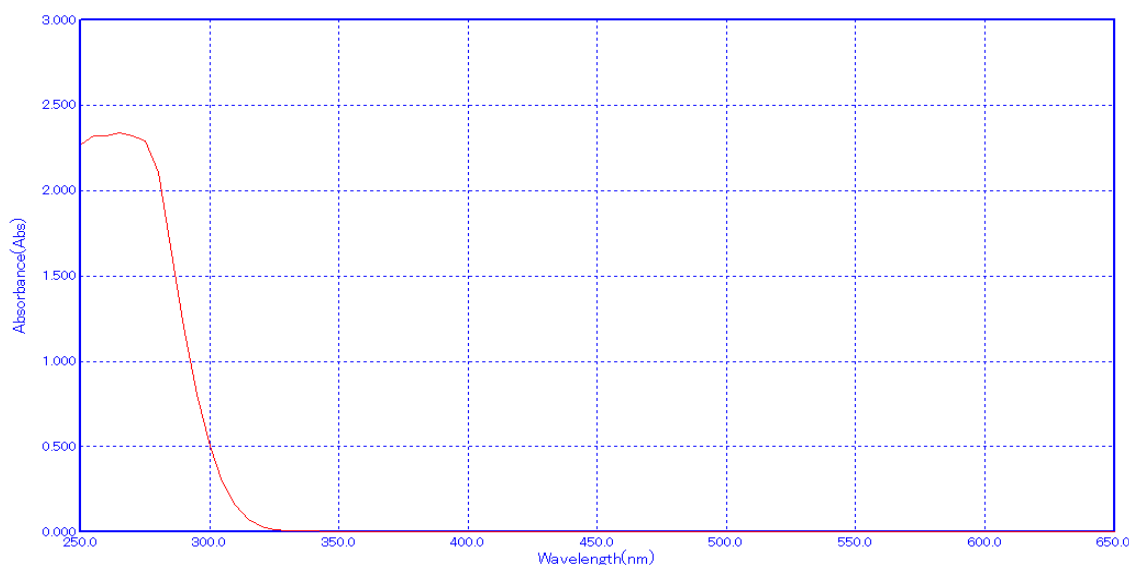


Fig. 1. Shows UV-vis spectroscopic analysis of TiO₂ nanoparticles synthesized using *Mucuna pruriens*

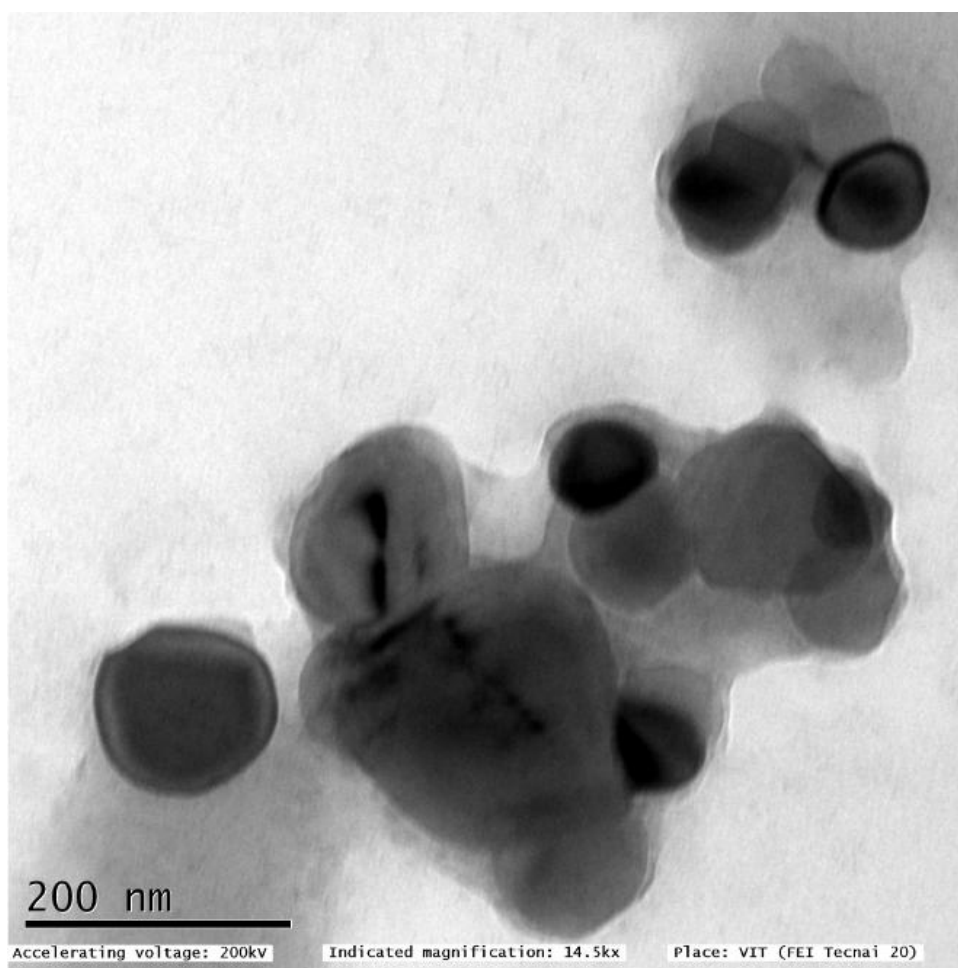


Fig. 2. Shows TEM IMAGE TiO₂ nanoparticles synthesized using Mucuna pruriens and its morphology at 200 nm

absorption spectra of the TiO₂ NPs formed in the solution had absorbance peaks at around 280 nm [45]. In previous studies, Srinivasan et al. observed the peak at 240nm using UV–vis spectral analysis [46,47] and Mohammad et al. observed the maximum peak at 360 nm [48].

3.2 Transmission Electron Microscopy

Green synthesised TiO NPs revealed a homogeneously dispersed nanocrystalline structure with a diameter of 25- 76 nm in morphology and arrangement. Fig. 2 depicts a TEM bright field picture of TiO₂ NPs. According to TEM research, Mucuna pruriens mediated TiO₂ NPs had spherical and irregular shapes, with an average diameter of 25-76 nm. Recently, Santhoshkumar et al. obtained irregular shaped titanium dioxide NPs under transmission electron microscope [49]. In previous studies, Tarafdar et al. observed different shapes and sizes of TiO₂

nanoparticles [50,51,52,53,54] (*First Report on Marine Actinobacterial Diversity around Madras Atomic Power Station (MAPS), India*, no date) [55] (*Physicochemical Profile of Acacia Catechu Bark Extract – An in Vitro Stud - International Journal of Pharmaceutical and Phytopharmacological Research*, no date) [56] (*Awareness of Drug Abuse among Teenagers - International Journal of Pharmaceutical and Phytopharmacological Research*, no date) [58,59] (*COX2 Inhibitory Activity of Abutilon Indicum - Pharmaceutical Research and Allied Sciences*, no date) [60] [61,62,63].

4. CONCLUSION

The synthesis of TiO₂ nanoparticles using a M. pruriens seed extract was successfully achieved. Analytical tools like UV-Visible spectrophotometer and Transmission Electron

microscope helped to understand the surface chemistry of the TiO₂ nanoparticles [64-73,74]. The TiO₂ nanoparticles synthesis showed spherical shape. This could open the door to a lot of applications.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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