GREEN SYNTHESIS AND CHARACTERISATION OF MUCUNA PRURIENS MEDIATED TITANIUM DIOXIDE NANOPARTICLES USING TRANSMISSION ELECTRON MICROSCOPE

Running title: Green synthesis and characterisation of Mucuna pruriens mediated titanium dioxide nanoparticle

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 (TiO_2) 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 TiO_2 nanoparticles.

Result:

UV-vis spectroscopic analysis of TiO_2 nanoparticles synthesized using Mucuna pruriens showed the peak at 280 nm and confirms the TiO_2 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 TiO_2 nanoparticles synthesised showed spherical shape.

KEYWORDS: Titanium dioxide nanoparticles, Mucuna pruriens, green synthesis, characterisation, Transmission electron microscope, UV- Spectrophotometer

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 (Karthik, Arivarasu and Rajeshkumar, 2020). 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(Shree *et al.*, 2020). 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 (Devaraj *et al.*, 2020). As an option in contrast to noxious and expensive actual methodologies for amalgamation of, utilizing microorganisms, plants and green growth will help a ton (Nasim, Kamath and Rajeshkumar, 2020). Additionally, the noxious nature of the side-effect would be less when contrasted with other manufactured strategies (Balraj, 2020). The utility of plant-based phytochemicals by and large (Shankar *et al.*, 2020)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(Niveditha *et al.*, 2020). Phytochemicals show synergistic impact in the decrease of gold salt into its nano phytomedicine(S and Satheesha, 2020).

Titanium dioxide (TiO_2) semiconductor nanoparticles are one sort of significant and promising photocatalysts in photocatalysis as a result of their extraordinary optical and electronic properties(Duarte, António Armando Lima and Amorim, 2017). Ultrafine TiO_2 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(Barakat and Kumar, 2016). The wellbeing dangers of ultrafine TiO_2 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(Stock *et al.*, 2021).

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 (Dhanasekaran, Tharakan and Manyam, 2008). 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 (Hairiah, Stulen and Kuiper, 1990). 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 (Jayasundara, no date). The velvet bean has been customarily utilized as a food source by certain ethnic gatherings in various nations (Shunmugam *et al.*, 2021). 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(Ikechukwu, Okafor and Egba, 2020)(Devi, Subathra Devi and Gnanavel, 2014) (Gupta, Ariga and Deogade, 2018) (Saravanan *et al.*, 2018) (Needhidasan, Samuel and Chidambaram, 2014).

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 (S. Rajeshkumar *et al.*, 2021). M. pruriens var. pruriens has the most noteworthy substance of L-dopa (Saranya *et al.*, 2020). A normal of 52.11% debasement of L-dopa into harming quinones and responsive oxygen species was found in seeds of M. pruriens assortments (Maldonado, 2014; Vikneshan *et al.*, 2020). Our team has extensive knowledge and research experience that has translate into high quality publications(Rajeshkumar *et al.*, 2018; Nandhini, Rajeshkumar and Mythili, 2019; M. Gomathi *et al.*, 2020; Rajasekaran *et al.*, 2020; Vairavel, Devaraj and Shanmugam, 2020),(Santhoshkumar *et al.*, 2019),(Raj R, D and S, 2020),(Saravanan *et al.*, 2018),(Gheena and Ezhilarasan, 2019),(Ezhilarasan, Sokal and Najimi, 2018),(Ezhilarasan, 2018),((Dua *et al.*, 2019; A. C. Gomathi *et al.*, 2020; Vairavel, Devaraj and Shanmugam, 2020),(Ramesh *et al.*, 2018; Duraisamy *et al.*, 2019; Ezhilarasan, Apoorva and Ashok Vardhan, 2019; Arumugam, George and Jayaseelan, 2021; Joseph and Prasanth, 2021) .,(Gnanavel, Roopan and Rajeshkumar, 2019),(Markov *et al.*, 2021) . 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:

Titanium isopropoxide 97% (Aldrich) diluted in isopropyl alcohol 99.5% (Merck) was used as a starting solution, where TiO_2 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 8C.

UV-vis spectrophotometer:

The bioreduction of pure TiO_2 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.

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.

RESULT AND DISCUSSION:

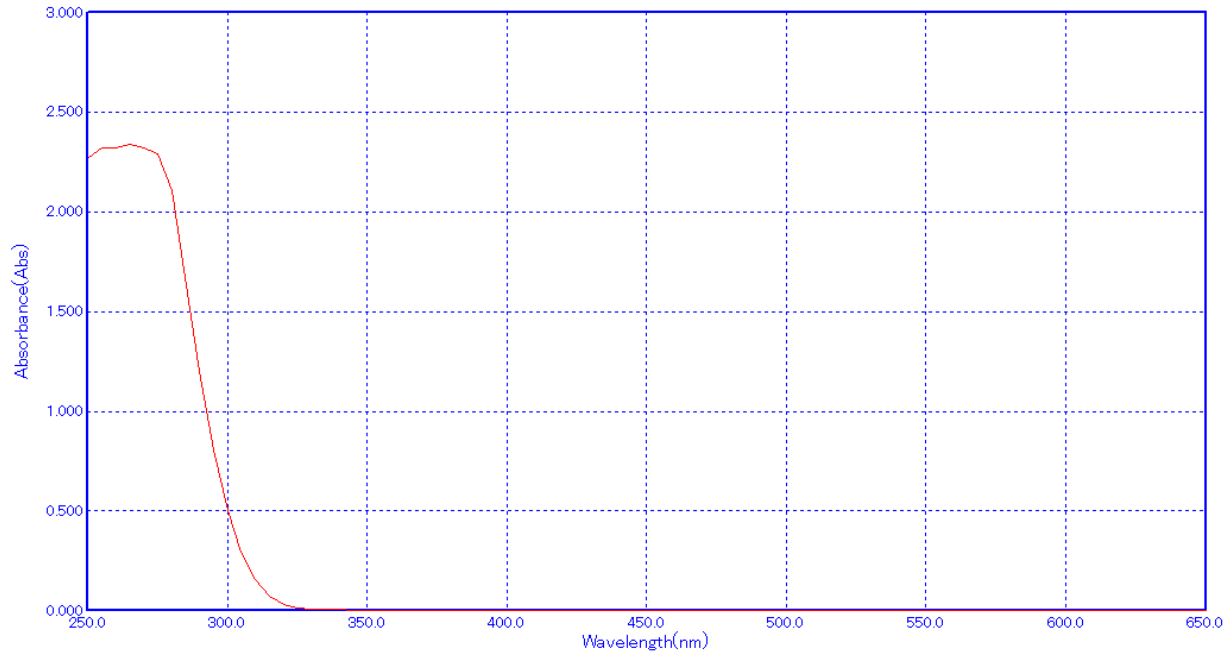

FIGURE 1: Shows UV-vis spectroscopic analysis of TiO_2 nanoparticles synthesized using Mucuna pruriens.

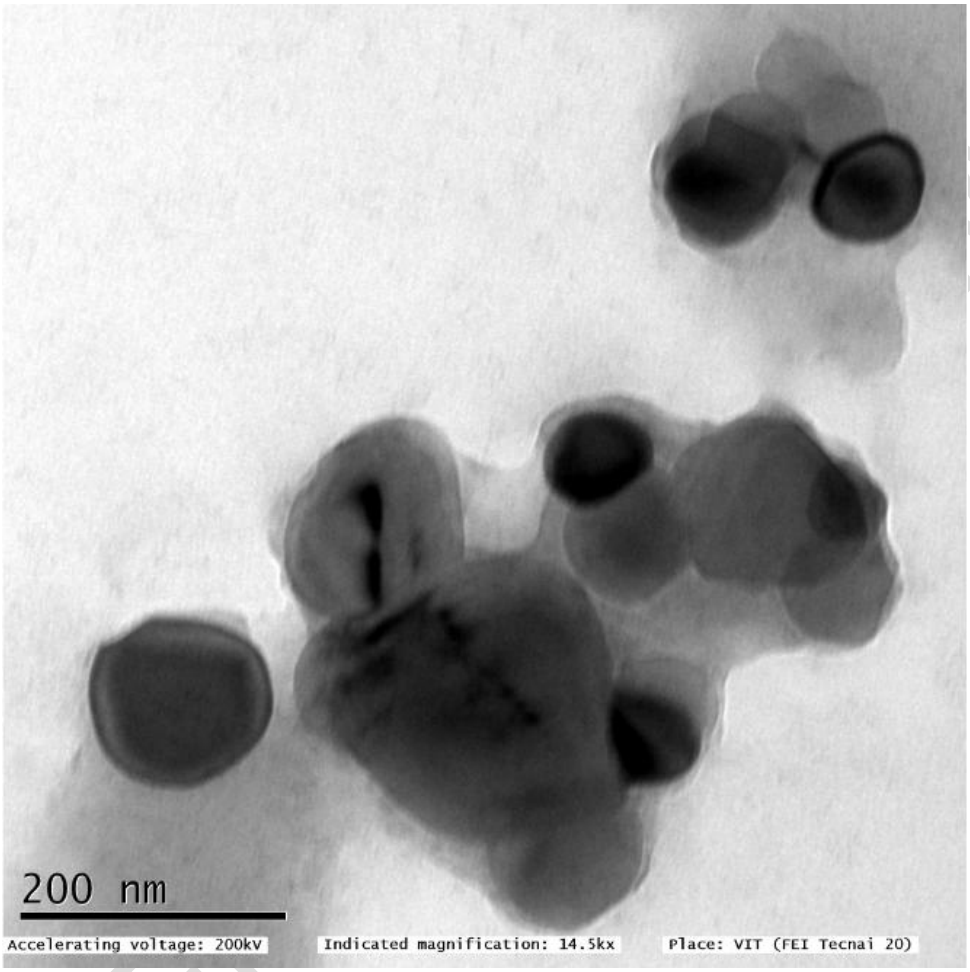

FIGURE 2: Shows TEM IMAGE TiO_2 nanoparticles synthesized using Mucuna pruriens and its morphology at 200 nm.

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.

UV-vis spectrophotometer:

The reduction of aqueous titanium ions by M. Pruriens seed extract mediated synthesis of TiO_2 NPs was identified in this study. UV–vis spectral analysis was used to confirm the formation of TiO_2 NPs in aqueous solution. The reduction of titanium ions and generation of TiO_2 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 TiO_2 NPs, the absorption spectra of the TiO_2 NPs formed in the solution had absorbance peaks at around 280 nm (Rajakumar *et al.*, 2012). In previous studies, Srinivasan et al. observed the peak at 240nm using UV–vis spectral analysis (Srinivasan *et al.*, 2019; Barma *et al.*, 2020) and Mohammad et al. observed the maximum peak at 360 nm (Nasrollahzadeh and Mohammad Sajadi, 2015).

Transmission electron microscopy:

Green synthesised TiO NPs revealed a homogeneously dispersed nanocrystalline structure with a diameter of 25- 76 nm in morphology and arrangement. Figure 2 depicts a TEM bright field picture of TiO_2 NPs. According to TEM research, Mucuna pruriens mediated TiO_2 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 (Santhoshkumar *et al.*, 2014). In previous studies, Tarafdar et al. observed different shapes and sizes of TiO_2 nanoparticles (Tarafdar *et al.*, 2014) (Pushpaanjali, Geetha and Lakshmi, 2020) (Aathira, Geetha and Lakshmi, 2020) (Baskar and Lakshmi, 2020) (Manya Suresh, 2020) (*First Report on Marine Actinobacterial Diversity around Madras Atomic Power Station (MAPS), India*, no date) (*Physicochemical Profile of Acacia Catechu Bark Extract – An in Vitro Stud - International Journal of Pharmaceutical and Phytopharmacological Research*, no date) (Lakshmi, 2021) (*Awareness of Drug Abuse among Teenagers - International Journal of Pharmaceutical and Phytopharmacological Research*, no date) (Mangal, Anitha and Lakshmi, 2018) (*COX2 Inhibitory Activity of Abutilon Indicum - Pharmaceutical Research and Allied Sciences*, no date) (Jibu, Geetha and Lakshmi, 2020) (Sindhu *et al.*, 2020) (Nivethitha *et al.*, 2020) (Mariona, Roy and Lakshmi, 2020)

CONCLUSION:

The synthesis of TiO_2 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 TiO_2 nanoparticles(Rajendran *et al.*, 2019)(Ashok, Ajith and Sivanesan, 2017)(Malli *et al.*, 2019)(Mohan and Jagannathan, 2014)(Menon *et al.*, 2018)(Samuel, Acharya and Rao, 2020)(Praveen *et al.*, 2001)(Neelakantan *et al.*, 2011)('Oligonucleotide therapy: An emerging focus area for drug delivery in chronic inflammatory respiratory diseases', 2019)(Kumar *et al.*, 2006). The TiO_2 nanoparticles synthesis showed spherical shape. This could open the door to a lot of applications.

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