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Formulation and Evaluation of Silver Nanoparticles of Tamarindus Indica for Cancer

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ABSTRACT

Green synthesis of metal nanoparticles has become a main branch of nanotechnology and there is an increasing commercial demand for nanoparticles due to their ample applications. Nanoparticles play a major role in the field of engineering and medicine. This study investigates an efficient and sustainable route of Silver nanoparticle preparation from aqueous silver nitrate (AgNO3) using fruit shell extract of Tamarindus indica well adorned for their wide availability and medicinal property. For the synthesis of silver nanoparticles using the fruit shell extract of Tamarindus indica as a reducing agent from silver nitrate (AgNO3) has been investigated. The synthesis of silver nanoparticles mostly helps in enhancement of their antimicrobial and antioxidant properties. The synthesized tamarind silver nanoparticles have been characterized using Ultraviolet Visible Spectroscopy (UV–Vis Spec), Fourier Transform Infrared Spectroscopy (FT-IR), synthesized Silver Nanoparticles showed an absorption peak at approximately 450 nm in the UV-visible spectrum. This method is rapid, simple without any hazardous chemicals as reducing or stabilizing agents and economical to synthesized SNPs.

KEYWORDS: green synthesis, nanotechnology, nanoparticle, Tamarindus indica, UV–Vis

INTRODUCTION

1.1 Nanoparticles

Nanoparticles were described as a small material with a size ranges between 1 and 100 nm and these nanoparticles act as a whole system with respect to its transport and properties. Nanoparticles are widely used in scientific studies and research in the 1970s and 1980s. Nanoparticles have size related properties and it differs significantly than bulk materials. Nanoparticles have variety of diversity such as metal, metal oxides, carbon materials, metal sulfides, semiconductor etc. Nanoparticles exhibit different morphological diversity such as rod, sphere, cylinders, cubes, hollow spheres, tubes, disks etc. Nanoparticles are the main components of nanotechnology for a variety of applications. Nanoparticle exhibits various forms such as nanoclusters and nanopowders. Nanoclusters are characterized as materials with a range of between 1 and 10 nm with a narrow size distribution. Nanoclusters are a one-dimensional material. Nanopowders are defined as the collective type of ultrafine particles such as nanoclusters and nanoparticles (Fahlman 2007). Among the diversity of nanostructure, noble metal nanostructures receive a great deal of attention due to their unique properties, including significant optical enhancements and photothermal properties. The optical field improvement of nanoparticles is due to the high dispersion and absorption of light. This enhancement result shows that metal nanoparticles grow from the resonant oscillation of their collective free electrons in the presence of light known as Localized Surface Plasmon Resonance (LSPR) (Jain *et al.,* 2008). Noble metal nanoparticles were exhibit wide range of behavior at the atomic to bulk transition (Kreibig and Volmer, 1995).

1.2 Properties of Silver Nanoparticles

The electrical, thermal and optical properties of silver nanoparticles are different. It is used by incorporating with various products. Silver based compounds are nontoxic, inorganic and antimicrobial agents. Physical, chemical and biological properties of nanostructured silver were significant when compared to their macroscaled materials. The high use of silver nanoparticles is due to low sintering temperatures, high electrical conductivity and stability.

1.3 Methods Used for Preparation of Nanoparticles

The "bottom-up" and "top-down" approaches are basically two types of methods to be used for the preparation of nanoparticles (Figure 1.6)The main drawback of this approach is it cannot prepare nanomaterials with controlled or desired properties. Top-down approach is defined as synthesis of nanomaterials starts with bulk materials and ends in the nanoscale materials formation via series of degradation process. The limitation of this approach is low reproducibility.

Plant Used Description

Tamarindus indica L. is the member of the Caesalpiniaceae subfamily of Fabaceae family and commonly known as tamarind fruit. It is an evergreen monotypic species. The native of this plant is Africa and now highly planted in India. This tree has grown even in dry regions of long duration

Figure 1.11: Tamarind Tree, Fruit, Pulp and Shell

Tamarind tree is a multipurpose tropical tree and it consumed mostly for its fruits. Fruits have been eaten as raw or processed for food purpose. The geographical distribution of this plant is subtropics and semiarid tropics. Tamarind has been used as a medicinal plant for centuries; its fruits are the most valuable part and have often been recorded as curative in a variety of pharmacopoeias. The parts of the Tamarind plants are seeds, fruits and leaves; they are used in traditional medicines for the treatment of various diseases (Figure 1.11)

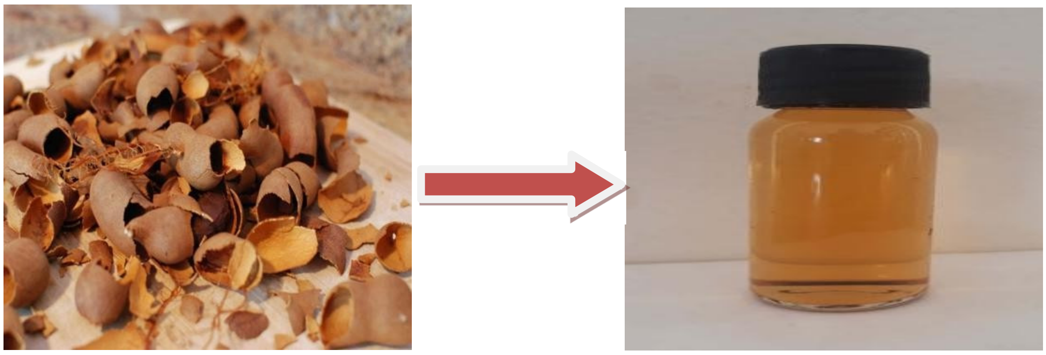
EXPERIMENTAL METHODOLOGY

Chemicals

Analytical grade Silver Nitrate, DPPH (2,2-Diphenyl-1-Picrylhydrazyl), Ammonium Molybdate, Hydrogen Peroxide, Ascorbic Acid, MTT reagent (3-(4, 5- dimethylthiazol- 2-yl)-2, 5-diphenyltetrazolium bromide), Dimethyl Sulfoxide (DMSO), Acridine Orange and Ethidium Bromide (Ao/EtBr), Phosphate Buffer Saline (PBS), Rhodamine 123, Propidium Iodide (PI), Mono Dansyl Cadaverine (MDC) and other chemicals and solvents were obtained from Sigma Aldrich (Bangalore, India) and Himedia Ltd (Mumbai, India) with highest purity and used without further purification.

Preparation of Plant Extract

Aqueous extract of *Tamarindus indica* fruit shell was prepared by mixing 10 g fruit shell powder with 100 ml deionized water in the 250 ml Erlenmeyer flask. The mixture was then heated in the hot plate at 60 °C for 20 minutes. The prepared solution was initially filtered through normal filter paper mesh so that the unwanted materials could be filtered out; then the extract was filtered through Whatman filte



(a) **(b)**

Figure 4.1 (a) *Tamarindus indica* Fruit Shell (b) Aqueous Fruit Shell Extract

Green Synthesis of Silver Nanoparticles

10 mM silver nitrate solution was prepared in an Erlenmeyer flask using double distilled water. Then 400 ml of fruit shell extract was added to 100 ml of 10 mM silver nitrate solution and made upto 1000 ml with double distilled water. Then the mixture was stirred for 2 hours at 45 °C by hot plate method with magnetic stirrer. Reduction of silver ions (Ag^{+}) to silver nanoparticles (Ag^{0}) was confirmed by the colour change of solution from colourless to brown (Figure 4.2).

Tamarindus indica *Silver Nanoparticles Fruit Shell(SNPs)*

Figure 4.2 Green Synthesis of Silver Nanoparticles using Aqueous Extract of

RESULTS AND DISCUSSION

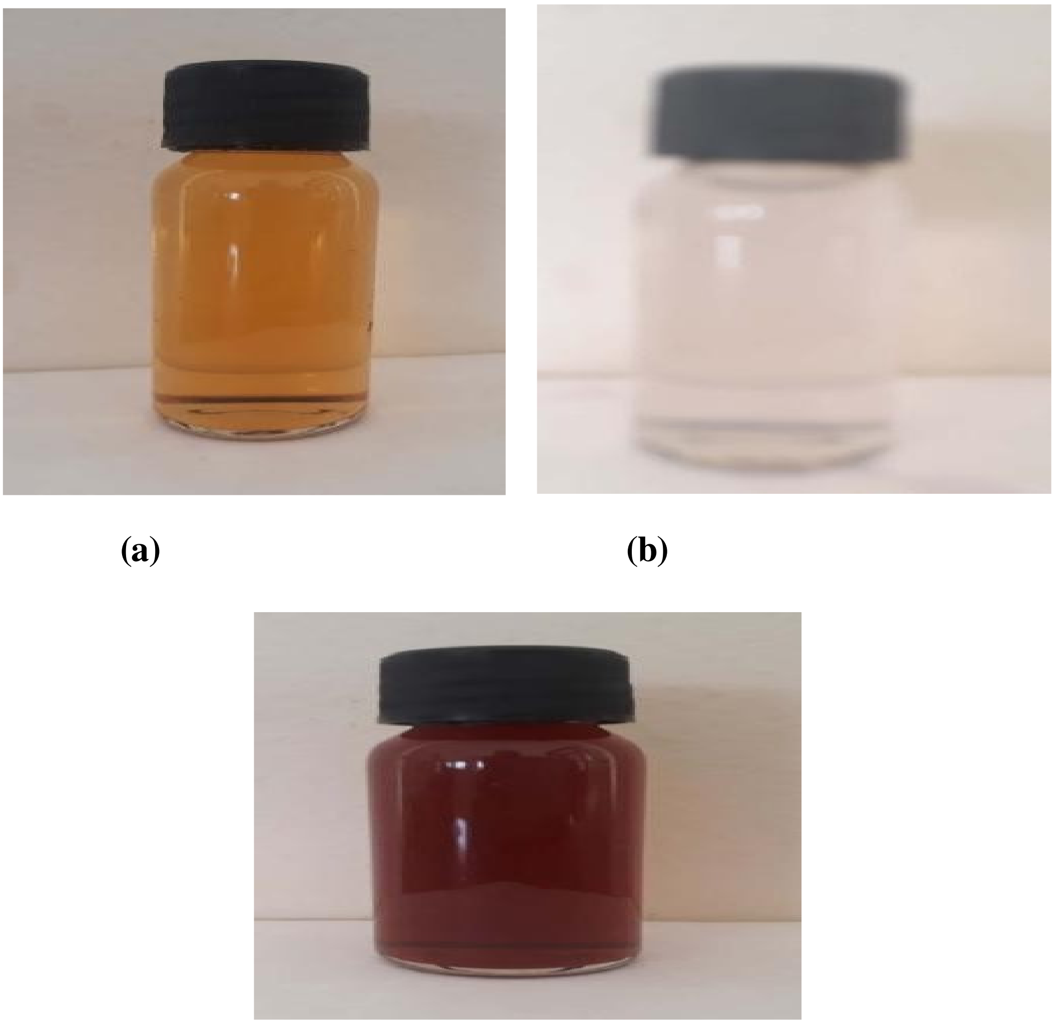
1.4 Phytochemical Screening Assay

Compounds	Test	Result	Present /Absent
Alkaloids	Mayer's Test	Yellow color precipitate	Present
	Wagner's Test	Formation of brown precipitate	Present
Saponins	Foam Test	formation of froth	Present
Flavonoids	Sodium Hydroxide Test	Yellow to colorless	Present
	Shinado's Test	Pink color formation	Present
Carbohydrates	Molisch's Test	Purple ring formation	Present
	Fehling's Test	Brick red formation	Present
Terpenoids		Blue green color formation	Present
Phenols		Green or blue	Present
Quinones		Red color formation	Present
Tannins	Ferric Chloride Test	Dark green appearance	Present
	Bromine Test	Decoloration of bromine water	Present
	Lead Acetate	White color precipitate	Present
Glycosides		Brown ring	Present
Xanthoproteins	Xanthoproteic Test	Orange color	Absent
Steroids	Salkowski Test	Red color formed at the lower layer	Absent
Coumarins	Sodium Hydroxide Test	Yellow color formation	Absent
Resins	Turbidity Test	Turbid formation	Absent

Synthesis of Silver Nanoparticles (SNPs) Using Plants

5.3.1Visual Observation

Green synthesized silver nanoparticles using Tamarind fruit shell extract was initially confirmed by visual observation. The silver nanoparticles were formed, when silver nitrate solution was added to fruit shell extract. Initially, the reaction mixture appeared pale yellow in colour and it changed into brown indicates the formation of silver nanoparticles (Figure 5.3). After one hour, the reaction mixture changed into dark brown and finally blackish brown indicating that the reduction of silver ion process was completed. The different colours of silver nanoparticles are related to the excitation effect of surface Plasmon resonance in the reaction mixture. Likewise, prepared nanoparticles
were not aggregate. Several research findings observed that the stability of nanoparticles were extended for more than a week (Sudha *et al.,* 2017; Bindhu and Umadevi, 2013; Chandran *et al.,* 2006).



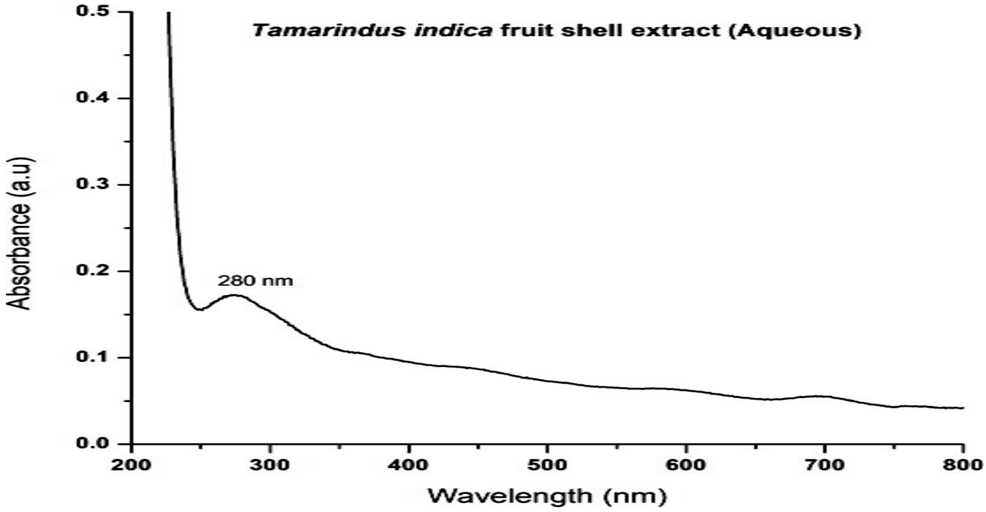
(a) **(b)**

(c)

Figure 5.3: Visual Observation of Tamarind Fruit Shell Extract Mediated Silver Nanoparticles Synthesis (a) Fruit Shell Extract (b) Silver Nitrate Solution (c) Silver Nanoparticles (SNPs)

1.5 Characterization of Synthesized Silver Nanoparticles

1.5.1 UV-Visible Absorption Spectrum



UV-visible spectrophotometer is the interesting tool to determine the optical property of silver nanoparticles. The UV-visible spectrum of silver nanoparticles was characterized in the range of 400-540 nm.

Figure 5.4: UV-Visible Spectrum of Aqueous Extract of Tamarind Fruit Shell

The SPR band was formed owing to the excitation of free electrons present in the silver nanoparticles while absorbing visible light (Baia *et al.,* 2007). A single peak was observed and that indicates the formation of spherical shape of nanoparticles (He *et al.,* 2002).

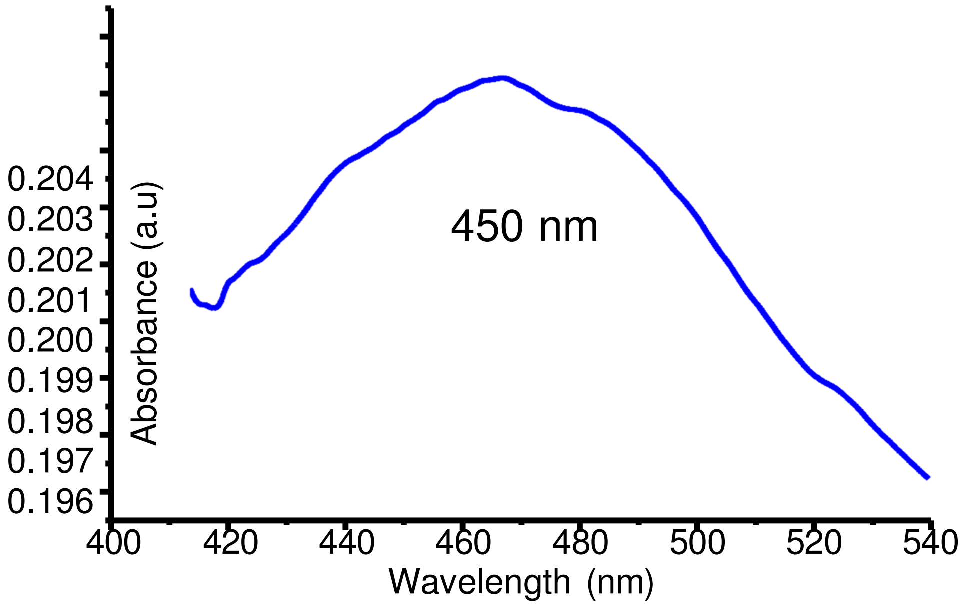


Figure 5.5: UV-Vis ble Spectrum of Green Synthesized Silver Nanoparticles

5.4.2 FTIR Spectrum

FTIR Spectrum is used to determine the presence of organic molecules on the surface of Nanoparticles. In this present investigation, FTIR measurement was used to identify the phytochemicals present in Tamarind fruit shell extract responsible for reduction of Silver ions to Silver Nanoparticles. FTIR results revealed that similar bands were present in both fruit shell extract and Silver Nanoparticles with slight modifications in wave number (Figure 5.6). Four new peaks were formed and one small peak was disappeared in silver nanoparticles.

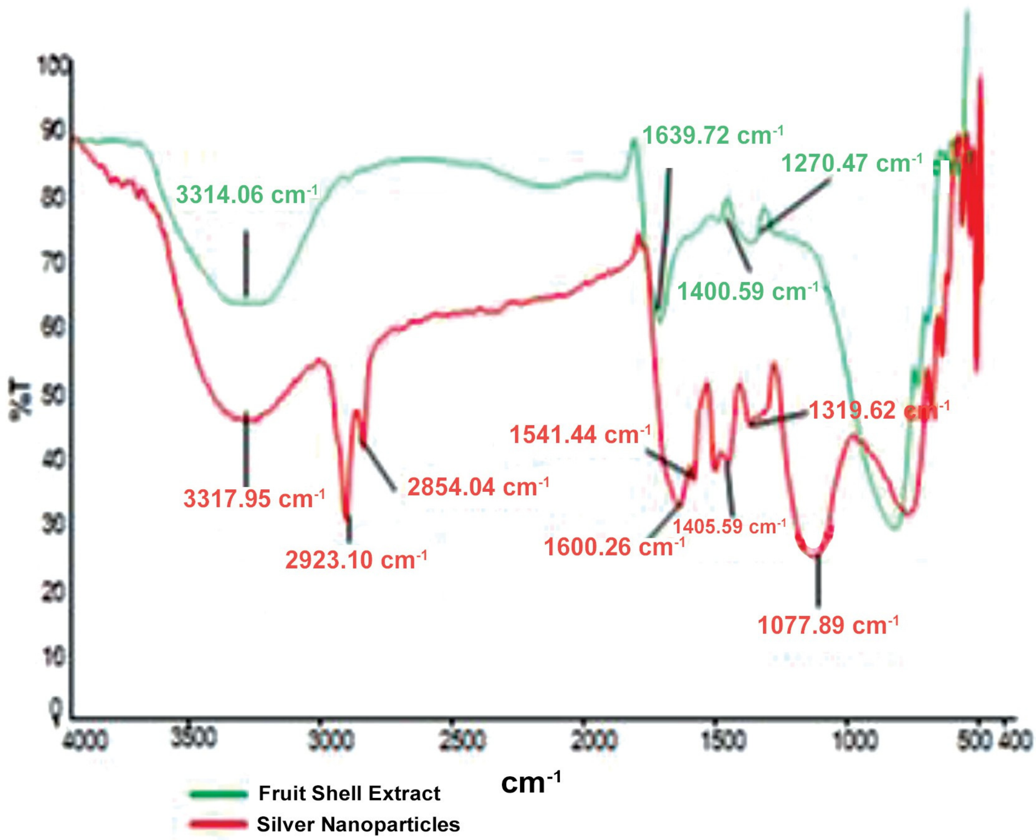


Figure 5.6: FTIR Spectrum of Tamarind Fruit Shell Extract and Synthesized Silver Nanoparticles

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Table 5.3: Observation Peak Modification of Fruit Shell Extract and Silver Nanoparticles

Wave Number (Fruit Shell Extract)	Wave Number (Silver Nanoparticles)	Bond	Molecules	Changes
3314.06 cm^{-1}	3317.95 cm^{-1}	O-H	Carboxylic Acids	Slight change in wave number
	2923.10 cm^{-1}	C–H stretching	Alkanes	New and weak peak
	2854.04 cm^{-1}	C–H stretching	Alkanes	New and weak peak
1639.72 cm^{-1}	1600.26 cm^{-1}	C-C & N=H	Aromatic Compounds and Primary Amines	Narrow peak to broad peak and slight changes in wave number
	1541.44 cm^{-1}	N–O asymmetric stretching	Nitro Compounds	New and weak peak
1400.59 cm^{-1}	1405.59 cm^{-1}	C–C stretching	Aromatics	Slight change in wave number
1270.47 cm^{-1}	-	-	-	Peak disappeared
	1319.62 cm^{-1}	C-O stretching	Alcohols and Carboxylic Acids	Weak peak formed
	1077.89 cm^{-1}	C–N stretching	Aliphatic Amines	New broad peak

6. CONCLUSION AND FUTURE RECOMMENDATIONS

6.1 Conclusion

The present study describes the synthesis, characterization and biological activity of silver nanoparticles synthesized using aqueous extract of *Tamarindus indica* L. fruit shell. This simple technique is designed and successfully synthesized silver nanoparticles using tamarind fruit shell extract and applied in medicinal field such as antibacterial, antioxidant, anticancer activity and also in environmental catalysis such as catalytic activity. The phytochemical screening assay was performed by using various standardized biochemical methods. The result confirms the presence of secondary metabolites like alkaloids, saponins, flavonoids, carbohydrates, terpenoids, quinones, tannins, glycosides and phenols. GC-MS analysis revealed that more than 20 phyto-compounds are present in the Tamarind fruit shell extract.

This analysis shows the presence of sugar moiety such as Mome Inositol with highest peak area of 97.27 %. Mome Inositol was one of the highly abundant medicinal compounds present in the tamarind fruit shell extract, confirmed by GC-MS analysis. Other chemical constituents (2.73 %) include hydrocarbon derivatives, amino acid derivatives, pyridine compound, carboxylic acid derivatives, aromatic compound, alcoholic compound, ether, ester, ketone compund, fatty acid, alkane and phytol compound. Some of these compounds are reported to have antimicrobial, anticancer and antioxidant activities.

Tamarind Fruit shell extract was mixed with silver nitrate solution to prepare silver nanoparticles. The color of the reaction solution was changed into brown; it

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indicates the synthesis of silver nanoparticles

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