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REVIEW ON GUM GHATTI BASED SYNTHESIS OF SILVER NANOPARTICLES AND THEIR BIOLOGICAL ACTIVITY

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Abstract: Gum Ghatti is obtained from the bark of *Anogeissuslatifolia*. It is the native tree gum of India. It is a simple and friendly method to obtain the synthesis of silver nanoparticles from silver nitrates and Gum Ghatti used as reducing and stabilizing agents. UV–visible spectroscopy, transmission electron microscopy, FTIR-spectroscopy, Raman spectroscopy and X-ray diffraction analytical techniques are used to characterize the synthesized nanoparticles. In this review article we will give an overview of the Gum Ghatti based synthesis of nanoparticles and their biological activity.

Index Terms **- Silver nanoparticles, UV-visible spectroscopy, X-Ray diffraction, Transmission electron microscopy, FTIR-spectroscopy, Raman spectroscopy and Antimicrobial activity.**

I.INTRODUCTION

Nanotechnology is a branch of science and which is dedicated to materials, having dimensions around 100th of nanometer or less. This technology is used to develop more efficiency in the field of nanoparticles.(***Mody et al., 2010***) Due to their antimicrobial activity, Silver nanoparticles (Ag° nanoparticles) are widely used in the production of nanomaterials which was regulated by the US-FDA(U.S.Food and Drug Administration) in 1920s.(***Durán et al., 2016a, 2016b***) Gum Ghatti is obtained from the bark of Anogeissuslatifolia. Anogeissuslatifolia belongs to the family called Combretaceae which is naturally occurring water soluble plant. Gum Ghatti production worldwide is around 1,000–1,500 MT/year.(***Kora et al., 2012***) It is found in India and Sri- lanka (***Zhang et al., 2016***). Gum Ghatti has excellent emulsification properties. It has about 4.34 % (W/W) protein and it is linked to polysaccharides which indicated its good emulsification property.(***Kang et al., 2015***). Being an anionic and biodegradable polysaccharide, Gum Ghatti (Gg) contains reactive functional groups like hydroxyl groups & carboxylic acid.(***Mittal et al., 2014***) The CAS number of Gum Ghatti is 9000-28-6 & it is recognized as "Generally Recognized As Safe" (GRAS) and has the approval of being a food ingredient with code 184.1333 by the (FDA) Food and Drug Administration. In Gum Ghatti, around 80% dietary fiber is present and it acts prebiotic by supplying the matrix required to sustain the bacterial flora of the human colon(***Kora et al., 2012***). The Gum Ghatti is also used in the treatment of diarrhea, hypolipidemia and diabetes(***Kora et al., 2012***)(***Salvioni et al., 2017***) The emulsifier concentration in decreased in the order Gum Acacia>Gum Ghatti >Sugar Beet Pectin(***Yao et al., 2016***).

II.ROLE OF SILVER NANOPARTICLES

Silver is a lewis acid and it reacts as a lewis base like: phosphorous and sulfur which are major components of the cell membrane, proteins and DNA base. Silver nanoparticles were the first that resulted in the morphological changes on the cell wall and membrane, where the membrane detachment, shrinkage of the cytoplasm, numerous electron dense pits, and finally disrupted membrane were observed by Transmission Electron Microscopy (TEM).(***Tang and Zheng, 2018***) The particle size of the silver nanoparticles exists between 1 to 100 nm in size .Silver is composed of large amount of silver oxide percentage because of the presence of large ratio of surface of bulk silver atom.(***Mody et al., 2010***)

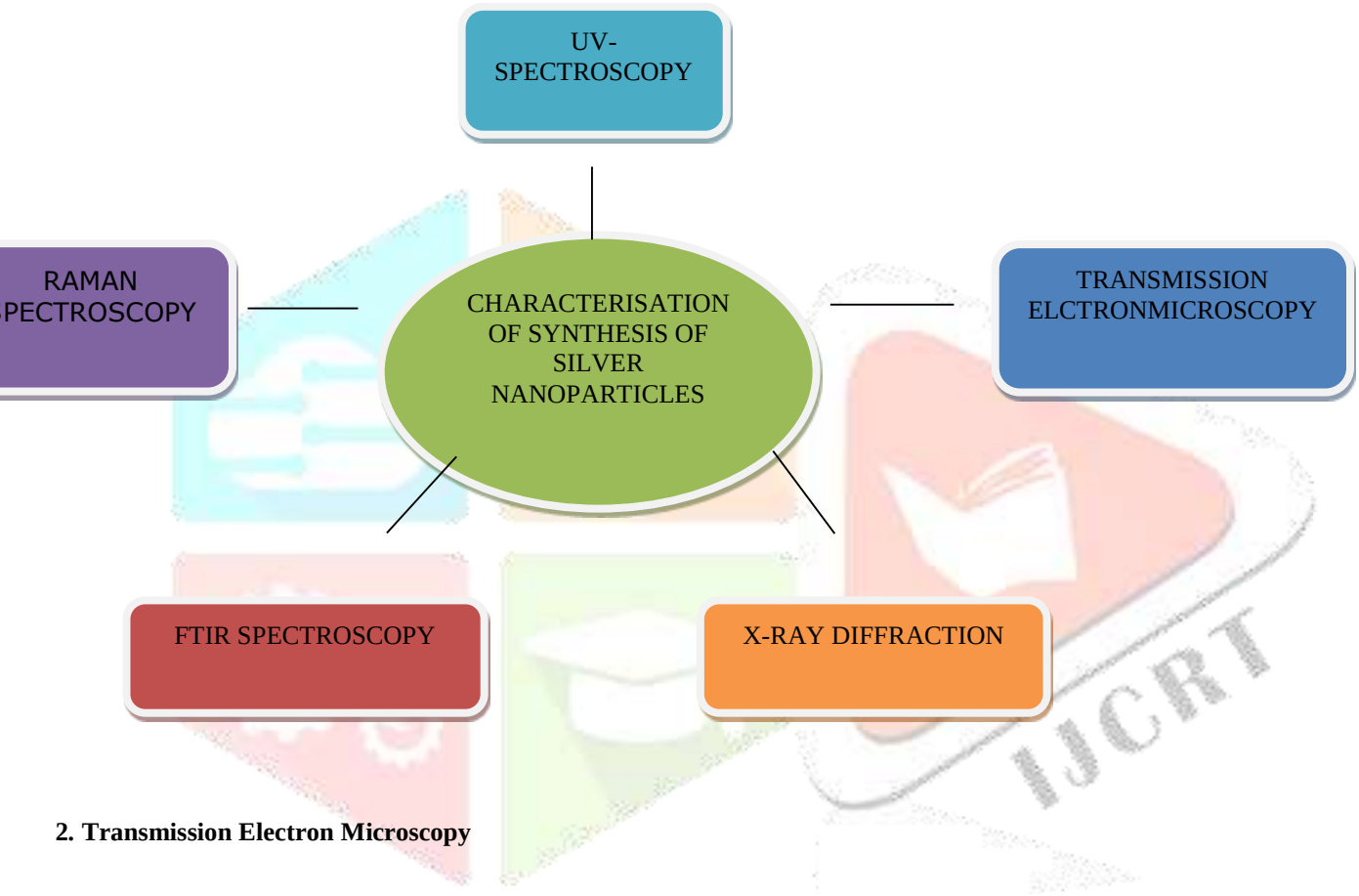
III.METHODS FOR CHARACTERIZATION OF SYNTHESIZED SILVER NANOPARTICLES

An Elico SL 196 spectrophotometer is used in the study of silver nanoparticles formulation to measure the UV–Visible absorption spectra of colloidal solutions which are prepared and they lie between 250 to 800nm. All this process is carried out against the autoclave gum blank and this is done before and after the autoclaving.***(Kora et al., 2012***) Around wavelength of 300-700 nm was measured by Hitachi-U 2900 spectrophotometer.(***Balakumaran et al., 2016***) Hitachi H 7500 and JEOL 3010 transmission electron microscopes (TEM), operates at 80 and 200 kV are used for obtaining the shape and size of the nanoparticles. For preparing the sample, we take the drop of colloidal solution on a carbon-coated copper grid and drying at room temperature.(***Kora et al., 2012***) The x –ray diffraction (XRD) analysis was recorded with the Rigaku, Ultima IV diffractometer using monochromatic Cu Kα radiation wavelength is around lambda = 1.5406 Å and that operates at 40 kV and 30 mA. The intensity data for nanoparticles was recorded around 2θ range of 35–85° with a scan rate of 1°/min. (***Balakumaran et al., 2016***)(***Kora et al., 2012***). Bruker Optics, TENSOR 27 FT-IR spectrometer is used for recording the IR spectra of the lyophilized

samples. SUWTECH, G-SLM diode laser is used for recording the Raman spectroscopy for synthesizing nanoparticles at room temperature using the 532-nm line. The scattered light was collected by using a CCD-based monochromator because it measures the range between 150–1700 cm.(***Kora et al., 2012***) Shimazdu IR Prestige-21 FTIR instrument has a diffuse reflectance mode which measures the range between 400-4000 cm-1 at a resolution of 4 cm-1. (***Balakumaran et al., 2016***). After the synthesis of 168 hours, the sample is centrifuged at 14,000 RPM(Revolution Per Minute) for 30 minutes at room temperature.(***Mittal et al., 2014***)

1. UV–Visible Spectroscopy

UV-Visible Spectroscopy is the one of the most widely used technique that is used in the synthesis of nanoparticles observation. This is also used for the observation of an absorption spectra of synthesized of silver nanoparticles which is recorded against the autoclave gum blank(***Kora et al., 2012***) It records by a 2000c Nanodrop spectrophotometer by Thermo Scientific (USA). All the samples are diluted three times at pH 7.2.***(Salvioni et al., 2017)*** The gum role concentration is studied by autoclaving the gum solution containing 1 mM of silver nitrate for about 30 min. After the autoclaving silver nitrate containing gum solution, yellow colour appears in the reaction mixture which indicates the formation of silver nanoparticles by the gum. In this, maximum peak was recorded which is around 412 nm, which corresponds to the typical surface plasmon resonance (SPR) of conducting electrons from the surface of silver nanoparticles. The SPR absorption of metal nanoparticles like silver & gold is quite sensitive to the changes of the size and shape of the nanoparticles formed(***Kora et al., 2012***)



2. Transmission Electron Microscopy

Transmission Electron Microscopy of the synthesized silver nanoparticles is performed with gum and $AgNO_3$ autoclaved for about 30 mins and the particle size is obtained from the micrographs. The nanoparticles are isotropic in nature and of spherical shape and particle size diameter distribution is around 5.7 ± 0.2 nm.(***Kora et al., 2012***). This is also used for identifying the morphology of the sample such as Gg-gP(DMA)-Ag1 with the help of TEM (USA) which operates at 200 keV.**(*Babaladimath and Badalamoole, 2019*)** In this, various shapes are observed such as hexagonal and polygonal nanoprisms, ellipsoidal and uneven shaped nanoparticles. When 0.1% gum and 1 mM of $AgNO_3$ concentration is autoclaved for about 30 mins, it gives around 70 % of the nanoparticles with the size of about 5.7nm. When the concentration of gum is decreased by0.5 to 0.1%, particle size of silver nanoparticles is also decreased. It changes the particle shape from sphere to anisotropic nanostructure(***Kora et al., 2012***)

3. X-ray Diffraction

The structure of silver nanoparticles is determined by X-Ray Diffraction. The X-ray diffraction of the silver nanoparticles is defined as five well characteristics such as peaks at 81.9°, 77.6°, 64.8°, 44.6°, 3° respectively, which are corresponding to (311), (222), (220), (200), (111) planes of fcc crystal structure of metallic silver.**(*Kora et al., 2012*)** When there is formation of Ag NPs in the Gg-g-P (DMA) network, X-Ray Diffraction is used to identify it. Rikagu diffractometer (Germany) at 40 kV is used for the analysis.(***Babaladimath and Badalamoole, 2019***)

4. Fourier Transform Infrared Spectroscopy (FTIR)

FTIR is a technique that is used for finding out the functional group of gum and this involves the reduction and stability of the synthesized nanoparticles. Gum Ghatti's broad spectrum is 3425 cm^{-1} which is observed by stretching of the o-h group of Gum Ghatti.(***Kora et al., 2012***) The FTIR spectra of Gg and the other samples such as: Gg-gP(DMA)-1 and Gg-g-P(DMA)-Ag1 are recorded in KBr pellet form by using FTIR spectrophotometer (USA).***(Babaladimath and Badalamoole, 2019***) Some other bands are also found with the help of methods like scissoring, stretching, rocking and twisting vibrations of methylene groups. The broad band at 2122 cm^{-1} appears to assessing various carbonyl species. The strong broad band is observed while stretching the carboxylate group. The variations in the peak position and shape of the carboxylate and hydroxyl hydroxyl have been reported, where silver nanoparticles were synthesized using another polysaccharide, Gum Acacia(***Kora et al., 2012***)

5. Raman Spectroscopy

Raman Spectroscopy is used to determine the functional group of capping agent which link to the stability of silver nanoparticles. This spectrum determines the strongest and sharp band at 240 cm^{-1}, which can be found out by stretching of the Ag-O and Ag-N bonds groups. The peak indicates the formation of chemical bonds between the amino nitrogen and silver and silver and carboxylate groups of gum molecules. Due to these bands, the amino and carboxylate groups of the gum are used for capping of the silver nanoparticles. The carboxylate groups of glycoprotein of gum *Acacia* are involved in the binding of silver nanoparticles .The Gum Ghatti contains the proteins of about 2.8–3.7%. After the IR spectra is found, the Gum Ghatti contains numerous functional groups that provides the surface reactivity while capping of the silver nanoparticles.(***Kora et al., 2012***)

IV. ANTIMICROBIAL ACTIVITY

The reactive reducing agents and toxic organic solvents are required for the synthesis of the nanoparticles, which have both environmental and biological risks. The physical methods of synthesizing the nanoparticles have high energy consumption, low production rates, and consequently high cost. The silver nanoparticles which are chemogenic in nature are non-biocompatible and cytotoxic and because of the contamination due to chemical precursors, generation of hazardous by-products and residual solvent toxicity are observed.(***Singh et al., 2013***) Silver nanoparticles exhibits antimicrobial properties which is represented by their broad spectra of activity against Gram-positive and Gram-negative bacteria, fungi, and viruses. Gram-negative bacteria E. coli and Gram-positive bacteria S. exhibits properties that are similar to the silver nanoparticles.*(**Salvioni et al., 2017***) The antibacterial mechanisms of silver nanoparticles are understood by the structure of silver nanoparticles.(***Tang and Zheng, 2018***)

V. CONCLUSION

Gum Ghatti has proven to be an effective agent for the synthesis of silver nanoparticles. A number of studies have been carried but more research is required on Gum Ghatti and Silver Nanoparticles for the efficient and benefits of this field in delivering drug preparations. Gum Ghatti also showcase anti-microbial activity which also adds an advantage for the usage of Gum Ghatti. In the future we expect more research to be conducted which will help us gain knowledge regarding the Gum Ghatti bases synthesis of Silver Nanoparticles.

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