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A NOVEL METHOD OF SILVER NANO PARTICLE-GREEN SYNTHESIS, USING THE YELLOW PETAL EXTRACT OF BUTEA MONOSPERMA LUTEA MAHESWARI FOUND IN GANGETIC WEST BENGAL & THEIR CHARACTERIZATION

Suvakshan Dutta[*1], Dipsankar Saha[2], Arnab Ganguli[2] & Sandhimita Mondal[2]
[*1,2]Department of Microbiology, Techno India University, West Bengal, INDIA

ABSTRACT

There is a growing need of novel antimicrobial agents specially nano materials against multi drug resistant micro organisms. Especially the bio synthesised nanoparticles become popular as they show lesser or no toxicity and the procedure is environment friendly. Here, at the present study, silver nanoparticles (AgNPs) were obtained through green process using the aqueous yellow petal extract of *Butea monosperma lutea* Maheswari. The synthesised particles were characterised by UV–visible spectroscopy, Fourier Transform Infra-Red Spectroscopic study (FTIR), X-ray diffraction data (XRD), Scanning Electron Microscopy (SEM), Dynamic light scattering (DLS) and Zeta potential. These together confirm the formation of silver nano particles.

Key words: *Silver nanoparticle, petal extract, green synthesis, Butea monosperma lutea*.

I. INTRODUCTION

Approximately the time-span from the mid 20th Century to late 20th century is known as golden era of antibiotics. But from the beginning of the new millennium or in last two decades the situation has changed drastically as there is no invention of new class of antibiotics. Meanwhile, multi drug resistant micro organisms slowly but steadily occupying the battle field and made their presence felt. "The prevalence of multidrug resistance has increased worldwide and there is an urgent need of another option to control the multidrug resistant strains" [1]. At one point of time it seems that the research community is battling a losing game as no stronger antibiotics are found to fight against these multi drug resistant (MDR) micro organisms. In this scenario, at the beginning of 21st Century, there comes nano technology. Nano sized materials develop certain special characteristics, hitherto unknown, as also certain other characters get augmented in comparison to the original (parent) macro or micro sized particles. This has led to the development of Nanotechnology. Nanomaterials are easily produced from reducing different metal salts of Ag, Au, Pt, Pd using varieties of methods, including hard template [2], using bacteria [3], fungi [4] and plants [5]. "While chemical synthesis procedures can lead to the generation of toxic chemical by-products or require high temperatures and/or pressure, biosynthesis of nanoparticles using plant extracts provides a facile and green method of nanoparticle synthesis" [6]. In last few years, the plant mediated bio synthesis of metal nanoparticle is gaining huge popularity because it is fast, environment friendly and nonpathogenic. Green synthesis normally involves a few non complicated steps unlike other chemical or physical techniques where high energy, pressure, temperatures are required. Thus it becomes an energy saving process too. Moreover its large scale production is cost effective. Various metabolites present in plant parts such as sugar, flavonoids, phenolic acids, terpenoids, polyphenols etc acts as an important reductant for the transformation of metallic atoms/ions into nano sized materials. Here active biological components play the role of the reductant and cap. Mainly due to these reasons I found plant extracts are the most suitable candidate to produce silver nano particles using green chemistry. "Silver has long been recognized as an antiseptic and anti-biotic since it is having an inhibitory effect towards many microorganisms" [7]. Silver and its products are used in biomedical purpose, improvement of air and water quality, production of food, clothing, cosmetics etc. because of its broad range antimicrobial properties. "With the rapid progress of nanotechnology, applications of nanomaterials have been extended further, and now, silver is the most commonly used engineered nanomaterial" [8]. Many researchers are already using variety of plant parts for the making of nano sized silver particles. Traditionally in India, different species of *Butea* is used to heal anti-

inflammatory, antimicrobial, anti-diabetic problems for centuries. In Ayurveda also it is mentioned to cure various diseases. The flowers of *Butea* sp. are vastly used as a dyeing material and fabric colour. Now a days, it is also used to prepare the traditional organic gulal/abir (colouring powder). "There are reported works on an environmental friendly process for the synthesis of silver nanoparticles using *Butea monosperma* bark extract which is used both as a reducing as well as capping agent at normal room temperature and pH" [9]. "There are even reports of delivery of anti-cancer drug to the cancer cells using green synthesized silver and gold nanoparticles" [10]. To date, there is no record on the synthesis of silver nanoparticles using the yellow petal extract from *Butea monosperma lutea* Maheswari.

II. METHOD & MATERIAL

Materials
The chemicals used in this experiment were of highest purity.
Silver nitrate ($AgNO_3$) bought from RANKEM, CAS No. 7761-88-8.
Sodium hydroxide (NaOH) bought from RANKEM.

Site Selection: Yellow flowers of *Butea monosperma lutea* Maheswari. were collected locally from Banabitan, Salt Lake, Kolkata (Latitude- 22^0 5864' N, Longitude- 88^0 4155' E).

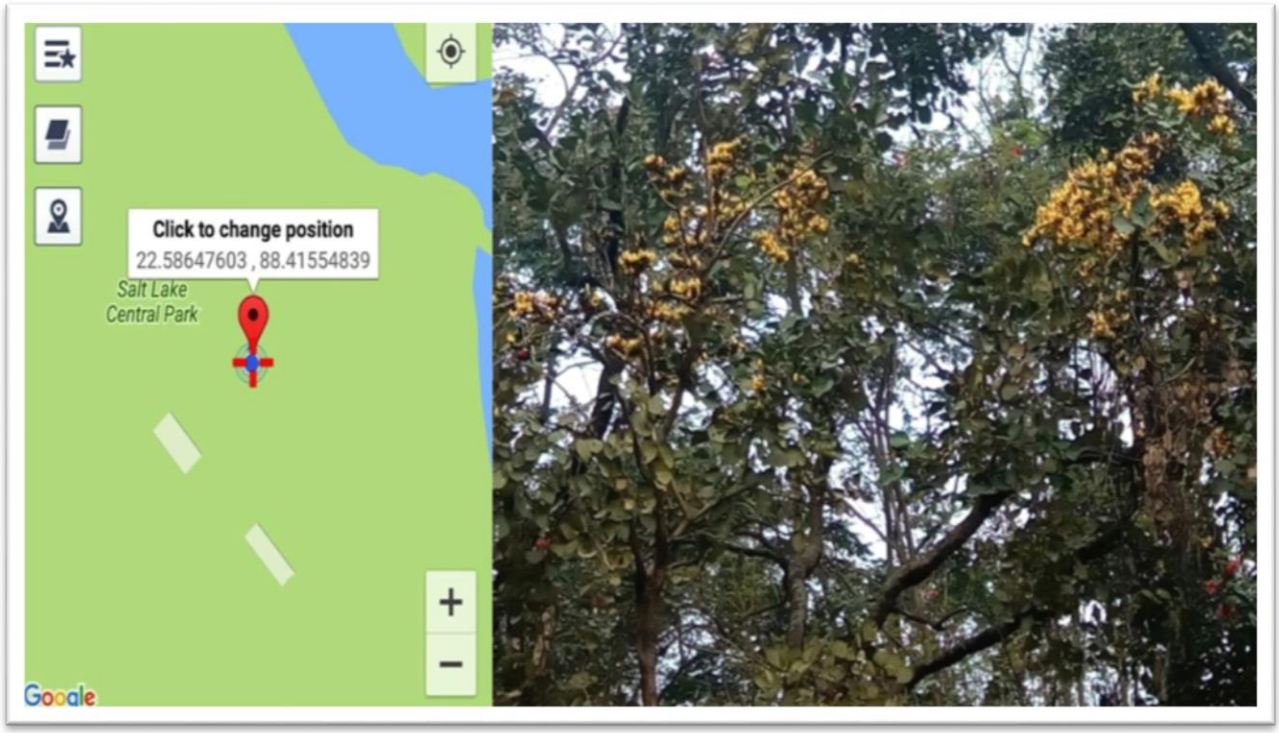

Fig1 : Location tracker Butea monosperma collection

Aqueous Petals extract preparation:
250ml distilled water added with 25gm petals and filtered through Whatman filter paper (paper no.1 and pore size 125mm). The extract was pre- heated for 4 hours at 40ºC and stored for further experiments. And produce 250ml extract.

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Experiment:

Freshly prepared 750ml $AgNO_3$ salt solution was added with 250ml of extract at ambient temperature and stirred continuously for 45 min using magnetic stirrer. Slow reduction took place and it was kept for 24 hours to obtain the color change by bio-reduction process. After 24 hours, bright green color changed to dark brown color which was indicating the formation of silver nanoparticles (Fig. 2C). By several rounds of centrifugation at 10,000 rpm for 15 min using REMI R-8C Centrifuge, the silver nanoparticles (AgNPs) obtained from the solution were purified. The AgNPs obtained were dried and stored for further analysis.

III. RESULT & DISCUSSION

Synthesis of Silver nanoparticle

The Silver nitrate solution & petal extract goes through bio-reduction process and significant colour change was observed. The clear solution turns to dark brown which was the indication of Silver nanoparticle formation. Clear $AgNO_3$ solution & addition of petal extract is shown at Fig. 2(A), the change of colour is shown at Fig. 2(B), and at last complete change of colour by the process of reduction is shown at Fig. 2(C).

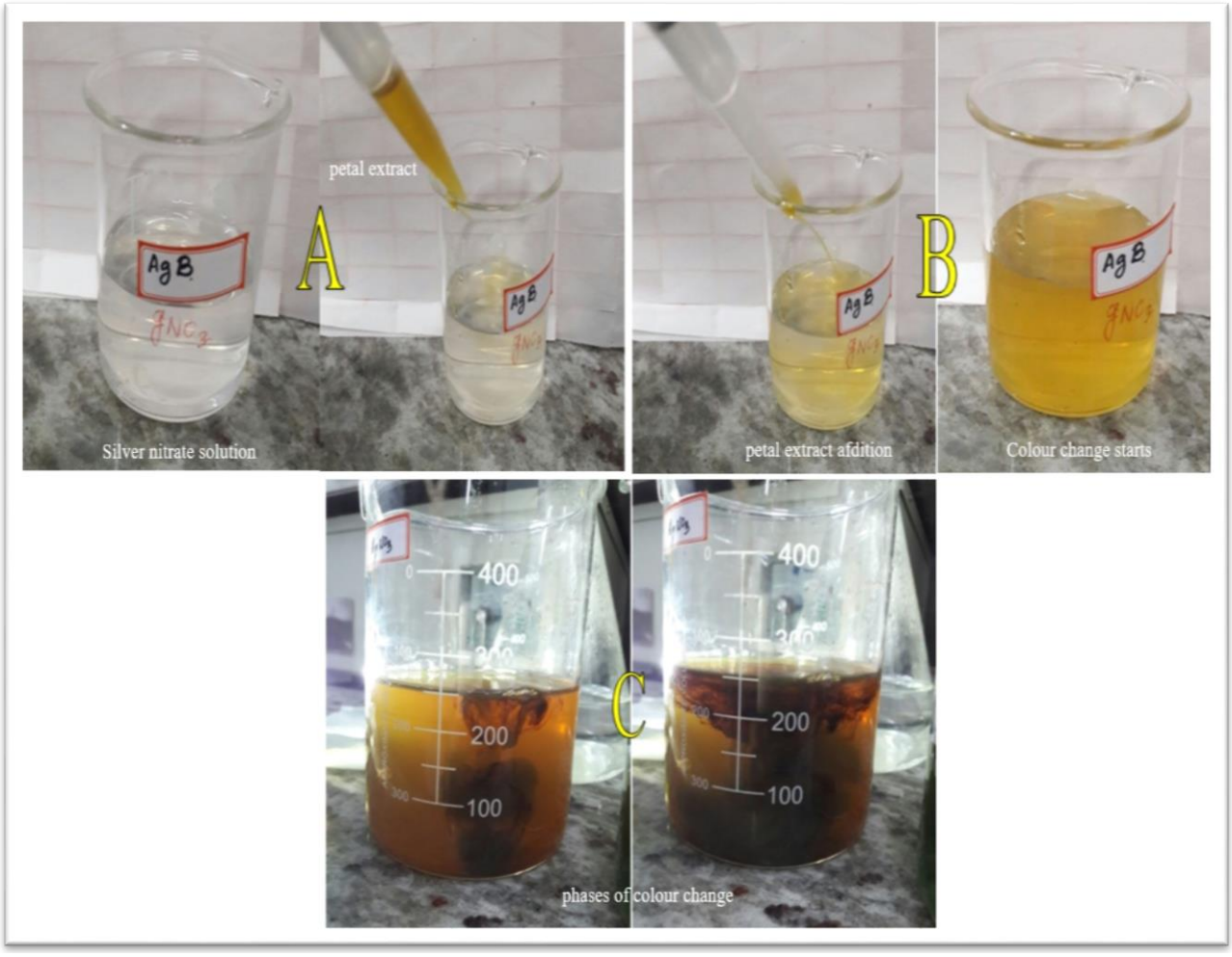

Fig 2: Formation of AgNPs: Bio reduction procedure (A-C)

Here the color intensity increased & changed with time owing to Ag^+ ion reduction. The silver ions have undergone reduction procedure and it was visibly manifested by the changing of colour associated to it. Fig.2 shows the

addition of petal extract to $AgNO_3$ solution (A), the initial phases of color changing (B) and totally changed colour of the solution (C). Here, Ag^+ transformed into the Silver nanoparticles under ambient conditions after hours during its preservation. The extract played a pivotal role in the making of Silver nanoparticle. It may be noted that excitation of surface plasmon vibration with the silver nanoparticles is primarily responsible for change in colour of solution.

Characterization of *Butea monosperma Lutea M.* Mediated Green Synthesized Silver Nanoparticles
UV-Vis Spectroscopy
The electronic spectra of the synthesised silver nanoparticles are being shown in Fig. 3. The study was performed over the absorption range of 200-800 nm. It resembled surface-plasmon characteristic of AgNPs.

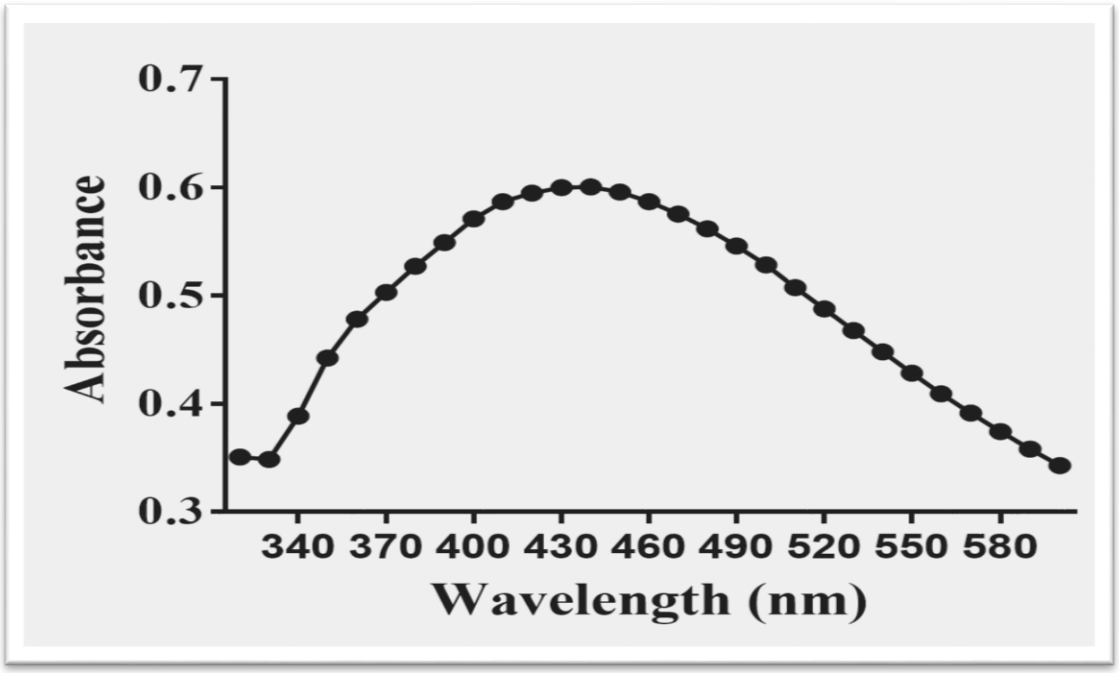

Fig 3: Absorption spectra of the synthesised Silver Nanoparticles

The electronic spectra exhibit a peak at 438 nm, because of surface plasmon resonance (SPR).
In metal NPs, the conduction band & the valance band are near to each other permitting the electrons to move across the bands freely. This leads to a surface plasmon resonance (SPR). Here the colour of the Silver Nanoparticles is dark brown. The λ_{max} of absorption peak depends on size of particles, dielectric constant of medium and chemical environment. The electronic spectra indicated the surface plasmon property, characteristic of Silver nano particles.

FTIR Spectroscopic study
The FTIR study of green synthesized silver nanoparticles were carried out and Results of FTIR study showed sharp absorption peaks at about 1592.21 and 3366.89 cm^{-1} (Fig.4).

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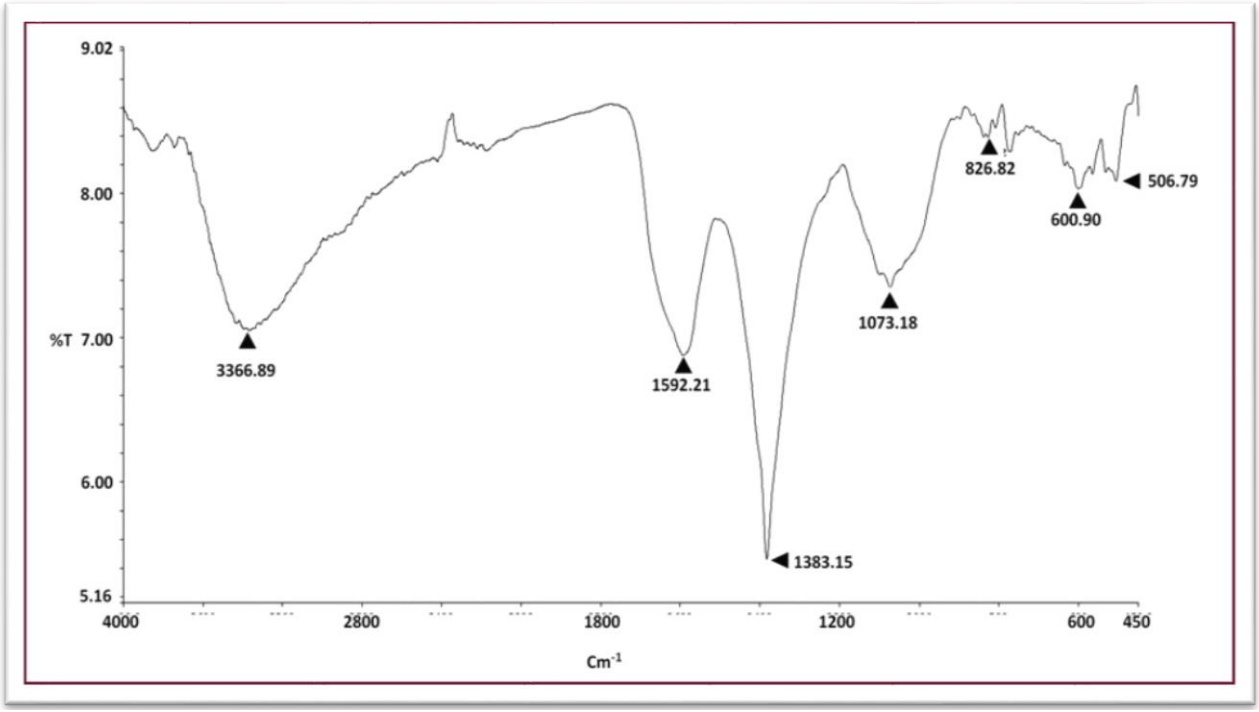

Fig.4 FTIR pattern of synthesized Silver Nanoparticles

The absorption peak at 3366.89 cm^{-1} is assigned to moderately H-bonded –OH stretch in alcohols & phenols. (free –OH stretch appears at around 3650 cm^{-1}). The absorption peak at 1592.21 cm^{-1} corresponds to sequestered carbonyl stretch. Unencumbered Carbonyl stretch appears at about 1700 cm^{-1}. Sequestering with Ag+ weakens the C=O bond and hence the consequent lowering of stretching frequency.

The bands that arise at 1383 cm^{-1} & 1073 cm^{-1} indicate skeletal vibration of organic residues which might be assigned to aliphatic C-H bending vibration and the presence of C-OH stretch in alcohols, as also to the presence of glycosidic linkage in components of *Butea monosperma Lutea* M respectively. The rest at lower frequencies are the finger print region due to unassigned bending vibrations.

These IR spectroscopic studies confirm the presence of sequestered Carbonyl group, moderately hydrogen bonded –OH groups (alcoholic, phenolic), glycosidic linkage in the organic residue that are in strong bonding environment with AgNPs, resulting in the formation of a coverage layer around the metal nano particles. This coverage layer acts as the cap and does not allow agglomeration, also provide stability in the medium and otherwise.

XRD Study

X-ray diffraction (XRD) on powder samples was executed for researching the crystallinity of synthesised AgNPs. The findings are represented in Fig. 5

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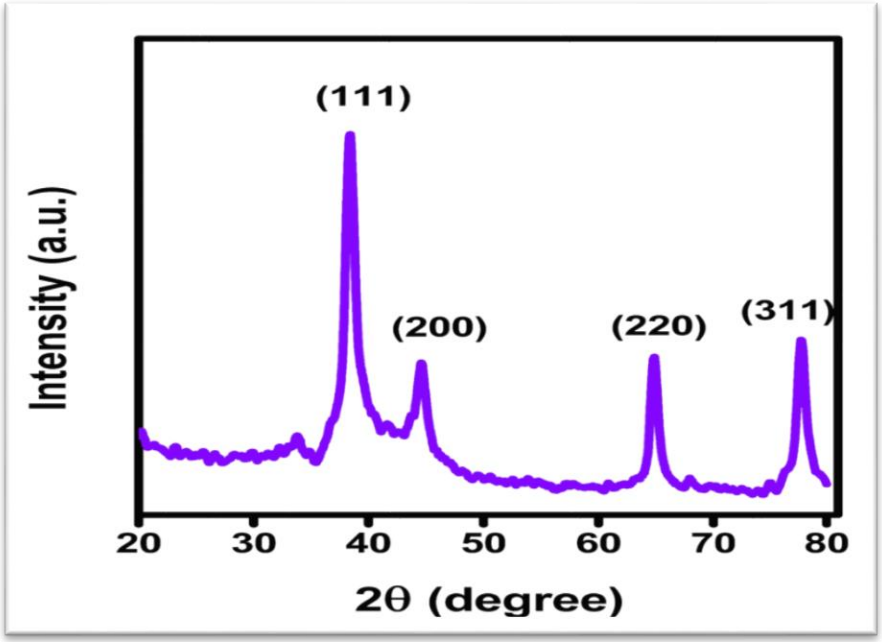

Fig.5 XRD study of synthesized Silver Nanoparticles

The XRD peaks of the graph are a good match with cubic AgNPs corresponding to ICSD data 01-087-0718. The evidence is the diffraction peaks at 2θ values = 38.20°, 44.40°, 64.6°, and 77.6° which correspond to (111), (200), (220), and (311) sets of lattice planes. From this data we can conclude that silver is the main component of the crystalline nanoparticles. The crystallite size (τ)was calculated using Scherer's equation "τ= 0.94λ/βCosθ, where λ wavelength of X-ray used (1.54 angstrom) and β is full width at half maximum of the peak 111. The equation gave the crystallite size to 58.82 nm along that plane.

Scanning Electron Microscopy

Scanning Electron Microscopy (SEM) analysis was done to further characterise the size, shape and morphology of the green synthesized silver nanoparticles. This finding is represented in Fig. 6.

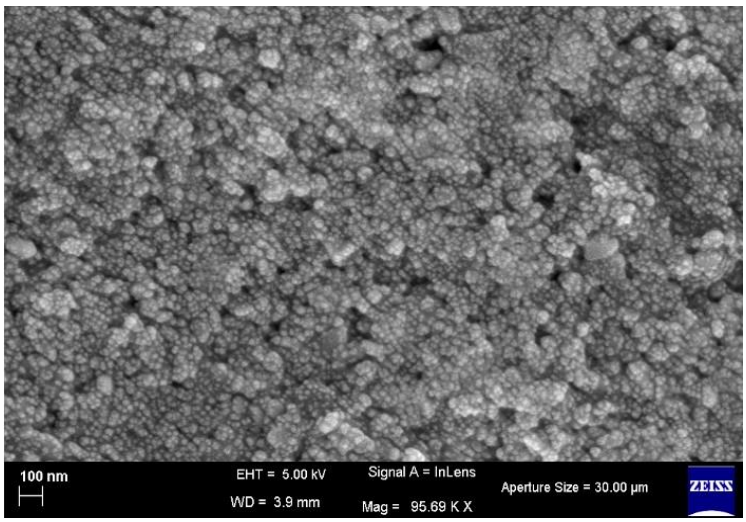

Fig.6 SEM images of synthesized Silver Nanoparticles

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The SEM morphological study of silver nanoparticles showed that AgNPs had almost spherical geometry with well-defined structure. SEM analysis also showed the silver nanoparticles were distributed uniformly on cell surfaces; though all the nano particles may not be bound to cell surfaces, because all those dispersing in the medium, can also deposit on the cell surfaces. The image (Fig. 6) has shown separate silver nanoparticles as well as particle agglomeration. This study indicates that the particle size is irregular and the shape is spherical. The sizes of nanoparticles were of 51.90 nm approximately.

Dynamic light scattering (DLS) and Zeta potential

The DLS technique was used here to evaluate mean size of particles, distribution and polydispersity index (PDI) of synthesised silver nanoparticles by green method.

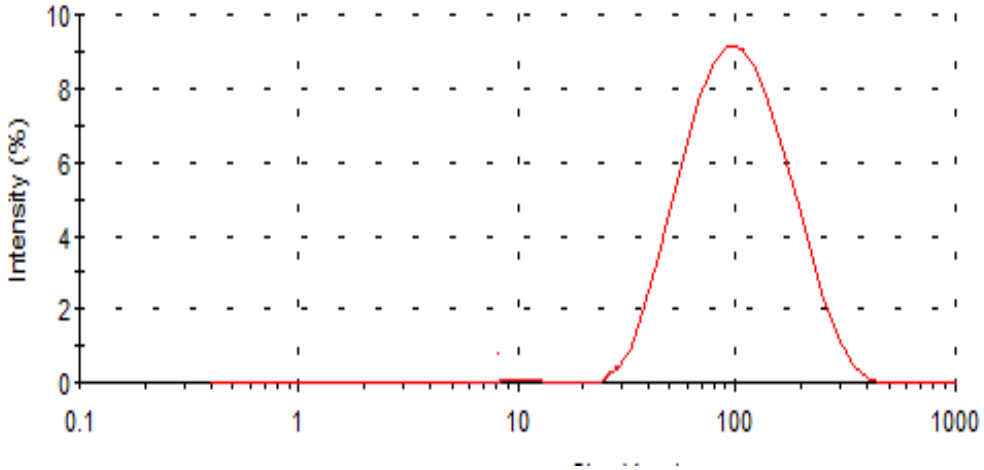

Fig.7: DLS study of synthesized AgNPs

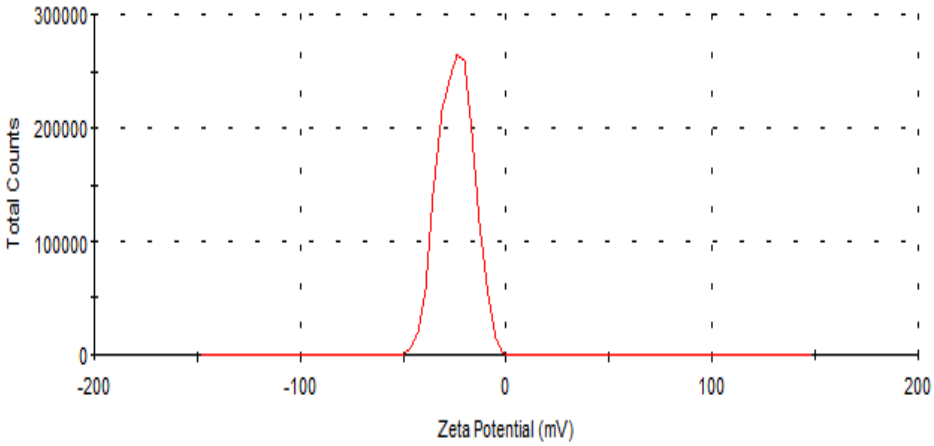

Fig.8: Zeta potential of synthesized AgNPs

The result showed nanoparticles had a Z average diameter of 60.23 nm. Now relating the number in percentage with polydispersity index (PDI) of 0.632 we can suggest the synthesised nanoparticles were highly dispersive in aqueous medium. Another interesting data regarding the particle size was revealed here. The actual diameter obtained from SEM image was lesser than the hydrodynamic diameter of the nanoparticles obtained by DLS. Synthesised silver nanoparticles showed the zeta potential value of -25.32 mV. It indicates that because of electrostatic repulsion the AgNPs showed good stability in water. The organic moieties act as space-fillers to prevent close association amongst silver nanoparticles. The zeta potential value and stability of the synthesised AgNPs together gave a clear

indication of an electrosteric mechanism. We guess the petal extract constituents absorbed by nanoparticles, acts as a separator & hinder close contact between particles.

IV. CONCLUSION

The present study indicates a successful green synthesis of Silver nanoparticles where yellow petal extract of *Butea monosperma lutea* Maheswari acts as biological reducing agent. Moreover, the phytochemicals of *Butea* sp. was absorbed by nanoparticles and it played the role of capping agent. As we use bare minimum amount of chemicals during the procedure there is almost no scope of chemical toxicity & harmful effluents. Hence the procedure becomes environment friendly too. The different characteristic assays evaluated the synthesis and minute size of silver nanoparticles. Here, for the first time we have reported the synthesis of silver nanoparticles by the aqueous petals extract of the plant. In future different antimicrobial activities can be determined by using this green synthesised silver nanoparticle.

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