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Silver Nanoparticles Mediated Through Green Route Using Pyrus Seed Extract

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ABSTRACT

Progress in biological sciences inspired mediation of silver nanoparticles through biological route. Nano particle synthesis is demand of Nano technology as these particles are being used in the research areas like, catalyst, energy, chemistry and medicines. Synthesis of nanoparticles through green route has been reported using extract of plants, which has characteristics like emulsifying and stabilizing agent. Various biological sources are identified aimed at the green synthesis of Nano silver yet still work being done on identifying new sources. In this work Nano particles of silver has been synthesized at room temperature by using pear (Pyrus) seed extract. Pyrus seed extract is good in terms of conversion and reducing rate. Synthesized green Nano particles were confirmed by UV-Visible, and other thoughtful techniques like FTIR, XRD and SEM. Polyphenols act as stabilizing and also reducing agent in this process. Nucleation of silver nanoparticles started to proceed after two hours. Phenolic groups which act as reducing agents for silver Nano particles were confirmed by FTIR spectra. Spherical morphology of silver Nano particles were confirmed using SEM between range of 11-28nm. Four prominent peaks of silver has been shown on XRD spectra. So it is recommended to produce silver Nano particles through green route as it is inexpensive, convenient and ecofriendly process and it is applicable to several industries like medicine, Nano electronics etc. For the first time Pyrus seed extract is used to synthesize Nano silver.

KEYWORDS: 1. Nanotechnology 2. Green route 3. Pyrus seed 3. SEM 4. Silver nanoparticles 5. XRD 6. FTIR 7. Biological synthesis

Graphical Abstract

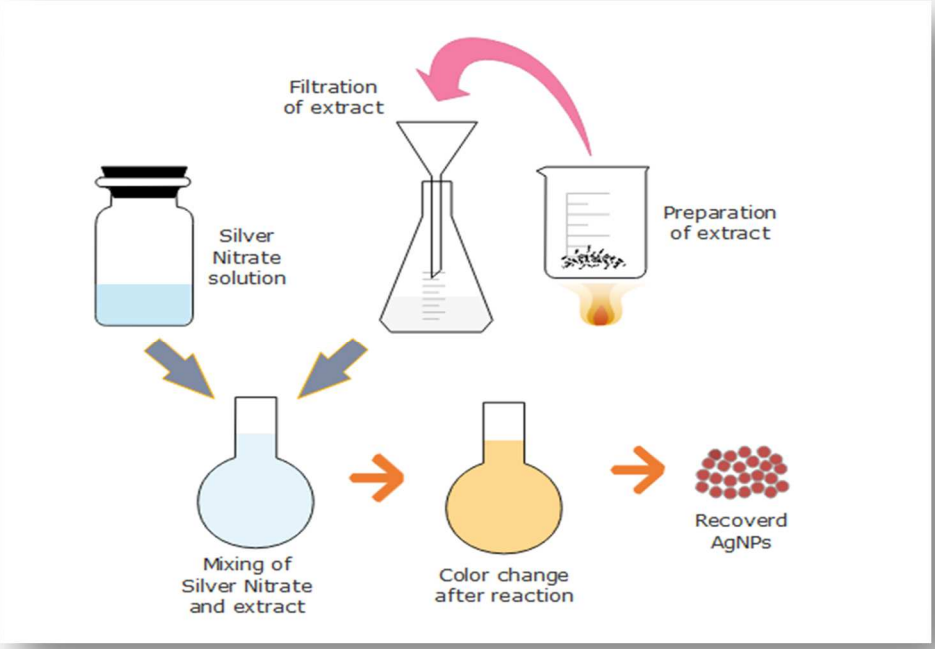

Fig. 1 Graphical abstract of silver nanoparticle synthesis through green route using Pyrus seed extract

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INTRODUCTION

Nanotechnology has been exploring ways to produce nanoparticles which are inexpensive as well as beneficial and can be used commercially. Nanotechnology is predictable to contribute too many technological advances of 21st century. Nanoparticles possess lager surface area and helpful physiochemical properties i.e. morphology, size and distribution [1].

Nearly five thousand years ago Romans, Greeks and Persians were found using silver to store and preserve food [2]. In several dynasties the use of silver utensils were common for eating and drinking purpose probably due to its antibacterial action [3]. Silver was used as antimicrobial agent before the Alexander Flemmings's discovery of antibiotics.

With the development in nanotechnology various new nanomaterials are appearing which are contributing in different technological fields. The areas of science which comes under constant interest of nanotechnology are electronics, catalysis, environmental and biological sciences [4, 5]In the field of nanotechnology due to the broad scope of application meditation of silver nanoparticles shown its importance [6]New emerging field of research are explored in Nano sciences [7][[8][[9].

Synthesis of nanoparticles are carried out and stabilized by chemical methods and now a days through green route. Now a days mostly nanoparticles are made from Nobel metals like silver, platinum, gold and palladium but for making nanoparticles through green route but silver is the best choice among metals as per they can be further used in medical field [10].

There are different methods to produce wide spectrum of silver Nano particles. Typically chemical methods are used for chemically reduce metal ions into nanoparticles [11, 12]. Now it's become important to avoid chemical methods to produce nanoparticles as chemical used during this process can be toxic as to avoid its adverse effects in medicinal field. The green route for synthesizing nanoparticles are better method then the chemical one as no strict conditions of temperature, pressure an energy is required [13]. The use of pure natural material like seed extracts or microorganism proved very beneficial in biomedical applications [14, 15] [16] [17] [18] [19] [20] [21].

There is an increasing public problem that disease causing microbes are becoming resistant against drug therapies so it's the need of time to produce antimicrobials. Silver Nano particles has advantage of showing toxic effect against variety of microbes [22]. In the formation of nanoparticles kinetics of solution play a vital role as it effects their size. For developing of synthesis route process parameters are very important factor.

Consumption of seeds in production of Nano silver is quite innovative way which leads to strictly green process chemistry which can deliver improvement over chemical and physical process by means of its cost effectiveness and environment friendliness. In this study, Nano silver was produced using Pyrus seed extract as reducing agent for silver nitrate solution. Reaction parameters are well optimized for better reduction of green silver nanoparticles. Pyrus has several species most of them used as edible fruit and it is also cultivated as ornamental plant. Pyrus nutrition values are good in curing diseases, intake of flavonoids can decreased the risk for diabetes of type-2. Pile acid in intestine can be reduced by Pyrus fibers, it decrease the risk of colorectal cancer [23, 24].

MATERIALS AND METHODS

Material:

Analytical grade silver nitrate is used as obtained by sigma Aldrich. Pyrus are obtained from the suburbs of Swat (Pakistan) and their seeds being extracted from the fruits and are dried for further use. Deionize water is purchased from science center, Pakistan. Distill water and analytical grade acetone for washing purpose are taken from SCME, NUST.

Preparation of seed extract

Pyrus seeds are being extracted from the fruits. At room temperature seeds were collected and dried for three days. Deionized water is used to wash dried seeds and their aqueous extract was being prepared. Prepared extract had been centrifuged and then filtered through filter paper for recovering a clear solution. Freshly extracted seeds of Pyrus were being washed and then put it under direct sunlight till they became fully dried. The extract was prepared by first grinding them and then this powdered biomass is boiled in distill water to get the pure extract after filtration.

Green mediation of silver nanoparticles

Filtrate was utilized immediately for silver Nano particles activity which served while reducing and stabilizing agent. 15 mL aqueous Pyrus extract is added to 90 mL of AgNO3 with molarity of 1 mM was mixed using a magnetic stirrer. The effect of temperature has been studied and silver nanoparticles are synthesized at 70°C. Stirring is being

done to aid reduction change of color is also observed from pale to reddish brown. The emergence of light orange to minor reddish brown color in whitish color solution is indication of silver nanoparticle synthesis by almost all the scientists. To split up unreacted species involving reaction mixture from synthesized silver Nano particles, the mixture was then centrifuged on 4000 rpm pertaining to 25 min and also washing is being done for three times using deionized water . Moisture-less powder of the silver nanoparticles had been obtained by vacuum oven drying.

UV-Vis analysis

Confirmation analysis of Nano silver was done on UV-Vis spectrometer using broth of nanoparticles. The maxima has been scanned on the range of spectra between 200-800mm.

XRD analysis

For examining the quality and type of compound which has been produced during the reaction XRD is being carried out. Using dried powder sample of silver nanoparticles was prepared for the STOE Theta/theta diffract meter which is operated on 40KV with current of 30mA and radiations of Cu Kα between ranges of -10°-168°.

FTIR analysis

FTIR sample pallet was prepared by mixing silver nanoparticles with KBR obtained from sigma. Disc preparing machine was used to press the sample to make it into disc shape. Then disc sample was placed in FTIR for analysis which is carried out in ranges of 4000-400cm^{-1} with resolution of4.0cm^{-1} and the model which is used to do analysis was Model-Perkin Elmer spectrometer FTIR spectrum 100.

SEM analysis

Suspension of nanoparticles in deionize water was prepared by sonication to do SEM analysis. Further the drop of suspension used to put on clear dry stubs and allowing water to vaporize. Samples were sputtered coated with gold. The model used foe SEM analysis was JEOL-6490A-JSM SEM with current of 41 Ma and 15 KV voltage.

RESULTS AND DISCUSSION

During reaction of Pyrus seed extract the color change is seen from pale to orange and then reddish brown. This is the indication of production of silver nanoparticle from silver ion. In fig 2. Showing UV spectra of silver nanoparticle broth. The peak which shows the occurrence of Nano silver is shown between range of 415-420mm it shows that the silver nan particles has isotropic shape and their size is uniform. This band is called SPR surface Plasmon resonance. Results suggests the release of proteins into the filtrate which is the possible way to reduce silver ions [25]. Change of color in broth was observed from pale to reddish brown as shown in figure 3. It can be possible due to longitudinal vibrational motion of silver nanoparticles in broth.

SEM images shown in figure is taken from the drop coated film of nanoparticles of Pyrus seed extract. SEM images display spherical shape of Nano silver with size ranges from 11-28 nm.

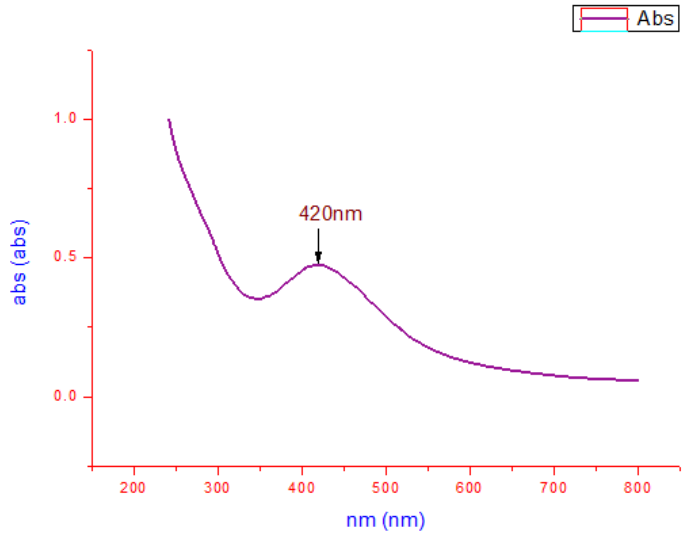


Fig.2 UV-Vis spectrometer graph of Nano silver.

Fig.3 Picture of aqueous Pyrus seed extract and broth after reaction respectively.

XRD studies show numbers of Bragg's reflections, Spectra of XRD is shown in Fig 4. The XRD graph in fig4 confirms the crystalline structure of silver NPs. The identified peaks represents the face centered cubic (FCC) crystal structure of Nano silver. Average size of silver Nano particles as evaluated from this XRD data is found to be around 10nm. It is relatively in accordance with the known particle size measured from SEM. The relatively high intense peak at (111) in accordance with other shows the direction of nano crystal growth. The broader diffraction peaks indicates the size of crystallite to be very small.

Debye-Scherrer's equation (d = (kλ×180)/ β Cos θβ Π) is used to calculate the average particle size by defining the width of the (111) Bragg's reflection where , β and θβ are full width half maximum of the Bragg angle, λ is the wavelength of the X-rays, k is Scherrer's constant, the projected mean particle size was 10 nm.

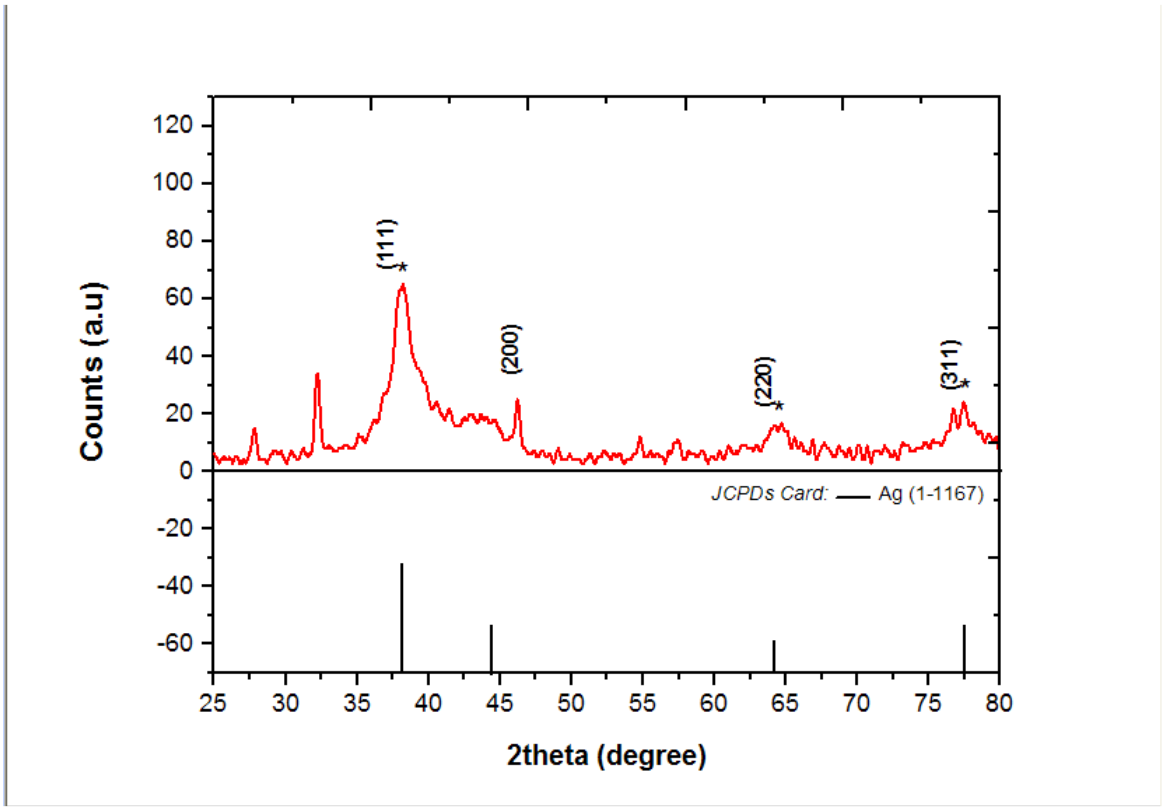


Fig.4 XRD graph for Nano silver synthesized using Pyrus seed extract.

FTIR measurements are taken for silver nanoparticles made by Pyrus seed extract to check and indicate different functional groups present in it. Fig 4. Shows FTIR analysis of silver Nano particles. A strong band is observed at 2378 cm-1 along with two other shoulder peaks at 1621 cm-1 and 1318 cm-1. 2378 cm-1 indicates the strong aliphatic C-H stretching vibration and the additional shoulder peaks correspond to silver ions. The FTIR spectra of Ag NPs exhibited prominent peaks at 3431; 1616; 1381; 1045; 818; 509; and 420 cm(-1). The alkenes C-H absorption 675-100 cm-1. The carbonyl (C=O) absorption 1690-1760cm-1 (indicates an aldehyde, ketone, carboxylic acid, ester, amide, anhydride or acyl halide). The alkenes group C-C 2100- 2260 cm-1. The c-c either alkenes above 3000 cm-1. The O-H or N-H group stretching 3200 - 3600 cm-1 (amine or amide).
The proteins could possibly form nanoparticles which has strong effect for binding metal that is capping of Nano silver as to elude agglomeration and stabilizing the medium.

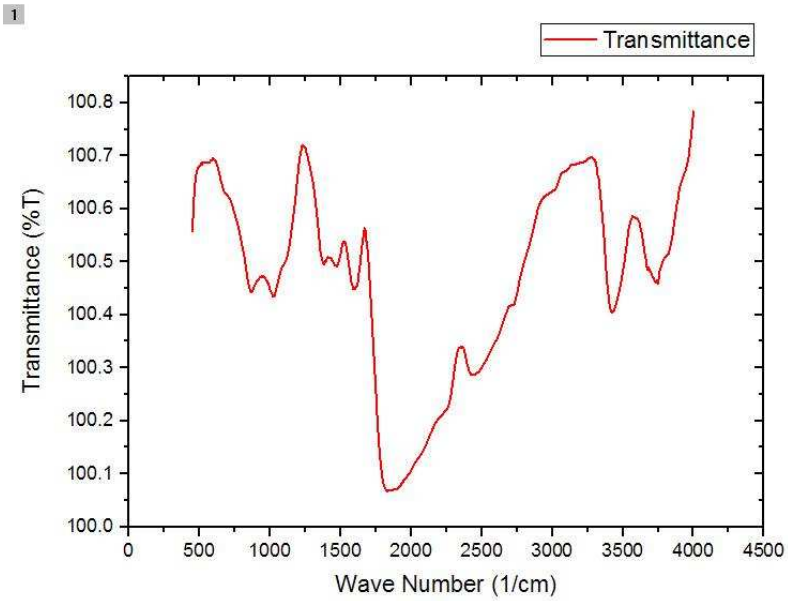
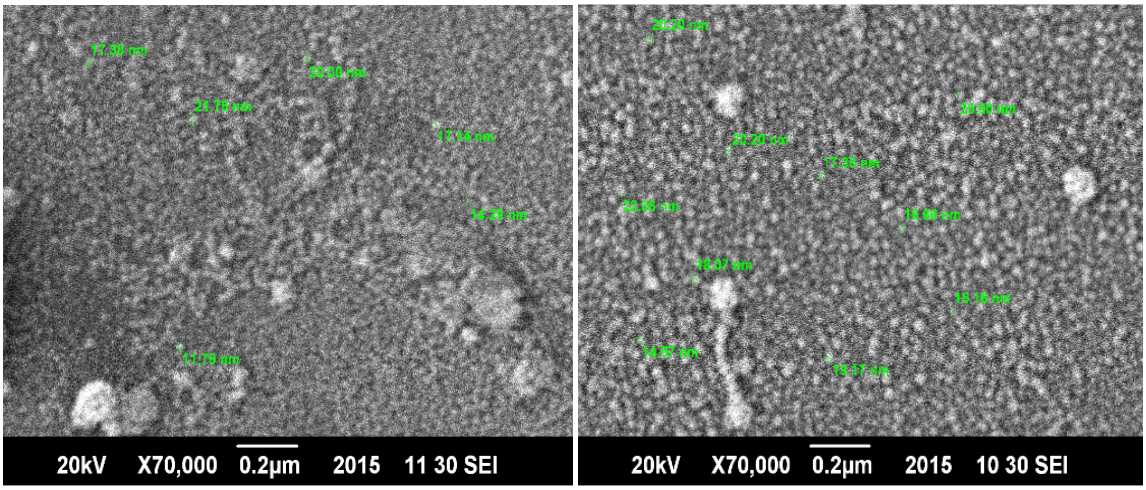


Fig.5 FTIR spectra of Nano silver synthesized using Pyrus seed extract.

The SEM analysis shows the uniformly distributed nanoparticles of silver.



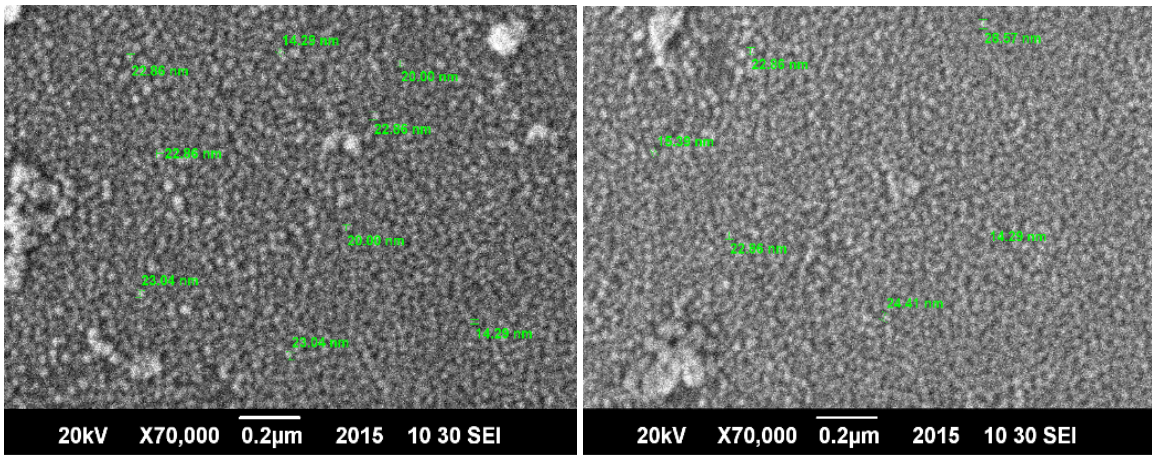


Fig. 6. SEM images at different magnification showed the formation of nanoparticles

Conclusion

Mediation of Nano silver through green route is efficient and fast method. Using Pyrus seed extract the nanoparticles which were synthesized are of average particles size of28nm. The stability and production of silver Nano particles are confirmed using the techniques like UV-Vis, FTIR, XRD & SEM which shown results in favor of nanoparticles. The XRD conformed the FCC structure of nanoparticles. Nano particles synthesized through this method is cost effective as it do not need any expensive pre-treatment step. These nanoparticles can be used in food, pharmaceutical and medicinal fields. The most probable use of silver nanoparticles in cancer treatment for their use as drug carriers, as biosensors for metabolites and pollutants, also as catalyst etc. is quite high and needs thorough and integrated research activity for harnessing it.

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