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"Banana extract synthesized silver nanoparticles have higher stability as compared to orange extract synthesized silver nanoparticles."

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ABSTRACT

Phyto-mediated synthesis of silver nanoparticles (AgNp's) was carried out using aqueous extracts of banana and orange fruits to check the stability of nanoparticles. The characterisation of synthesized nanoparticles was carried out using UV-Vis spectrophotometry, SEM, PSA and zeta potential analysis. UV-Visible spectrophotometry of synthesized nanoparticles solution showed plasmonpeak absorbance at 452 nm and 401 nm for banana and orange extracts respectively. SEM analysis revealed that spherical or cocci shaped silver nanoparticles were synthesized from both the extracts. PSA analysis described that silver nanoparticles of size 344 nm and 325 nm from banana and orange extracts were synthesized respectively. Zeta potential analysis showed that the silver nanoparticles (AgNp's) synthesized by banana extract had higher stability as compared to orange extract synthesized nanoparticles.

Keywords- Silver nanoparticles (AgNp's), Green synthesis, Biogenic, UV-spectrophotometry, SEM, PSA, Zeta potential, Orange peel, Banana leaf.

Introduction

In recent times the noble metal nanoparticles are subject of focus in research due to their unique optical, electronic, mechanical, magnetic and chemical properties which significantly differs when in bulk metal form.[1] Silver shows the same difference in several properties at nanometre level. These properties make nanoparticles suitable for several applications across various fields including the field of biology. Nanoparticles are reported to haveanti microbial activity[2] and they be used for cell tagging and drug delivery.[3] The biosynthesis process of the silver nanoparticles has been a cost-effective, less time consuming process and is simple to perform. Many of the nanoparticles synthesis or production methods involve use of hazardous chemicals, low material conversions and high energy requirements.[4,5] However using the process of biosynthesis for the production of AgNp's provides a single step technique along and a eco-friendly protocol. Instead of chemical methods for synthesis of silver nanoparticles, usage of plant extracts are a preferred alternative.[6]

Nanoparticles are rapidly used nowadays for formation of aptamer biosensors.[7] The microbial enzymes or the plant phytochemicals with anti-oxidant or reducing properties are usually responsible for reduction of metal compounds into their respective nanoparticles.[8,9] Biological reducing agents such as flavonoids, tannins and vitamin C can be used instead of chemical ones, so as to solve problems of price and pollution, among others. It has also been stated that silver nanoparticles possess antioxidant property.[8,9]

Silver nanoparticles are produced by the reduction of silver ions to neutral silver atoms. This is done by the reduction of silver ions using a reducing agent. Reports suggest that nanoparticles can also be applied as a conjugated biosensor for reaction oxygen species in diabetes. Nanoparticles can be used to monitor the oxidative status of tissues invivo using conjugated biosensors.[10,11]

In this study the banana leaf was used, along with orange peel. Banana plant is the largest herbaceous flowering plant. All the above-ground parts of a banana plant grow from a structure usually called a "corm". Plants are normally tall and fairly sturdy, and are often mistaken for trees, but what appears to be a trunk is actually a "false stem" or pseudostem. Leaves are spirally arranged and may grow 2.7 metres (8.9 ft) long and 60 cm (2.0 ft) wide. They

are easily torn by the wind, resulting in the familiar frond look.all modern edible parthenocarpic (seedless) bananas come from two wild species – Musa acuminata and Musa balbisiana.

Citrus sinensis of the family Rutaceae is also known as orange. Oranges, like most citrus fruits, are a good source of vitamin C.[12,13] This study reports the synthesis of silver nanoparticles due to the reduction of aqueous Ag+ (1mm) ions by the fruit extract of orange and banana .The reduction of metal ions is fairly rapid, occurs readily in solution[14,15]. It has also been reported that polymer nanoparticles show similar activities.[16,17,18]

Materials and Methods.

Materials-

Banana leaf and orange peel used for the preparation of extract which was procured from a local supermarket. The silver nitrate was supplied by Sigma-Aldrich Chemicals. The aqueous solutions used for synthesis were made using deionised water.

Preparation of Sample Extract-

25 gms of Banana leaf(Musa paradisiaca) and orange peel (Citrus sinensis) were accurately weighed, thoroughly washed under running tap water followed by washing it with double deionised water to remove surface impurities. They were cut into small pieces. After homogenisation 25 ml double deionised water was added and heated and maintained at 80°C for 5 minutes. The extract obtained was filtered through muslin cloth and then through Whatmann No.1 filter paper pore size 25 µm. The prepared extract was centrifuged at 5000 rpm for 10 mins for the debris to settle. The supernatant was taken for further synthesis of AgNp's.[19,20,21]

Synthesis of silver nanoparticles- Silver nitrate ($AgNO_3$) solution (1 mm) was prepared by dissolution of 0.017 g in 100 ml distilled water. 20 ml of extract was added to 5 ml of 1mm $AgNO_3$ solution at room temperature. The mixture was allowed to stand for approximately 30 mins to 1 hour until a yellowish brown colour solution was observed. The solution was incubated at room temperature for 24 hours and then silver nanoparticles were separated by centrifugation at 12000 rpm for 30 mins. The pellet was dried and used for further analysis.[22,23,24]

Fig.1. a).Banana extract treated with AgNO3 b). $AgNO_3$ solution c). Orange extract treated with $AgNO_3$

Characterization of silver nanoparticles:

UV-Vis spectroscopy

Silver nanoparticles have shown yellowish brown colour in aqueous solution due to excitation of surface plasma vibrations in silver nanoparticles.[25] After adding the extract with silver nitrate the colour of the solution changed from clear to yellowish brown due to the reduction of Ag+ into Ag0 which had shown the formation of silver nanoparticles.[26] Silver nanoparticles exhibit interesting optical properties directly associated with localized surface plasmon resonance which highly depends on the morphology of the nanoparticles to determine the time point of maximum production of silver nanoparticles[27,28,29]. The absorption spectra of samples were taken between 200 to 800 nm using a UV–vis spectrophotometer (Systronicmec 102). The deionized water was used as the blank.

Scanning electron microscopy (SEM)

The solution containing silver nanoparticles was tested under Scanning Electron Microscope (JEOL-JSM6610 LV). Image of Ag nanoparticles obtained from 1mm $AgNO_3$ added to the plant extracts was obtained. Powdered nanoparticles samples were sent to SEM analysis. The results by SEM indicate the morphology of synthesized nanoparticles[3,34].

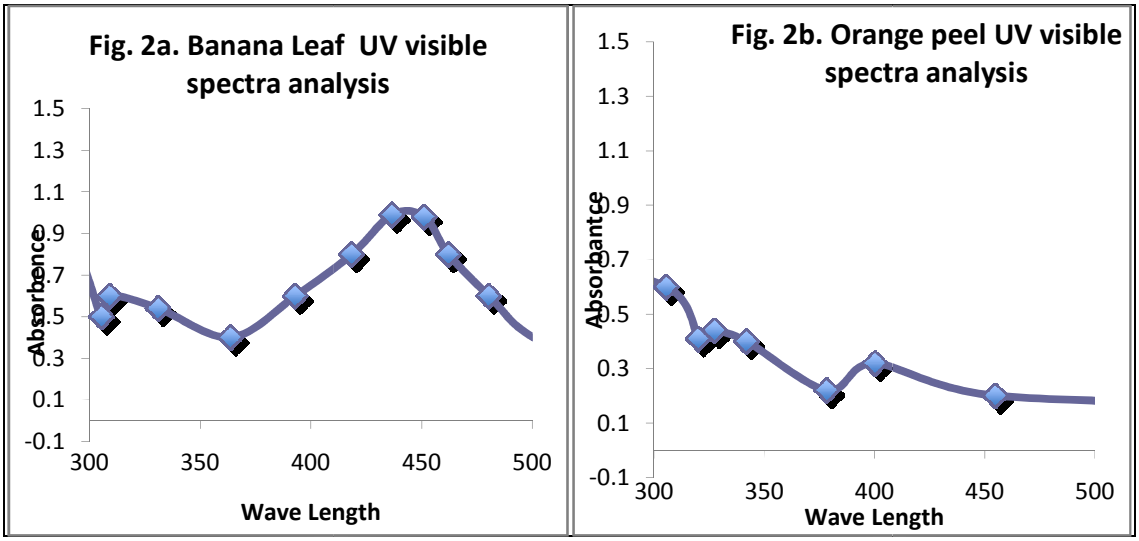
Zeta potential .

Zeta potential analysis is carried to measure the stability of nanoparticles. It describes the stability of nanosuspensions and explains the agglomeration phenomenon[5]. Measurements were carried out using a Delsa Nano (Beckman Coulter). An aqueous suspension of silver nanoparticles was filtered through a 0.45 μm PTFE membrane before measurement. The zeta potential was calculated using Henry's equation. This instrument allows the measurement of particle sized distribution in the range 200 mv to -200 mv.[29,30]

Particle size analysis (PSA)

Particle size analysis, particle size measurement, or simply particle sizing is the collective name of the technical procedures, or laboratory techniques which determines the size range, and/or the average, or mean size of the particles in a powder or liquid sample. Particles size analyzing experiment were carried by NANOPHOX (NX0088) and itsmeanparticles size was calculated.[30,35]

Results and Discussions:



Synthesis of AgNp's and their characterisation:

The bio reduction of aqueous solution of silver nitrate is one of the most widely used methods for the synthesis of silver nanoparticles. The appearance of a yellowish brown color reaction from clear solution suggested the formation of silver nanoparticles(Fig 1).[28] This solution was exposed to UV-vis spectroscopy. A Plasmon resonance peak was observed at 452 nm (fig 2a) and 401 nm (fig 2b) for banana and orange extracts synthesized nanoparticles. This is a primitive confirmation for the presence of silver nanoparticles.[3]

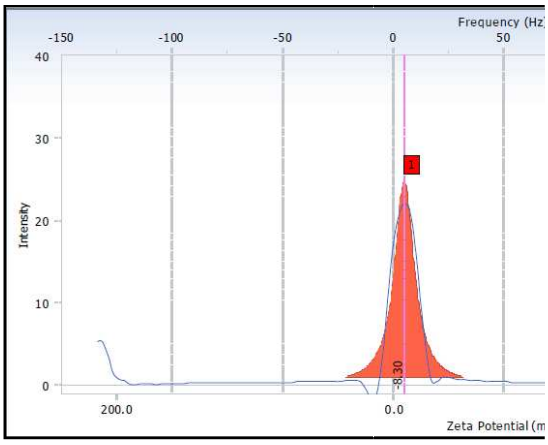


Fig. 3.a Zeta potential ($AgNO_3$ treated Orange extract)

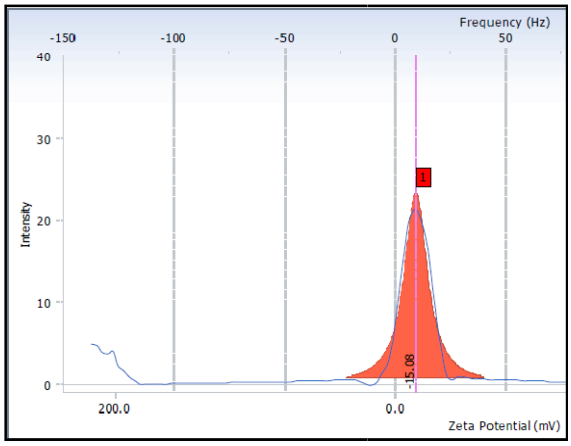
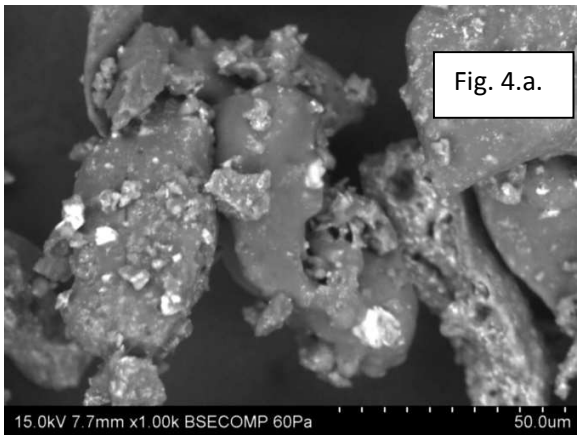
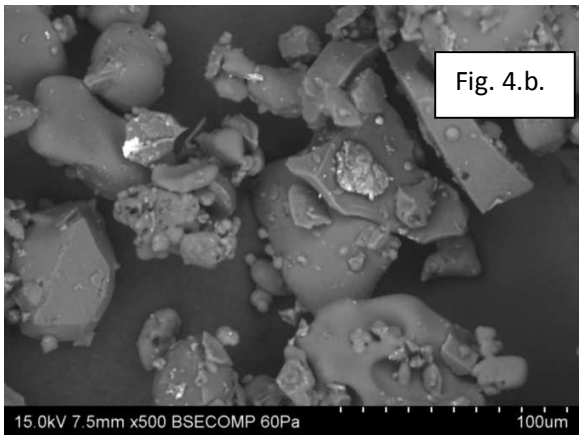


Fig. 3a. Zeta potential ($AgNO_3$ treated Banana Extract)

As shown in the figure 3a. and 3b., it is confirmed that silver nanoparticles produced from banana and orange extract posses negative zeta potential. Zeta potential is an important parameter to assess the stability of aqueous nanosuspensions. It is observed that silver nanoparticles synthesized using banana extract had -15.08 mV zeta potential while that from orange extract had -8.30 mV. These results clearly indicate that AgNp's synthesized from banana extract were fairly stable as compared with the AgNp's synthesized from orange extract. It can be hypothesized that presence of higher quantities of flavonoids, tannins and saponins may have contributed

SEM images obtained from the powdered samples show presence of nano sized particles. Fig

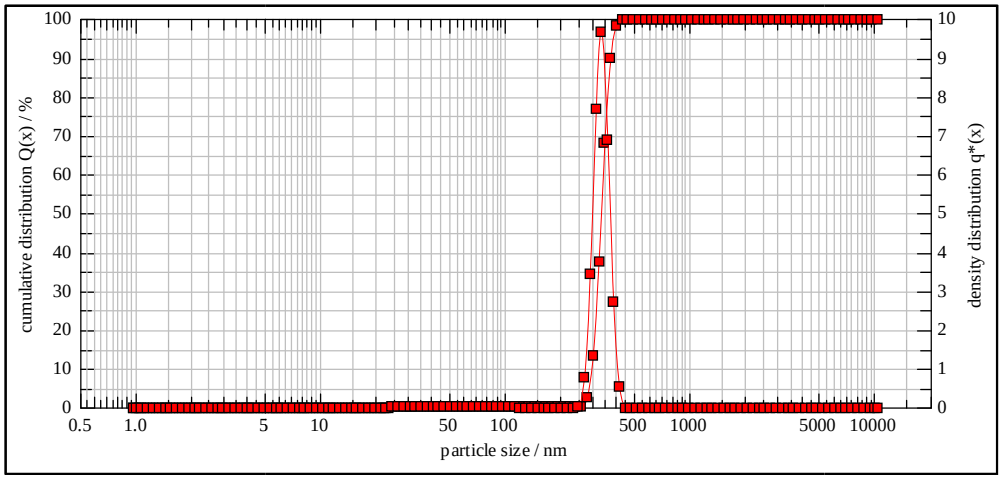




4.a. (Banana extract) indicates the formation of nanoparticles clumped with extracts. These nanoparticles are octahedral or rock shaped forms clumped on the fruit extracts. Fig 4.b. (Orange extract) indicates the similar nanoparticles formation. It can be observed that spherical or cocci shaped silver nanoparticles have clumped over the fruit extract powdered. The fruit extract after treatment was dried using hot air oven which causes churning of carbohydrates. This churning caused larger macro particle formation on which the nanoparticles are settled. It can be confirmed that drying can affect their size and shape. It was observed that nanoparticles are partially clumped due to the drying process**.**

PSA analysis was carried for determining the uniformity of synthesized nanoparticles. PSA pattern for analysedAgNp's reveals formation of particles of size 344 nm in diameter from banana extracts and 325 nm in diameter from orange extracts. These results are matching with the SEM results. It is also observed that polydispersity index of banana extract was 0.267 and orange extract was 0.241. It could be discussed that the nanoparticles were polydisperse and uniform in nature.

Fig. 5.a. PSA (Banana extract)



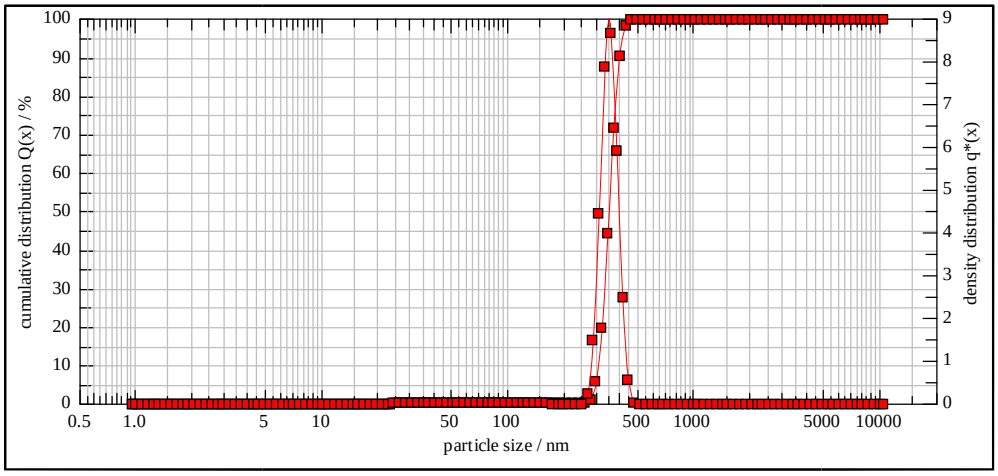


Fig. 5.b. PSA (Orange extract)

Conclusion:

The present study reveals higher stability of silver nanoparticles produced by biosynthesis from banana extract as compared to orange extract. Zeta potential analysis reveals higher negative zeta potential of AgNp's synthesized from banana extract as compared to orange extract. Banana peels shows presence of larger quantities of flavonoids, tannins and saponins as compared to orange which may have contributed to their stability. It can also be concluded from the SEM image that nanoparticles from orange extract agglomerated more as compared to banana extract. It has also been brought to notice that orange extracts synthesizes nanoparticles of lesser

diameter as compared to that of banana extract. The aqueous extracts of these fruits are eco-friendly and they describe an immediate method for synthesis of nanoparticles. It is a preliminary study for biogenic formation silver nanoparticles from banana and orange extracts and its targets controlling their size. In addition it also provides a theoretical base for investigations in biosynthesis of metal nanoparticles.

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