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RESEARCH ARTICLE

Green Synthesis of Silver Nanoparticles from Carrot

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ABSTRACT:
The green synthesis method has been widely used for the synthesis of metal NPs due to their environmentally friendly nature. A bioactive organic natural productsisolated from medicinal plantsexhibit many biological activity viz. antibacterial activity, anti-inflammatory activity, anticancer activity, anti-larvicidal activity etc. The organic natural products-AgNPs nanoconjugates provide an improved biological activity when compared to that of the natural product alone. In the present work,Beta-carotene is isolated from carrot by solvent extraction method. The isolated Beta-carotene is conjugated with the AgNPs by green synthetic method.The Beta-carotene acts as both antioxidant as well as capping agent in the green synthesis of AgNPs.The Beta-carotene-AgNPs nanoconjugates have been characterized by UV-Visible absorption spectral, transmission electron microscopy (TEM), and X-Ray diffraction (XRD) techniques.The Beta-carotene-AgNPs nanoconjugates can be used for biological applications such as antibacterial activity, anti-inflammatory activity and antioxidant activity.

KEYWORDS: Nanoparticles (NPs), Graphene Oxide (Go), Surface Plasmon Resonance (SPR), Transmission electron microscopy (TEM).

INTRODUCTION:
Nanoscale materials and structures, which by definition should fall in the range between 1 to 100 nanometers (nm), is an emerging area of nanoscience and nanotechnology. Nanomaterials are seen as solutions to many technological and environmental challenges in the areas of solar energy conversation, catalysis, medicine, and water treatment [1,2]. Nanotechnology is rapidly growing by producing nanoproducts and nanoparticles (NPs) that can have novel and size-related physico-chemical properties differing significantly from larger matter [3]. The novel properties of NPs have been exploited in a wide range of potential applications in medicine, cosmetics, renewable energies, environmental remediation and biomedical devices [4-6].

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Among them, silver nanoparticles (Ag-NPs or nanosilver) have attracted increasing interest due to their unique physical, chemical and biological properties compared to their macro-scaled counterparts [7]. Ag-NPs have distinctive physico-chemical properties, including a high electrical and thermal conductivity, surface-enhanced Raman scattering, chemical stability, catalytic activity and non linear optical behavior [8]. These properties make them of potential value in inks, microelectronics, and medical imaging [9]. Besides, Ag-NPs exhibit broad spectrum bactericidal and fungicidal activity [10] that has made them extremely popular in a diverse range of consumer products, including plastics, soaps, pastes, food and textiles, increasing their market value [11-13]. To date, nanosilver technologies have appeared in a variety of manufacturing processes and end products. Nanosilver can be used in a liquid form, such as a colloid (coating and spray) or contained within a shampoo (liquid) and can also appear embedded in a solid such as a polymer master batch or be suspended in a bar of soap (solid) [11-13]. Nanomaterials often show unique and considerably changed physical, chemical and biological properties compared to their macro scaled counterparts [14]. Synthesis of noble metal nanoparticles for applications in medicine, catalysis, electronics, optics, environmental and biotechnology is an area of constant interest [15]. Various metals have been used for the synthesis of stable dispersions of nanoparticles, biological labeling, photonics, optoelectronics and surface Enhanced Raman Scattering (SERS) detection [16]. Moreover functionalized, biocompatible and inert nanomaterials have potential application in cancer diagnosis and therapy.Nanomaterials have been used in the targeted delivery of anticancer drugs [17]. The detection monitoring of tumor biomakers have been demonstrated using fluorescent and magnetic nanocrystals [18].

Traditionally metal nanoparticles are prepared and stabilized by physical and chemical methods. Most widely used chemical approaches include chemical reduction electrochemical techniques and photo chemical reduction [19]. It has been reported that the experimental conditions and type of reducing agents strongly influence the size, shape, stability and properties of the metal nanoparticles. Hence, design of a synthesis method in which the particles with controlled properties are synthesized has currently become the research area of interest [20].

Silver nanoparticlesare nanoparticles of silver of between1 nm and 100 nm in size [21]. While frequently describedas being 'silver' some are composed of a large percentageof silver oxide due to their large ratio of surfaceto-bulk silver atoms. Numerous shapes of nanoparticlescan be constructed depending on the application at hand.Commonly used are spherical silver nanoparticles but diamond,octagonal and thin sheets are also popular.Silver nanoparticles may eventually offer treatment ofvarious diseases.

In 2015 showed that the use of silver nanoparticles isa cause of antimicrobial resistance. The same thesis showthat silver nanoparticles lack any effect against bacteria [22].Their extremely large surface area permits the coordinationof a vast number of ligands. The properties of silvernanoparticles applicable to human treatments are underinvestigation in laboratory and animal studies, assessingpotential efficacy, toxicity, and costs. Beta-carotene is a pigment found in plants that gives them their color. The name beta-carotene is derived from the Latin name for carrot. It gives yellow and orange fruits and vegetables their rich hues. Beta-carotene is also used to color foods such as margarine.

In the body, beta-carotene converts into vitamin A (retinol). We need vitamin A for good vision and eye health, for a strong immune system, and for healthy skin and mucous membranes. Taking big doses of vitamin A can be toxic, but your body only converts as much vitamin A from beta-carotene as it needs. That means beta-carotene is considered a safe source of vitamin A. However, too much beta-carotene can be dangerous for people who smoke. (Getting high amounts of either vitamin A or beta-carotene from food, not from supplements, is safe.)

Beta-carotene is an antioxidant. It protects the body from damaging molecules called free radicals. Free radicals damage cells through a process known as oxidation. Over time, this damage can lead to a number of chronic illnesses. There is good evidence that eating more antioxidants from foods helps boost your immune system, protect against free radicals, and may lower your risk of heart disease and cancer. But the issue is a little more complicated when it comes to taking antioxidant supplements.

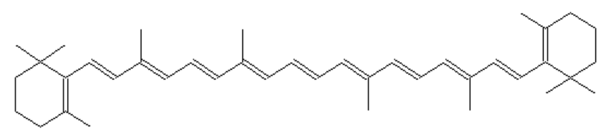

Fig 1.Molecular structure of beta- carotene

MATERIALS AND METHODS:

Fresh carrot slices (50g), Isopropyl alcohol (IPA) (Merck Chemicals Pvt Ltd), Petroleum ether (Merck Chemicals Pvt Ltd), Distilled water, Ethyl alcohol (Merck Chemicals Pvt Ltd) Sulphuric acid (Merck Chemicals Pvt Ltd), Sodium hydroxide (Merck Chemicals Pvt Ltd), Silver nitrate solution (Sigma Aldrich) were used.

Isolation of beta-carotene from carrot:

Carrot slices (50g) were taken in the round bottom flask and 200mL of isopropyl alcohol was added. The content was heated in a reflux condenser at 60ºC for 4 h with magnetic stirring and filtered via Buckner funnel. The filtrate was taken in a beaker and 200 mL of petroleum ether was added and shaken well. The filtrate was taken in a separating flask;100mL of water was added to the solution. The two layers are separated. The ether layer was evaporatedin a rotary evaporator. The dried particles of beta-carotene were separates out.

Synthesis of silver nanoparticles by using beta-carotene:

To prepare silver nanoparticles (AgNPs), initially the isolated beta-carotene were prepared as the solution with double distilled water to and sodium hydroxide was added for maintain the pH between 8.5 – 9.5. Then extract need to add into metallic salt solution (1mM silver nitrate solution) under stirring with 60ºC to 80ºC temperature in a magnetic stirrer and finally the color change was indicated the formation of silver nanoparticles (AgNPs).

Characterization technique:
The UV-Visible absorption spectra of Beta-carotene/ AgNPs nanoconjugates were recorded on a Perkin-Elmer spectrophotometer. The transmission electron microscopic (TEM) images were captured on FEI TECNAI G2 (T-30) transmission electron microscope, while the X-Ray diffraction pattern (XRD) of the Beta carotene/AgNPs nanoconjugates were recorded on Bruker D8 Advance X-ray diffractometer with monochromatic Cu-Kα1 radiation (l ¼ 1.5418 °A).

RESULTS AND DISCUSSION:
UV-Visible Absorption Spectral Analysis:
The simple approaches for the fabrication of GO-supported Go-Ag ,GO-Ru as well as GO-Ag - Ru NPs were synthesized by co-reduction method using $NaBH_4$ in aqueous medium. The catalyst of GO supported GO-Ag - Ru NPs was synthesized in three steps. In the first step, the graphene was converted in to graphene oxide by using hummer's method. The synthesis of stable nanoparticles was very difficult without any stabilizing agent. So before adding sodium boro hydride the metal ions and mixture was stirred at least 2 h. In step two then the colloidal metal ions solution was injected in to the GO solution under stirring condition. Finally, the sodium boro hydride solution was added drop wise in to the above mixture[23]. The reaction was further continues for 30 minutes in the third step. The obtained products viz., Go-Ag ,GO-Ru and GO-Ag – Ru, GO-Ru-Pd NPs[24] were characterized by SEM, FESEM, HRTEM, EDAX, Raman and XRD, spectroscopy is already reported. The catalytic efficiency of the newly developed NPs was studied for the reduction of organic dyes as a model reaction. The reduction reaction was monitored by using UV-visible techniques and the reusability of the superior catalyst was examined up to 3 cycles for the same reduction reaction [23].The electronic properties of β-carotene/AgNPs are analyzed by UV-Visible absorption spectral technique. The surface morphology of GO supported GO-Ag-Ru alloy NPs were investigated by using FESEM analysis.It clearly indicates that the spherical shape of Ru-Ag NPs was supported by GO. Based on the above results, the GO-Ag-Ru alloy NPs is well supported by GO.

The surface plasmon resonance (SPR) is a useful property of nanosized metal nanoparticles. Since, the oscillation energy of surface electrons (plasmons) of AgNPs is in resonance with the visible light around 421 nm, the AgNPs absorb the visible light around 421 nm and exhibit pale yellow color. The color of the AgNPs can be tuned from brown to pale yellow by changing the size of AgNPs. The bulk gold metal exhibits brown color while the nanosized silver particles (20 – 30 nm) exhibit pale yellow. Hence, the SPR is one of the characteristics of AgNPs. The SPR of AgNPs can be identified by recording the UV-Visible absorption spectrum.The UV-Visible absorption spectrum of β-carotene exhibits two signals at 221 nm and 249 nm. The absorption signal at 221 nm is corresponding to the π–π* transition, while a signal at 249 nm is corresponding to the n–π* transition. These electronic properties are the characteristics of Beta-carotene. The UV-Visible absorption spectra of β-carotene/AgNPs exhibit the SPR signal of AgNPs at 421 nm and it confirm the formation of AgNPs. In addition to the SPR peak at 421 nm, the beta carotene/AgNPs nanoconjugates exhibit two strong absorption signals at 221nm and 249 nm corresponding to the π – π* and n – π*transitions of beta carotene molecule. It confirms the conjugation of AgNPs to beta carotene molecule.

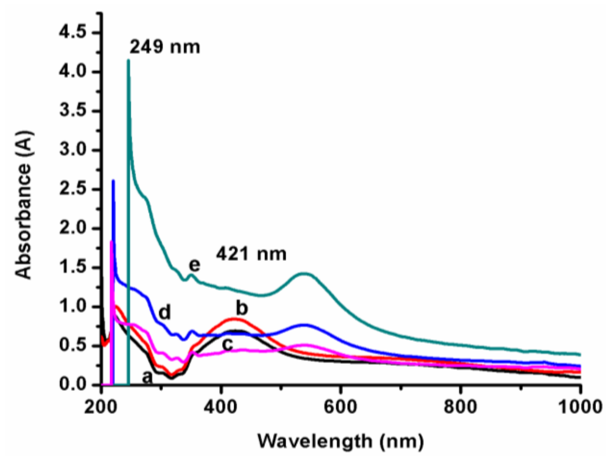

Fig 2.UV-Visible absorption spectra of (a) Beta carotene and (b) 1 mL, (c) 2 mL, (d) 3 mL and (e) 4 mL of AgNPs.

Transmission Electron Microscopy (TEM) analysis:
Transmission electron microscopy (TEM) has been employed to characterize the size, shape and morphologies of formed Ag nanoparticles. Figure 7,shows the TEM image of the Beta-carotene conjugated silver NPs. It shows that most of the prepared silver NPs are spherical in shape with 12 – 21nm diameter. The TEM analysis confirms the shape and morphology of the beta carotene/AgNPs nanoconjugates.

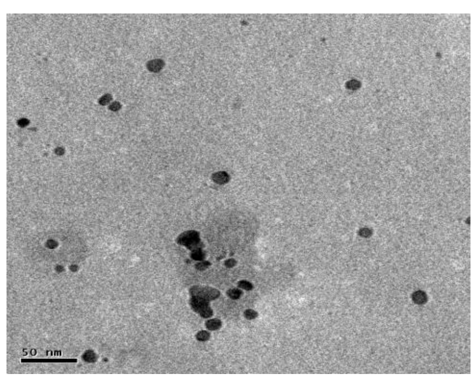

Fig 3.TEM image Beta carotene/AgNPs nanoconjugates

Powder X-Ray diffraction (XRD) analysis:

The XRD pattern of β-carotene/AgNPs nanoconjugates exhibit a strong and broad signal around 20° – 80^0 which is due to the presence of β-carotene molecule in the nanoconjugates. The diffraction peaks of AgNPs appear at 37.8° and 43.9° corresponding to the (200) and (220) planes respectively. The diffraction peaks of AgNPs are very weak which is due to the lower concentration of AgNPs. It confirms the presence of anthocyanin molecule on the surface of the AgNPs.

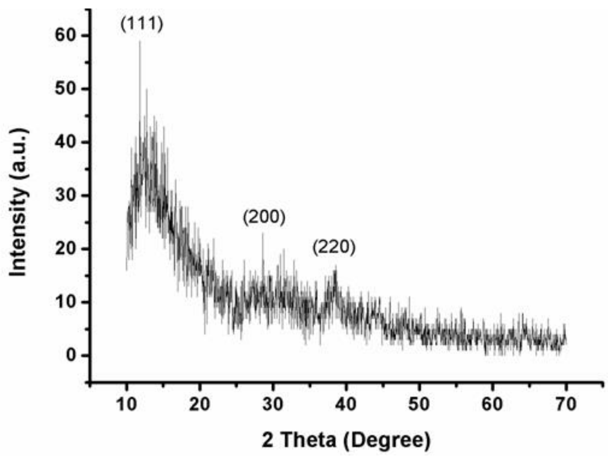

Fig 4.XRD pattern of Beta carotene/AgNPs nanoconjugates

CONCLUSION:

The synthesis of silver nanoparticle using Beta carotene extract has been studied. It has produced silver nanoparticles through efficient green nanochemistry methodology, avoiding the presence of hazardous and toxic solvents and waste. The prepared silver nanoparticles were characterized by UV-visible, TEM and XRD techniques to identify the size of silver NPs and biomolecules acting as reducing agents. XRD measurements show that the average size of the prepared silver nanoparticle was 50 nm. Spherical shape of the prepared silver nanoparticles was determined from TEM image.We have demonstrated silver nanoparticles from natural product like β-carotene at different volume of NaOH as an accelerator for reaction. Smaller volume of NaOH volume was favorable for forming Nanoparticles. Pectin act as an stabilizing and reducing agent. XRD, TEM measurements displayed the resultant nanoparticles were faced centered cubic (FCC) structures, using UV we were analyze the β-carotene. This green synthesis method has been used for the synthesis of silver nanoparticles due to their eco-friendly nature.This biological organic natural product isolated from medicinal plants exhibit many biological activity, anti-bacterial activity, anti-inflammatory activity, anti-cancer activity, etc. The organic natural products AgNPs nanoconjucates provide an important biological activity when compared to that of the natural product alone.

REFERENCES:

1. Dahl. JA Maddux BLS, Hutchison. JE, Toward Greener Nanosynthesis, Chem Rev, 107(6) , (2007),2228-2269
2. Hutchison .JE, Greener Nanoscience: A Proactive Approach to Advancing Applications and Reducing Implications of Nanotechnology, ACS Nano; 2(3) (2008),395-402.
3. Quang Huy Tran, Van Quy Nguyen and Anh-Tuan Le, Silver nanoparticles: synthesis, properties, toxicology, applications and perspectives, Adv. Nat. Sci.: Nanosci. Nanotechnol, 4, (2013),1-20.
4. De. M Ghosh. P. S and Rotello.V. M. Application of nanoparticles in Biology, Adv. Mater, 20(22), (2008),4225-4241.
5. Lu.A-H, Salabas.E.L and Schuth.F Magnetic Nanoparticles: Synthesis, Protection , Functionalization and Application. Angew. Chem. Int. Ed. Engl, 46(8), (2007) ,1222-1244.
6. Ghosh.C.R and Paria.S, Core/Shell Nanoparticles: Classes, Properties, Synthesis Mechanisms, Characterization, and Applications, Chem. Rev. 112(4), (2012), 2373-2433.
7. Sharma.V. K. Yngard. R .A and Lin.Y. Dispersions, novel nanomaterial sensors and nanoconjugates based on carbon nanotubes. Adv. Colloid Sur. Interface. 150(2),(2009),63-89.
8. Krutyakov.Y.A, Kudrynskiy.A. A, Olenin.A.Y and Lisichkin.G . V, Synthesis and properties of silver nanoparticles: advances and prospects, Russ. Chem. Rev. 77(2008),233-258.
9. Monteiro.D.R et al The growing importance of materials that prevent microbial adhesion: antimicrobial effect of medical devices containing silver, Antimicrob. Agents. 34(2),(2009)., 103 -110.
10. Ahamed.M. Alsalhi.M.S and Siddiqu.M.K,Silver nanoparticle applications and human health. Clin. Chim. Acta. 411(23-24)(2010),1841-1848.
11. García-Barrasa. J. López-de-luzuriaga.J.M and Monge.M. Silver nanoparticles: synthesis through chemical methods in solution and biomedical applications,Cent, Eur. J. Chem. 9(1),(2011),7-19
12. Fabrega.J. Luoma.S.N. Tyler.C .R. Galloway.T.S and Lead. J .R, Silver nanoparticles: Behaviour and effects in the aquatic environment,. Environ. Internat, 37(2), (2011), 517-531.
13. Dallas.P, Sharma.V .K and Zboril.R, Silver polymeric nanocomposites as advanced antimicrobial agents: Classification, synthetic paths, applications, and perspectives, Adv. Colloid Interface Sci.166(1-2),(2011),119-135.
14. Li .L, Hu.J , W.Yang,G. Alivistos.AP, Band Gap Variation of Size- and Shape-Controlled Colloidal CdSe Quantum Rods,Nano Lett ; 1(7), (2001)349-351.
15. Hussain.I , Brust. M,. Papworth. AJ, Cooper .AI, Preparation of Acrylate-Stabilized Gold and Silver Hydrosols and Gold−Polymer Composite Films, Langmuir; 19(11), (2003), 4831-4835.
16. Kearns.GJ, Foster. EW, Hutchison .JE, Anal Chem, 78(1), (2006), 298-303.
17. Sengupta. S, Eavarone. D, Capila. I, Zhao. GL, N. Watson, Kiziltepe. T, et al. Temporal targeting of tumour cells and neovasculature with a nanoscale delivery system,Nature, 436(7050), (2005), 568-572.
18. Alivisatos.P . Nat Biotechnol , The use of nanocrystals in biological detection, 22(1), (2004), 47-52.
19. Chen. W, Cai. W, Zhang.L, Wang.G, Zhang. L.J, Sonochemical Processes and Formation of Gold Nanoparticles within Pores of Mesoporous Silica, Colloid Interface Sci, 238, (2001),291-295.
20. B.Wiley, Y. Sun ,Y. Xia , Synthesis of Silver Nanostructures with Controlled Shapes and Properties, Acc Chem Res, 40(10) (2007), 1067-1076.
21. Graf. C, Vossen. L.J. D, Imhof. A, Alfrons .V. B, A General Method To Coat Colloidal Particles with Silica, Langmuir 19 (17), (2003), 6693–6700.
22. Dong. X, JI X, Jing.J, Li.M, Li .J,W. Yang, Synthesis Of Triangular Silver Nanoprisms by Stepwise Reduction of Sodium Borohydride and Trisodium Citrate, J. Phys. Chem. C 114 (5) (2010), 2070–2074.
23. Andal.P and Roopakala,Graphene oxide supported Ruthenium, silver and Ruthenium-silver nanoparticles as catalyst with Antibacterial activity, Asian Journal of Chemistry, 30(1), (2018), 89-96.
24. Andal. P, Loganayagi. C and Roopakala, Synthesis and characterisation of graphene oxide supported mono and bimetallic nano particles as catalyst with anti bacterial activity, Research Journal of Pharmacy and Technology,10(12) 2017.