Research Article

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# BIOSYNTHESIS AND CHARACTERIZATION OF SILVER NANO PARTICLES USING BLACK CARROT ROOT EXTRACT

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## ABSTRACT

The synthesis of nano particles using the bio system is referred to as Green Synthesis, as it a cost-effective, energy-efficient and easy method. Here we have used the green approach for the synthesis of silver nanoparticles (AgNPs) using Black carrots as the source phytochemicals for reducing and capping agent for the reduction of silver ions to silver atoms and stabilization of the particles. The black carrot extract was added into 1mM silver nitrate solution and the formation of AgNPs was primarily detected by the change of colour to reddish-brown. The nano particles were further characterized by using UV-Vis spectroscopy and Transmission Electron Microscopy (TEM) analysis. The maximum Plasmon absorbance peak of 413 nm was obtained, and nanoparticles sizes ranges from 4.32 nm to 17.65 nm with an average diameter of 9.46 nm. Around 88 % of the particles depicted by the TEM image fall within the range 4-12 nm. The method used here confirms the synthesis of AgNps by using the root extracts of black carrots and, it is simple, eco-friendly and economical for large-scale production of AgNps.

**Key Words:** Black carrot, Silver nitrate, Green synthesis, Silver nanoparticle, Nanometer

## INTRODUCTION

These days there are lot of research activities on nano particles which are going on all over the world. These particles that are intermediate between bulk materials and isolated atom sized materials in the range of 1 to 100 nm. They are being used for various pharmaceutical and agricultural applications [1]. Nowadays the nano particles are being synthesized from metal and also from non-metallic materials. But when it comes to the biological application of nanoparticles, silver and gold are most preferred metals [2, 3].

Synthesis of nanoparticles is an area of interest for many researchers, and is synthesized through various physical and chemical methods. During the chemical production of nanoparticles the toxic and hazardous risks are involved and is a potential threat to environment, as well as it is expensive [4]. The science of the synthesis of nanoparticles using biological means is a new emerging area and gained significant attention from researchers. The green approach uses living organisms or the bi-products of them, which act as reducing agent as well as stabilizers. Due to the environmentally friendly nature of such nano-products, it is being vastly utilized for production of nano particle [5-7] especially for synthesis of silver and gold nano particles.

The silver nano particles have a wide range of applications in the field of nanobiotechnology and other related fields because of its new or improved properties depending upon their size, morphology, and distribution [8]. It has antimicrobial property [8, 9] and is also believed to be potential anti cancer agent [10]. And the AgNps have been synthesized by using various plant extracts and many microorganisms [5], but there is only one study aimed at producing eco-friendly nanoparticles using the starch derived from carrot [11].

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Black carrot, also called purple carrot is one among the different colored varieties of carrot (*Daucus carrota* L.). It is rich in anthocyanin, which makes it suitable for use in food, nutraceutical and pharmaceutical preparations [12] and can be a potential source of reducing agent in the green synthesis of nanoparticles. It contains more than 40 phenolic acids and 5 predominant anthocyanins, two of which are nonacylated cyaniding glycosides and three derivatives of cyanidins acylated with sinapic, ferulic and *p*-coumaric acid [13]. Antioxidant activity of the carrot anthocyanins has the potential to synthesize NPs, but to our best knowledge, this is the first report on the green synthesis of silver nanoparticles using black carrot extract.

## MATERIALS AND METHODS

### Preparation of plant extract

Fresh roots of black carrots were collected from main research station of the school of agriculture, Lovely professional university, Phagwara, India situated at 31.25$^0$ North latitude, 75.70$^0$East longitude and altitude of 105.5 m above sea level. This was brought to laboratory where it was thoroughly washed and chopped into pieces. 10 g of the chopped carrot was taken into a flask of 100ml sterile double distilled water and the mixture boiled for 5 minute. The extract was filtered using Whatman filter paper and used as reducing agent for the synthesis of AgNPs.

### Preparation of silver nanoparticles

1mM aqueous solution of silver nitrate ($AgNO_3$) was prepared and used for the synthesis of silver nanoparticles. 10 ml of the black carrot extract was taken and added into 90 ml of aqueous solution of 1 mM Silver nitrate and incubated in the dark, overnight at room temperature.

### Characterization of AgNPs

Equal amount of sample aliquot and distilled water (1ml each) were mixed in a 10 mm-optical-path-length quartz cuvettes, and the UV-vis spectrum of the reaction medium was carried out to detect the reduction of pure Ag+ ions. The concentration of AgNPs produced was measured as reported by [14] using a Systronics UV double beam spectrophotometer, at a resolution of 1 nm, between 200 and 800 nm. The morphological analysis of the synthesized AgNPs was conducted using high-resolution, Hitachi H 7500 transmission electron microscopy (TEM).

### Statistical analysis

A simple statistical tool, histogram was used to represent the nanoparticles sizes and its number as obtained from the TEM images. Histogram was plotted for particle number against sizes.

## RESULTS AND DISCUSSION

The chemical reduction of aqueous solution of silver nitrate is one of the most widely used methods for the synthesis of silver nanoparticles. In the present study, the plant-mediated synthesis of nano silver particles was observed upon addition of the carrot extract into the colorless 1mM aqeuos solution of AgNO3. This is visibly detected by characteristic colour change of the reaction mixtures (Fig. 1), which occurs due to the reduction of ionic silver to atomic silver owing to the activities of phytochemicals present in black carrot root. The phenolics and anthocyanins compounds of black carrot [13] are capable of reducing the ions. Reddish brown color was formed within few minutes of incubation. Silver nanoparticles show different color ranging from brown to dark brown, and some times reddish or yellowish-brown color in aqueous solution due to the phenomenon of surface Plasmon [15]. The successful biosynthesis of the nanoparticles was further confirmed by using UV-Vis spectroscopy analysis.

The use of UV–Vis spectroscopy in metal nanoparticles characterization is crucial technique that gives information on formation and stability of the nanoparticles in aqueous solution [16]. There is a relationship between UV-visible absorbance characteristics and sizes and shapes of the particles formed [17]. Using UV-Vis spectroscopy, maximum surface Plasmon absorption band was obtained at the maximum peak of 413 nm. The absorbance peak was observed in the range of 425-460 in other studies, where the nanoparticles are synthesized by using different plants [4, 18-20] showing the presence of spherical Ag nanoparticles which was later confirmed by further analysis.

The TEM analysis depicted silver nanoparticles of varying sizes ranging from 4.32 nm to 17.65 nm with an average diameter of 9.46 nm. The highest number of particles obtained (42%) fall within the range of 10-12 nm, followed by 4-6 nm range (29%). Out of the particles captured by the TEM machine 88 percent were between the ranges of 4-12 nm. The efficiency of nanoparticles function depends on their sizes. Their small size nature, shape and surface structure, charge, chemical nature and solubility make them interact more with biomolecules and cells [21, 22] and it is this size modification that make them of significant interest compared to their bulk counterpart.

The size range (4-18 nm) of the AgNPs obtained in this study was comparably smaller than the earlier reported using other different plant material like 29-68 nm in *Acanthephylum bracteatum* [4], 5-55 nm size range in *Dalbergia sissoo* [20], and 55-80 nm using *Cinnamomum camphora* [23]. But there is study in which the leaf extracts of *Emblica officinalis* have been used to synthesize nanoparticles of silver having smaller sizes of 10-20 nm [24].

## CONCLUSION

Green synthesis of metal nanoparticles using both plants and microorganism is rapidly becoming area of interest due lack of environmental threat especially when plants are used. Black carrots, being an important crop (rich in phythochemicals that were to act as both reducing and capping agent) was used and silver nanoparticles of smaller sizes were successfully synthesized. In future the method can be standardized, and used for scaling up the production of sliver nano particles.

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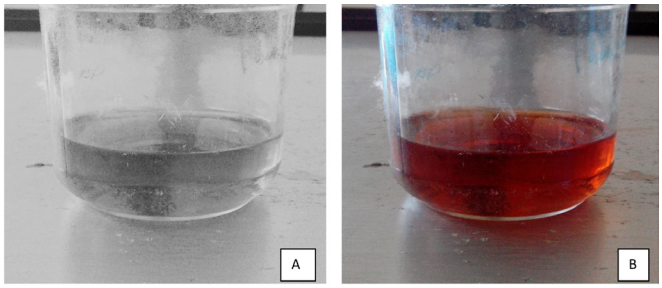


**Figure 1:** Color change before (A) and after (B) addition of the black carrot extract to the aqueous solution of $AgNO_3$. Reddish brown solution was formed, indicating the successful formation of silver nanoparticles.

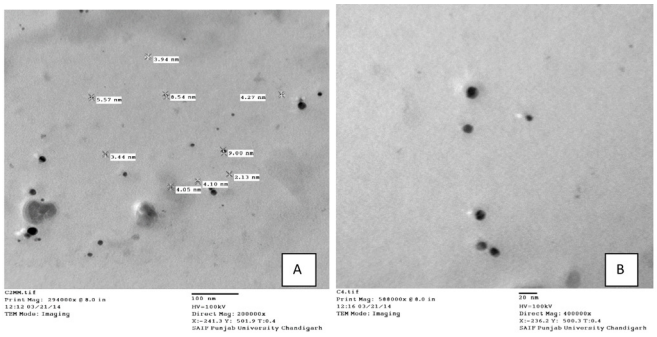


**Figure 3:** (A-B) TEM image at low magnification showing a spherical nature of AgNPs prepared from using the extract from Black carrot.

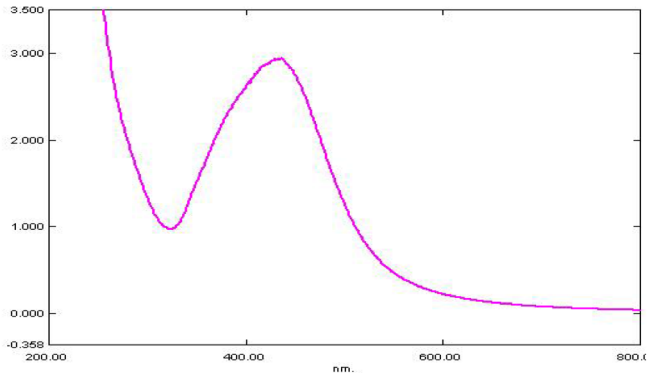


**Figure 2:** UV–Vis absorption spectrum of AgNPs prepare using extract of Black carrot showing the surface Plasmon resonance.

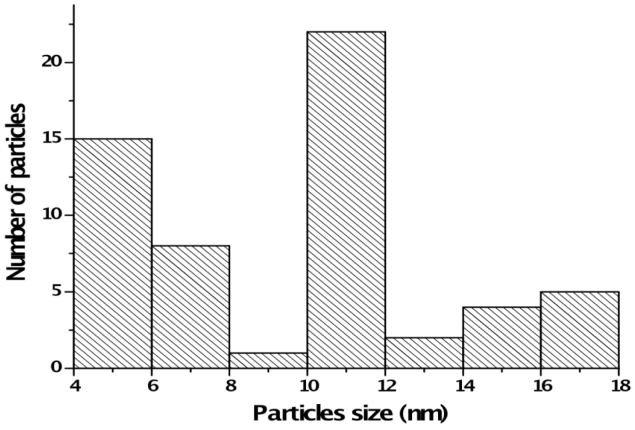


**Figure 4:** Size distribution of AgNPs formed using the extract from Black carrot.