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CHARACTERIZATION OF SILVER NANOPARTICLES PREPARED BY HERBO METALLIC METHOD

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ABSTRACT

Silver nanoparticles (Ag NPs) have burgeoning demand in medicinal and industrial applications. Researchers are fascinated by Ag NPs high electrical, optical and antibacterial properties. Ag NPs are having wide range of applications and Ag NPs are playing essential role in basic needs like food (including water), shelter, clothes etc. So the production and consumption of silver nanoparticles is increased. But the preparation of Ag NPs is not the new for Indians. The antibacterial properties of silver have been extensively using in the field of medicine from olden days for curing many diseases. In Ayurveda the nano silver (Rajatha Bhasma) have been using as a medicine before the invention of nanotechnology. In Ayurveda there is prescribed process to prepare the nanomedicine for different medicinal applications. The silver metal is reduced to nanopowder by herbo metallic method and in this method has three processes namely purification, grinding and calcination. These three processes completely remove toxicity of silver and changes macro particles to nanoparticles. The silver nanopowder was characterized by EDS (Energy-dispersive X-ray spectroscopy), SEM (Scanning Electron Microscope), XRD (X-Ray Diffraction) and particle analyser. The analysis by above methods reveals the presence of nanosize silver particles and some other minerals are present in the Rajatha Bhasma. The details will be discussed in detail.

KEYWORDS: Silver nanoparticles, EDS , SEM, XRD and particle analyser

INTRODUCTION

Long before, Richard Feynman predicted “There’s plenty of room at bottom” in 1959, in India Nanotechnology was in use in the form of Ayurveda medicines like Bhasmas whose particle size were in nano dimensions. Bhasmas are very effective medicines in the Ayurveda system to cure various diseases. Nanomaterial study of herbo minaral formulations is quite interesting field of research.The research of medicinal materials used in Indian system is an important research area which brought all the fields of modern scientists on one plat form. The material science, chemistry, pharmacology, medicine etc… are working to solve the difficulties in preparation and characterization of herbo metallic formulations [1]. Bhasmas are nanocrystals. In terms of nanotechnology nanocrystalline materials are solids composed of crystallites with size less than 100 nm in at least one dimension. Nanoparticles are present in this herbo metallic formulation. The reduction of the particle size may be due to concepts of trituration and levigation in the synthesis process [2].

In Indian system of medicine, seven metals such as gold, silver, copper iron, tin, lead and zinc are described as essential elements for the body. It has been described in metal based formulations that metals are present in human body in different parts of the body tissues. Any imbalance, whether excess or deficiency, disturbs the body metabolism [3]. Metallic formulations are well known for their quick effectiveness with smaller dose and a long shelf life [4] and this Indian nanomedicine adopts a holistic approach towards health care by balancing the physical, mental and spiritual functions of the human body. This way of treatment is non toxic [5].

Among all metals silver is a noble metal and the silver nanoparticles have many applications due to their high optical, electrical [6], chemical and antibacterial [7] properties. The morphology of silver nanoparticles can be effected by temperature, stirring time and different reducing agents in synthesis[8].The formation of nanoparticles is depending upon certain physiochemical properties such as temperature, time, pH, concentration of the substrate, and enzyme sources [9] etc.

This silver based nanomedicine of ancient Ayurveda known as Rajata bhasma is used extensively to strengthen brain, liver, heart and memory. It is also used as immunomodulator, analgesic, aphrodisiac, nervine tonic and general tonic and anti-inflammatory activity [10]. It has therapeutic properties in cases like diabetes mellitus, fever, anaemia, liver disorders and Psychological disorders [11]. In the present study a systematic effort has been put forth to synthesize and characterize silver nanoparticles in Ayurvedic standard procedure.

MATERIALS AND METHODS

There are many physical, chemical, biological and green methods to prepare Ag NPs but herbo metallic formulation is an oldest Indian method to prepare Ag NPs. Metal nanoparticles are present in the Indian herbo metallic formulation and herbo metallic preparation is much simpler and non toxic, with less chemical residue. The method is environmental friendly and a green method and it is bio safe [12]. In Ayurveda the processing of metals and minerals are done by standard manufacturing procedures which ensure the quality, safety, efficacy and reproducibility of the product [13].

In this method (herbo metallic preparation) metals and minerals are reduced to nano level, so that they are easily absorbable, therapeutically very effective and non toxic. Ag NPs are obtained by purification, wet grinding and calcination of bulk silver metal.

Figure:

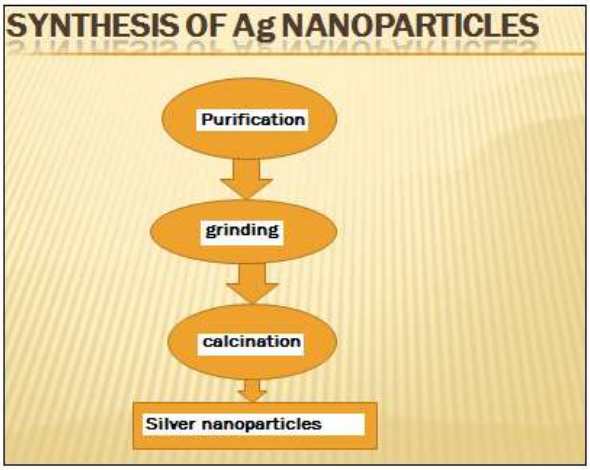
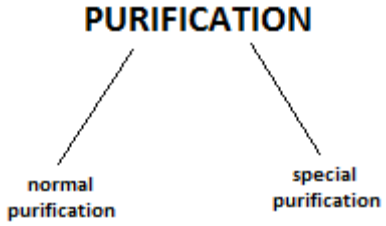


Fig1.synthesis of Ag NPs by herbo metallic method.

Purification is done by two standard procedures first by normal purification and later by special purification. In normal purification red hot silver foil quenched in some special liquids like rice gruel, cow urine, butter milk, sesame oil and decoction of Dolichos biflorus Linn. Special purification is done by quenching silver in lime juice medium for 7times. The purified silver then gone through trituration using Aloevera juice in mortar, after which it is dried. Further calcination is done using muffle furnace.



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a b

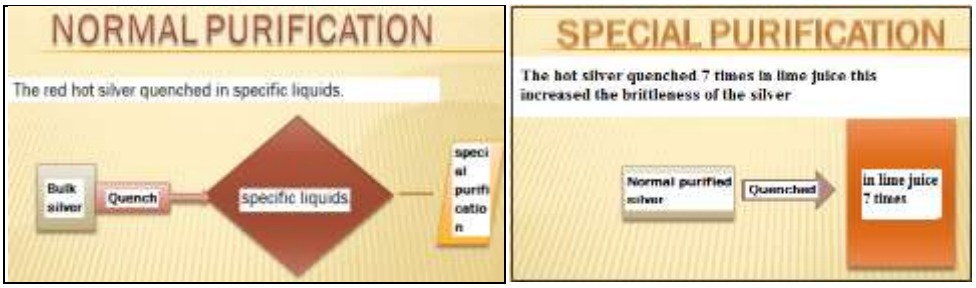

Fig 2 Purification of silver a. Normal purification b. Special purification

These three steps are repeated several number of times. This method of preparation ensures finally the silver metal is reduced to very small size and induces some medicinal properties into it. The Ag NPs prepared by the herbo metallic method is further characterized by the techniques of EDS (Energy-dispersive X-ray spectroscopy), SEM (Scanning Electron Microscope), XRD (X-Ray Diffraction) and particle analyser.

RESULTS AND DISCUSSION

EDS:

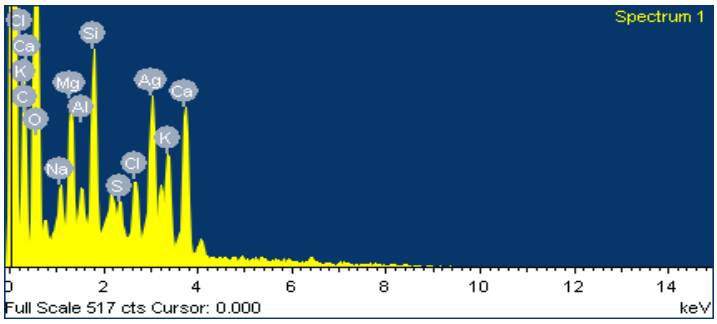

Fig 3 EDS analysis of Ag NPs.

Elemental analysis of silver nanoparticles is done by using EDAX. From the EDAX spectra it is clear that main constituent of the powder is Ag. However the traces of other elements Na, Mg, Al, Ca and Si etc… are in the small quantities these elements are present in the material because of the medicinal herbs and liquids used in synthesis process. These elements are the mediators of the preparation method to form silver nanoparticles. The major characteristic peak is (Ag L) silver nanoparticles. Because the presence of other elements in the sample medicinal properties are induced into it.

Table:

Table1. Chemical constituents of Ag NPs

Element	Weight %	Atomic %
Na K	1.11	1.24
Mg K	3.32	3.51
Al K	1.05	1.00
Si K	5.57	5.10

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Cl K	3.15	2.28
K K	6.05	3.98
Ca K	13.18	8.45
Ag L	77.63	76.69
Totals	100.00	

SEM:

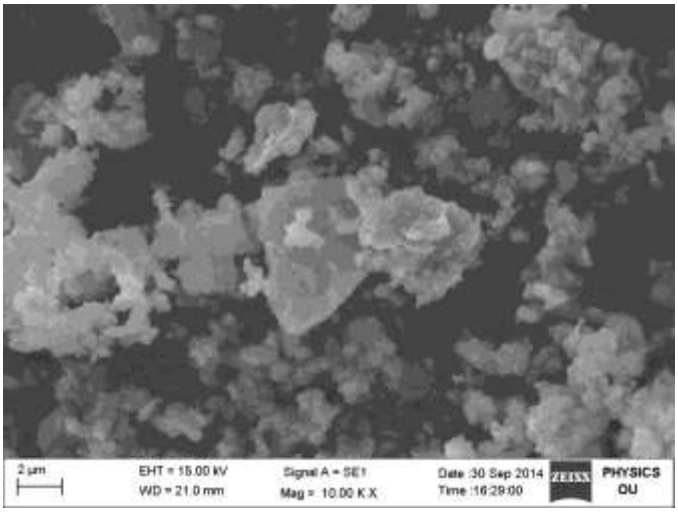

Fig 4 SEM image of Ag NPs

The morphology of Ag NPs from SEM micrograph in fig (4) represents the agglomeration of spherical shape Ag NPs and triangle shape Ag NPs clearly visible in SEM images. This agglomeration may be due to the exposure of the Ag NPs to the high temperatures in the synthesis process.

XRD Analysis:

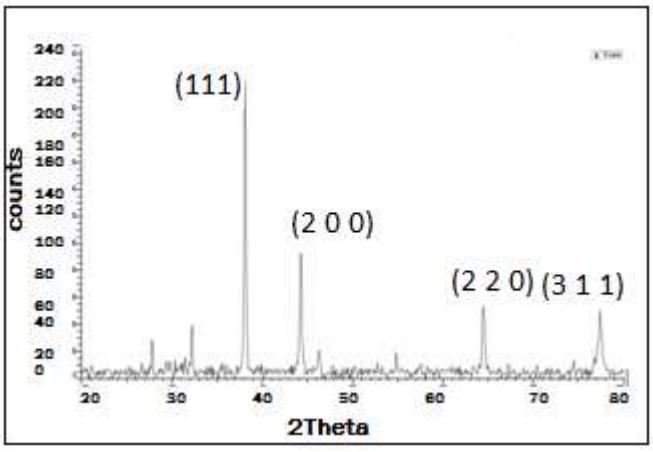

Fig5. Image of Ag NPs XRD analysis

Crystalline nature of silver nanoparticles was confirmed by the XRD analysis. In XRD analysis the sharpest peaks represent that this material prepared by herbo metallic method is highly crystalline not amorphous. These sharp peaks observed at the 2θ values equal to 380,440,640,770 and the corresponding planes of silver nanoparticles are (111), (200),(220),(311). Mean diameter of the silver nanoparticles calculated by Debye Scherrer's formula

Formula:

$$D = \frac{0.9\lambda}{(\beta \cos \theta)} \qquad (1)$$

In the equation (1) **λ** is wavelength of *X* ray, β is full width at half maxima, θ is Bragg's angle. Crystallite size calculated from XRD spectra for Ag NPs is nearly 50nm.

Particle analysis:

Measurement Results

Date	: Thursday, February 20, 2014 10:01:23 AM
Measurement Type	: Particle Size
Sample Name	: 2
Scattering Angle	: 173
Temperature of the holder	: 25.0 °C
T% before meas.	: 7131
Viscosity of the dispersion medium	: 0.894 mPa·s
Form Of Distribution	: Standard
Representation of result	: Scattering Light Intensity
Count rate	: 1539 kCPS

Table 2.Particle distribution of Ag NPs

Calculation Results

Peak No.	S.P.Area Ratio	Mean	S. D.	Mode
1	1.00	175.1 nm	106.3 nm	111.6 nm
2	---	--- nm	--- nm	--- nm
3	---	--- nm	--- nm	--- nm
Total	1.00	175.1 nm	106.3 nm	111.6 nm

Histogram Operations

% Cumulative (2)	: 10.0 (%) - 72.7 (nm)
% Cumulative (6)	: 50.0 (%) - 140.2 (nm)
% Cumulative (10)	: 90.0 (%) - 341.8 (nm)

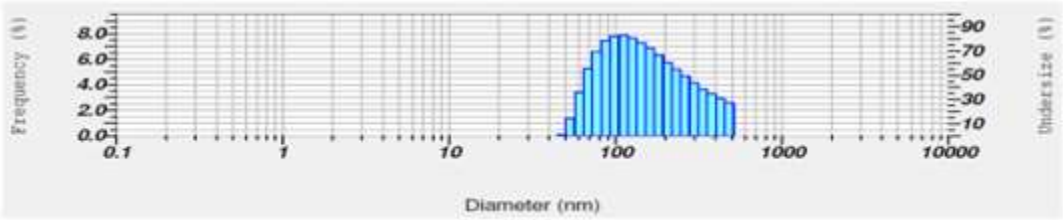

Fig 6. Particle size distribution of Ag NPs

Particle size analysis instruments provide the ability to measure and report the particle size distribution of the sample. The one peak shows the majority of the sample is silver. The peak represents the non symmetric distribution of the particles, and mean median and mode values are three different values which are in table 2. The sample has mode value 111.6nm represents the distribution of the particles is under nanolevel.

Zetapotential:

Table 3. value of Zeta potential of Ag NPs

Measurement Results

Date	: Friday, February 21, 2014 12:12:42 PM
Measurement Type	: Zeta Potential
Sample Name	: sample-2
Temperature of the holder	: 25.0 ℃
Viscosity of the dispersion medium	: 0.894 mPa·s
Conductivity	: 0.389 mS/cm
Electrode Voltage	: 9.6 V

Calculation Results

Peak No.	Zeta Potential	Electrophoretic Mobility
1	-35.0 mV	-0.000271 cm2/Vs
2	--- mV	--- cm2/Vs
3	--- mV	--- cm2/Vs

Zeta Potential (Mean)	: -35.0 mV
Electrophoretic Mobility mean	: -0.000271 cm²/Vs

Fig 7. Image of Zeta potential of Ag NPs

Zeta potential is one of the main forces that mediate the inter particles interaction. Zeta potential of the silver nanoparticles is measured using Horiba sz-100 and the peak from fig 7 represents showed that the Ag NPs have high zeta potential value. High zetapotential value shows the more stable nanoparticles present in the sample.
Zeta Potential (Mean) -35.0 mV.

Conclusion:

Silver nanoparticles were prepared by herbo metallic formulation and this sample further studied by the characterization of XRD, SEM, EDS, particle analyser, zetapotential. In XRD analysis the sample is highly crystalline and it has mean diameter of the particles is around 50nm.In SEM image agglomeration of the particles is observed. The EDAX peaks reveal major constituents of the sample are silver. From the particle analyser the distribution of the silver nanoparticles is 111.6nm and high zetapotential value shows the more stable nanoparticles present in the sample. These all characterization techniques reveals that the sample prepared in standard procedure of Ayurveda and it can be treated as nanomedicine.

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