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Physicochemical characterization of *Swarna Bhasma*: A micro/ nanoparticle used in traditional Indian medicine

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ABSTRACT

We describe here the comprehensive physicochemical characterization of commercial Swarna Bhasma samples for the first time. The commercial sample was characterized by Fourier-transform Infra-red FTIR) spectroscopy, X-ray diffraction XRD) analysis, scanning electron microscopy SEM) as well as by atomic absorption spectroscopy AAS). We conclude that the commercial *Swarna Bhasma* sample as used in Ayurvedic medicine, comprises gold-containing particles of both micrometer and nanometer sizes without any toxic impurities.

KEYWORDS

Gold;
Micro/nanoparticle;
Ayurvedic medicine;
Scanning electron microscopy;
X-ray diffraction;
Swarna Bhasma.

INTRODUCTION

In recent times, interest has grown on traditional medicines such as Homeopathic, Ayurvedic and traditional Chinese medicines for safety concerns and reduced side effects, which are very common in most allopathic medicines[1]. In India, traditional systems of medicines consist of mainly Ayurveda, Unani and Siddha. The medicines prepared under these systems use various natural products, which is well documented in the traditional and scientific literature for their healing properties.

Ayurvedic is a system of traditional Indian medicine and a form of alternative medicine. The earliest literature on Indian medical practice appeared during the Vedic period in India. Ayurvedic medicines can be prepared from a wide variety of natural products such as herbal, animal, metal and mineral sources. However, the use of metallic preparations as single drugs or as ingradients in many Ayurvedic medicines has evoked great concern and debate in recent times. The real physicochemical nature of the classical metal preparations which is commonly known as Bhasmas in the traditional Indian systems of medicines is not very clear[1,2]. The procedure for the preparation of Bhasmas was described by Nagarjuna around 800 AD and is strictly followed by the Ayurvedic practitioners Vaidyas) till today. Some Bhasmas are taken orally and the dose of a Bhasma is very small. Some Bhasmas have been pasted with honey, butter and ghee and the paste has been taken orally[3]. However, the exact mechanism of action of these preparations is not clearly understood

yet. In addition to this, its exact chemical composition has not yet been well characterized. Recently, doubts and debate has been raised over their utility and suitability as medicine. Therefore, it is necessary to resolve this problem by the physicochemical characterization of Bhasmas obtained commercially.

Swarna Bhasma or gold ash is a popular traditional Indian Ayurvedic medicine. It has been used as a therapeutic agent for several clinical disorders including bronchial asthma, rheumatoid arthritis, diabetes mellitus, nervous diseases, etc.[4,5]. Swarna Bhasma is given orally to patients and Ayurvedic doctors believe that gold particles present in this medicine get adsorbed through sublingual route directly into blood similar to Homeopathic medicine. However, there is no experimental proof available so far on its clinical effect. The scientific basis of its application to various diseases is not well understood. To understand the medicinal effect of Swarna Bhasma, one has to know its chemical composition[6]. There is only one report on the preparation and characterization of Swarna Bhasma sample[7]. However, there is no report on the systematic and comprehensive physicochemical characterization of commercial Swarna Bhasm*a* samples available in the market. Therefore, a systematic study was carried out to characterize the commercially available Swarna Bhasma sample for the first time and we report on this in the present communication. The commercial sample was characterized by Fourier-transform Infra-red FTIR) spectroscopy, X-ray diffraction XRD) analysis, scanning electron microscopy SEM) as well as by atomic absorption spectroscopy AAS). Our objectives in the present work have been to characterize Swarna Bhasm*a* in terms of its physicochemical properties including bulk/surface composition, crystalline phase analysis and particle size analysis.

EXPERIMENTAL

Swarna Bhasma sample was procured from commercial Ayurvedic medical shop Arya Vaidyasalsa, Kottakkal Kerala, India). The commercial drug was available in capsular form. For FTIR characterization, sample pellets were first prepared by mixing the gold ash with KBr in a 1: 100 wt/wt) ratio. FTIR spectra were then acquired using this KBr pellet on a Perkin Elmer Spectrum One FTIR spectrophotometer in the diffuse reflectance mode operating at a resolution of 4 cm^{-1}. X-ray diffraction XRD) analysis was carried out on homogeneous brown red powder of Swarna Bhasma sample using Bruker AXS model D8 Advance Series, Germany) instrument operating at a voltage of 40 kV and current of 40 mA with Cu Kα radiation. The size and morphology of the drug sample was characterized by scanning electron microscope SEM) JEOL JSM-6700F) with a field-emission electron gun operated at an accelerating voltage of 5 kV. For SEM studies, the powder goldash samples were spread onto copper tape and was sputter coated with platinum to minimize charging. The sample was quantitatively characterized by atomic absorption spectroscopy. An Atomic Absorption Spectrometer Perkin Elmer, USA) was used for quantitative analysis of gold in the Swarna Bhasma. Swarna Bhasma 10 mg) was digested in 2 ml of aqua regia 3 : 1 v/v of conc HCl and HNO_3) and after complete digestion, the volume of the solution was made up to 25 ml with distilled water.

RESULTS AND DISCUSSION

Figure 1 shows a typical FTIR spectrum of Swarna Bhasma sample. The Figure shows that the sample contains no organic compounds. The observed absorptions correspond to inorganic metal, hydrated metal salt or oxide. The absence of organic matter is further proof of proper incineration during the preparation of Swarna Bhasma. Our FTIR result replicates the results of earlier FTIR studies on Swarna Bhasma sample[7].

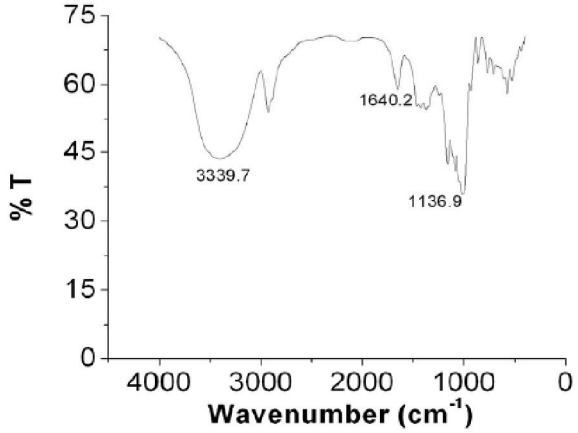

Figure 1 : The FTIR spectrum of commercial Swarna Bhasma sample KBr Disk).

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Figure 2 illustrates the XRD pattern of the sample. The diffraction peaks at 2θ = 38.2°, 44.4°, 64.6° and 77.6° are identical with those reported for the standard gold metal Au^0) JCPDS, USA). No other diffraction peaks were observed confirming that the drug Swarna Bhasma is composed of mainly gold particles. The high intensity of XRD lines in the XRD pattern suggests that the drug is present in crystalline form. All of the peaks, which correspond to the Bragg reflections from the 111), 200), 220) and 311) sets of lattice planes can be indexed to face-centered cubic fcc) bulk Au metal. The 200), 220) and 311) Bragg reflections are weak relative to the intense 111) reflection. It reveals that gold particles in the drug are polycrystalline in nature with predominantly 111)-oriented.

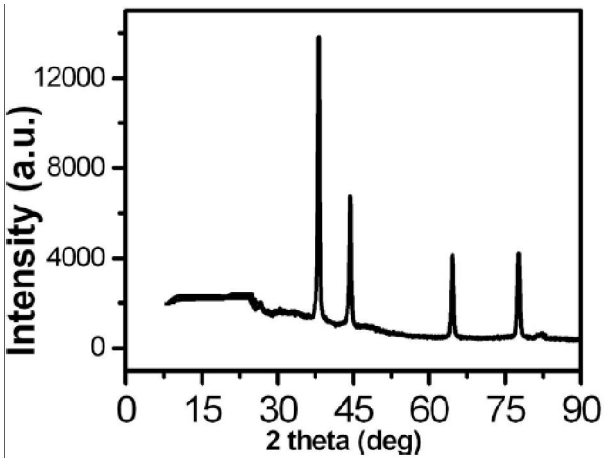

Figure 2 : The XRD pattern recorded for Swarna Bhasma sample.

Figure 3 shows the scanning electron microscope SEM) image of the drug sample. The SEM micrograph shows that the drug sample consists of micro/nanoparticles of variable sizes and shapes. The composition of the drug sample was verified by energy-dispersive X-ray EDX) spectroscopy. Figure 4 shows the EDX spectrum of the drug sample, which indicates that the composition of the commercial Swarna Bhasma is only gold without the presence of any other metal or non-metal.

The sample was quantitatively characterized by atomic absorption spectroscopy. An Atomic Absorption Spectrometer Perkin Elmer, USA) was used for quantitative analysis of gold in the Swarna Bhasma. Swarna Bhasma 10 mg) was digested in 2 ml of aqua regia 3 : 1 v/v of conc HCl and HNO_3) and after complete digestion, the volume of the solution was made up to 25 ml with distilled water. Appropriate dilutions were made and the concentration of gold was determined by flame AAS. The AAS experiment shows that the sample contains more than 90% of gold. This indicates that the sample was highly pure. Element like mercury was also not detected in the sample by AAS. The absence of toxic metals like arsenic As), lead Pb) and mercury Hg) suggests that the commercial Swarna Bhasma sample has better potential acceptability as a drug without any toxic effect.

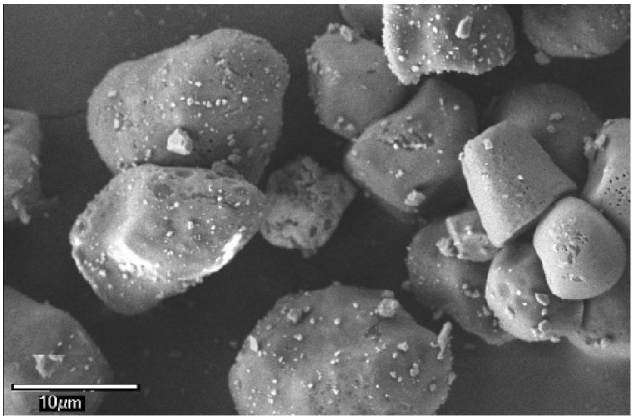

Figure 3 : The FE-SEM micrograph of Swarna Bhasma sample.

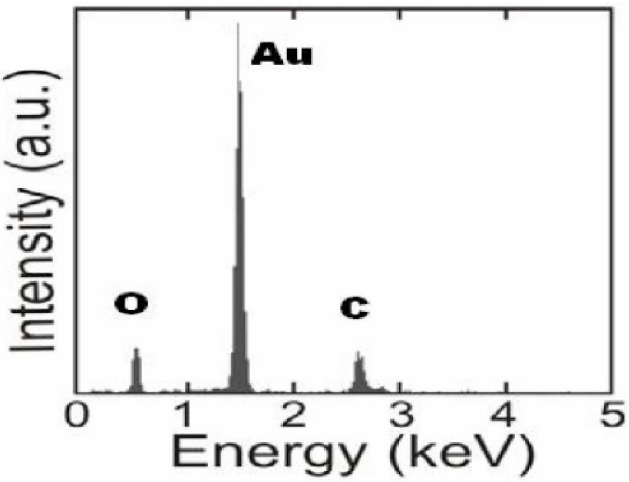

Figure 4 : The EDX spectrum of Swarna Bhasma sample.

CONCLUSIONS

We conclude that the commercial Swarna Bhasma sample as used in Ayurvedic medicine, comprises gold-containing particles of both micrometer and nanometer sizes without any toxic impurities. It is expected that such a qualitative and quantitative study will enhance the po-

tential acceptability of Swarna Bhasma as a drug, especially in western countries. We are also in the process of characterizing other Bhasmas such as Rajata silver), Tamra copper), Naga lead), Lauha iron) and Yashada zinc), which will be communicated later.

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