ORIGINAL ARTICLE

Green Synthesis and Morphological Investigation of Silver Nanoparticles Using Greater Burdock (*Arctium Lappa*) Aqueous Extracts

MAHTAB HAJJ HOSSEIN[1]*, SAJJAD SEDAGHAT[2]

ABSTRACT

Silver nanocomposite synthesis using Arctium Lappa is quite new in all respects hence it can be investigated as an innovation. Moreover, it, as a green technique, is also enumerated amongst the novel researches in Iran and the world. The present study has been conducted for silver nanocomposite synthesis as a green and highly safe method. The method not only leads to the production of a large amount of nanoparticles free of any pollution but also the produced nanoparticles are very appropriate in terms of morphology. In a biological process where the *Artium Lappa* fruit's aqueous extract was applied as a capping and reducing agent, nanoparticles (NPs) of silver were synthesized. These Silver NPs were classified via X-ray diffraction (XRD), Fourier transformed infrared spectroscopy,field emission scanning electron microscopy (FE-SEM), transmission electron microscopy (TEM) and UV-visible spectroscopy.According to the obtained results, it can be stated that arctium lappa is capable of silver nanoparticle synthesis and it was also observed in SEM spectrum that silver nanoparticle are in a range between 20nm and 30nm in size indicating the suitability of arctium lappa for synthesizing silver nanoparticles in desirable dimensions.

Keywords: Green Chemistry, silver nanoparticles, *Arctium Lappa*

INTRODUCTION

Silver nanoparticles are amongst the important materials that have been extensively studied. These nanoparticles feature unique physical, chemical and biological properties amongst which their antibacterial characteristics can be pointed out [4,6].These nanoparticles can be produced using several physical and chemical methods; however, these methods are not so much environment-friendly [7]. Moreover, since the application of green chemistry principles in nanotechnology can guarantee both safety and efficiency, such solutions are deemed necessary [8]. Silver nanoparticles' green synthesis using the plant extracts has been widely studied[1,10]. The biomolecules found in the plants cause the silver nitrate to lose Ag^+ ions and be reduced to silver nanoparticles.

Nanotechnology is a domain of technology wherein the various compounds, alloys, instruments and tools and, in general, various systems and constructs can be designed and prepared for production in atomic and molecular scales as well as in nonmetric dimensions. In the majority of the cases, the method of production includes dislocation of atoms and molecules and insertion of them in proper positions[5].

Also, nanotechnology can be named based on the constituent components, to wit "Nano-" and "technology". In general, technology means construction of applied instruments using scientific regulations. The dimensional range discussed in respect to nanotechnology is between 0 and 011x[12]. But, this domain incorporates a vast fraction of the dimensional ranges in various sciences, from ray-based crystallography to atomic physics and chemical discussions and so on. Thus, in order to specify the work realm, it is assumed that nanotechnology only includes manufacturing and production in the range specified for various certain instruments. In summary, nanotechnology includes the manipulation of the materials in the area of atoms, including the atoms' embedding in their right place and it allows the generation of lighter, stronger, cheaper and cleaner materials with higher dimensional precision. In simple terms, nano-size objects and materials possess a countable number of atoms and molecules[2,5].

Hossein et al. (2005) evaluated the toxicity of various nanomaterials, including silver nanoparticles, in rats' livers and considerable lactate dehydrogenase dosage-associated leakage was observed following 24 hours of being exposed to mitochondria [13].

On the other hand, Moudgi B.M. and Roberts S. M. et al. (2006) showed that the effect of nanoparticles on the humans' live cells depends on the diameter, form and size of the nanoparticles[13]. Therefore, it can be concluded that the spherical nanoparticles, 4nm in diameter, cause changes in the enzymatic activity amount of lactate dehydrogenase. But, on the other hand, tissue investigations were indicative of highest changes scored for 400ppm dosage thereof meaning that the tissue changes occur in high dosage of silver nanoparticles[9].

Asharani et al. (2009) investigated the cells damaged by silver nanoparticleand showed that the damages incurred by the cells depend on the extent to which nanoparticles can be pushed out by the cells, themselves. Therefore, the exocytose rate of silver nanoparticles was investigated for the better preservation and exit of the nanoparticles[11].

Greater burdock, with the scientific name (*Arctium Lappa*), belongs to aster family that are dicotyledonous. It is an herbaceous biennial plant reaching in height up to seven meters. The plan grows in wild in the moderate shaded and humid moors and regions in Europe and Asia.

[1]*Department of Pharmaceutical Chemistry, College of Science, Shahryar Branch, Islamic Azad University, Tehran, Iran*
[2]*Department of Chemistry, Faculty of Science, Shahr-e-Qods Branch, Islamic AzadUniversity, Tehran, Iran*
Correspondence to Dr. Mahtab Hajj Hossein,
Email: khademmazi@gmail.com

The plants' roots are long and spindle-shaped like a carrot reaching in thickness to the thickness of a finger and contain large amounts of potassium carbonate and potassium nitrate. Nanotechnology is a technology in which certain instruments are prepared for the investigation and conversion of biological systems. Nowadays, nanoparticle biosynthesis has been widely expanded considering its great many of the biochemical applications. Silver nanoparticles are amongst the most frequently applied particles in the Nano-area and its use in Nano world is increasing on a daily basis.

According to the fact that the nanocomposites have greater and more effective medicinal, antibacterial, antifungal and anticancer effects than their ordinary states and this is somewhat unknown about ArctiumLappa and considering the idea that there is no research performed in this regard based on the information obtained from the numerous studies reviewed, silver nanocomposite synthesis using Arctium Lappa is quite new in all respects hence it can be investigated as an innovation. Moreover, it, as a green technique, is also enumerated amongst the novel researches in Iran and the world. The present study has been conducted for silver nanocomposite synthesis as a green and highly safe method. The method not only leads to the production of a large amount of nanoparticles free of any pollution but also the produced nanoparticles are very appropriate in terms of morphology.

Objectives: Synthetizing silver nanocomposites using arctiumlappa extract; investigating the morphology of the obtained nanocomposite; investigating the effect of ssubstrateon nanocomposite'smorphology and size

MATERIALS AND METHODS

Preparing the Aqueous Extract from Greater Burdock (Arctium Lappa): Arctium Lappa was collected from various regions of the country (the plant used in the current research paper was collected from Karaj region). The plant was dried and used for the subsequent tests. Silver nitrate ($AgNO_3$) used in the present study was procured from German Merck Company.

To perform the experiments, aqueous extract was prepred from the dried arctium lappa plants; the obtained extract was exposed to metal silver ions. To do so, the intended plant was washed in deionized water and dried. Next, five grams of the dried plant was weighed and poured into a Beaker to which 50ml deionized water was also added. The mixture was placed in an 80-degree-centigrade water bath for a period of time between 10m to 1h during which the mixture was completely shaken. The extract's change of color indicated the formation of nanoparticles. The obtained extract was cooled down, filtered and stored in refrigerator in 4ºC to be subjected to further experiments.

Silver Nanoparticle Preparation: Four milliliters of the extract was poured into a Beaker that was subsequently placed in an ultrasonic device. The reaction took place in a fixed temperature with no increasing of temperature with 0.08 molar silver nitrate that had been poured inside a Bourt. To do so, the silver nitrate was added drop-by-drop till the completion of the first stage of silver nitrate indicated by the appearance of a brownish yellow. Magnet was added to the solution. The whole container was covered with a foil and the solution was stirred for a day without heating. Next, the silver nanoparticle is washed. Then, equal amounts of solution are poured inside a falcon tube and centrifuged for 15m in 4000rpm. In the first stage, the deposits are kept and the solution is poured away. The deposits were washed with twice distilled water and added to the main container and remixed with water again and centrifuged. In the end, the overhead water was thrown away and the deposits are ready for identification.

RESULTS AND DISCUSSIONS

Silver Nanoparticles Obtained from Aqueous Extracts of Arctium Lappa: Synthetized silver nanoparticles that had been prepared in the present study using arctium lappa based on green method were evaluated by various methods like spectrophotometry UV-Vis scanning electron microscope (SEM). The images presented in this chapter demonstrate the evaluation results of silver nanoparticles following UV-Vis, XRD, SEM and TEM examinations

Results Obtained from UV-Vis Spectra Images of Silver Nanoparticles, Arctium Lappa: One characteristic of the metal nanoparticles is their light properties that change in proportion to the shape and size of the nanoparticles. Surficial plasmon intensification in metal nanoparticles is responsible for their unique light properties that change subject to factors like nanoparticle size, nanoparticle form, their distances from one another and the refractive index of the peripheral environment.

According to UV-Vis spectrum (Figure 1), the plant extract and silver nitrate that were examined based on reference spectrum are found devoid of any peak in 400nm to 500nm wavelength range pertinent to the resonance of the silver nanoparticles' surficial plasmon. Plant extract and silver nitrate that were examined acording to the reference spectrum do not have any peak. In conrast to UV-Vis spectrum (Figure 1) and reference silver nitrate spectrum and silver nanoparticle reference spectrum,UV-Vis spectrum (Figure 2) illustrates the effect of metal ion concentration on the nanoparticle synthesis. According to the figure, it can be observed that the addition of lowest silver nitrate amount to the container containing plant extract, the adsorption by silver nanoparticle can be seen. According to UV-Vis spectrum (Figure 2), the adsorption band of the surficial plasmon has occurred in 479 nm for silver nanoparticle which is reflective of silver nanoparticle synthesis.

Figure 1: UV-Vis spectrum of dissolved arctium lappa extract

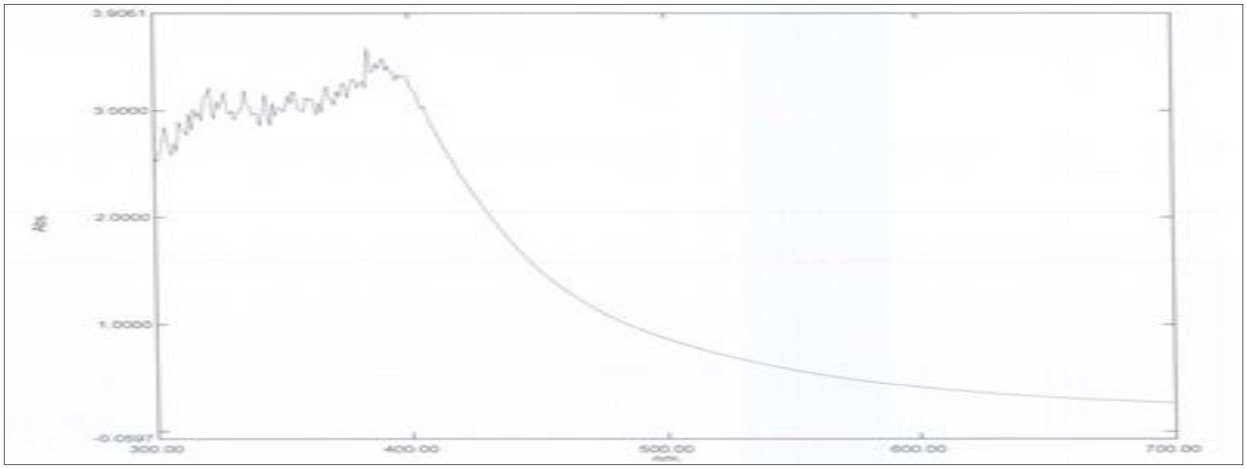
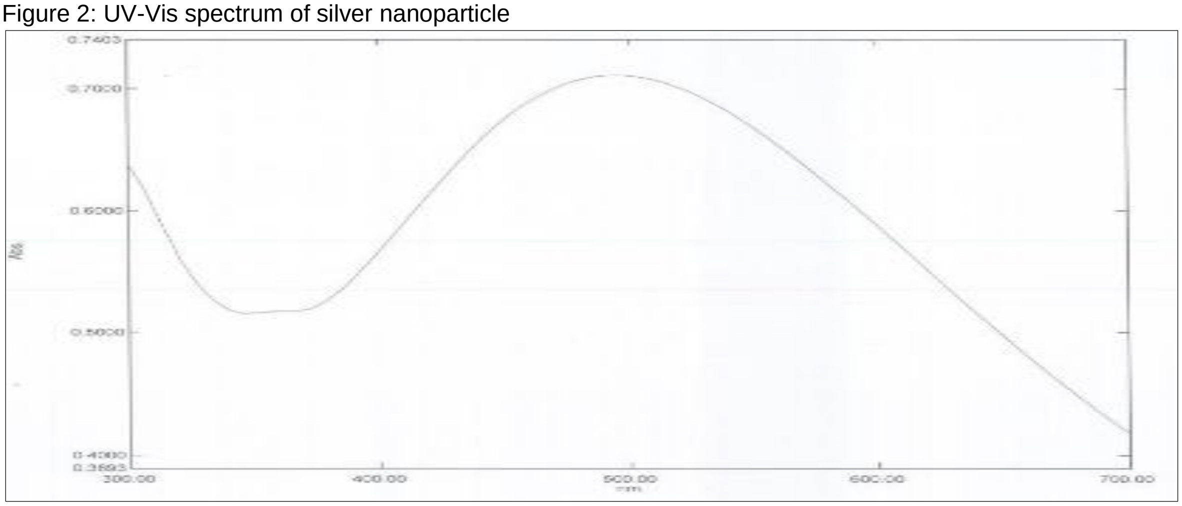


Figure 2: UV-Vis spectrum of silver nanoparticle



SEM Analytical Results: Figure 3 displays the scanning electron microscopy (SEM) of the synthetized powders. SEM images provide information about the morphology and size of silver nanoparticles. As it can be observed in the figure, finer nanoparticles have been produced in low concentration of silver nitrate due to faster nucleation. Thus, to determine the exact size of the nanoparticles, use was made of laser-based measurements. Synthetized particles are about 25.61nm in size on average and completely spherical with nearly identical scattering. This is suggestive of the idea that the method used for nanoparticle synthesis has been optimum.

TEM Results: The distribution and size of the synthetized nanoparticles were examined using scanning electron microscopy. Figure 4 depicts the synthetized SEM images via exerting all the optimum conditions. The image indicates that all of the obtained nanoparticles are almost spherical and 30nm in size.

Figure 3: FESEM spectrum of silver nanoparticle

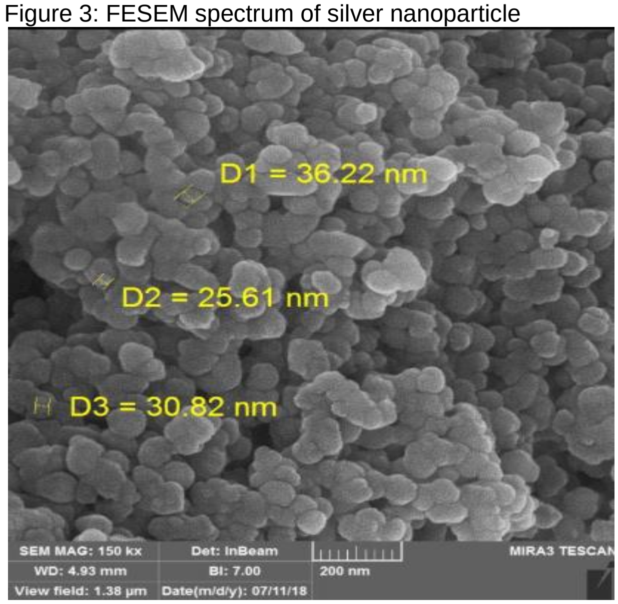


Diagram 1: the average size of the siver nanoparticles formed using arctium lappa extract

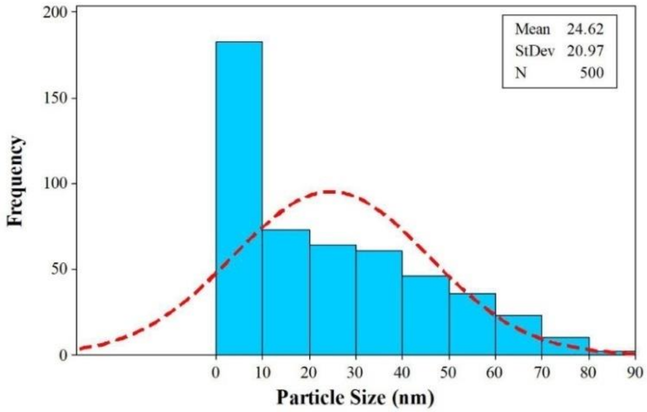
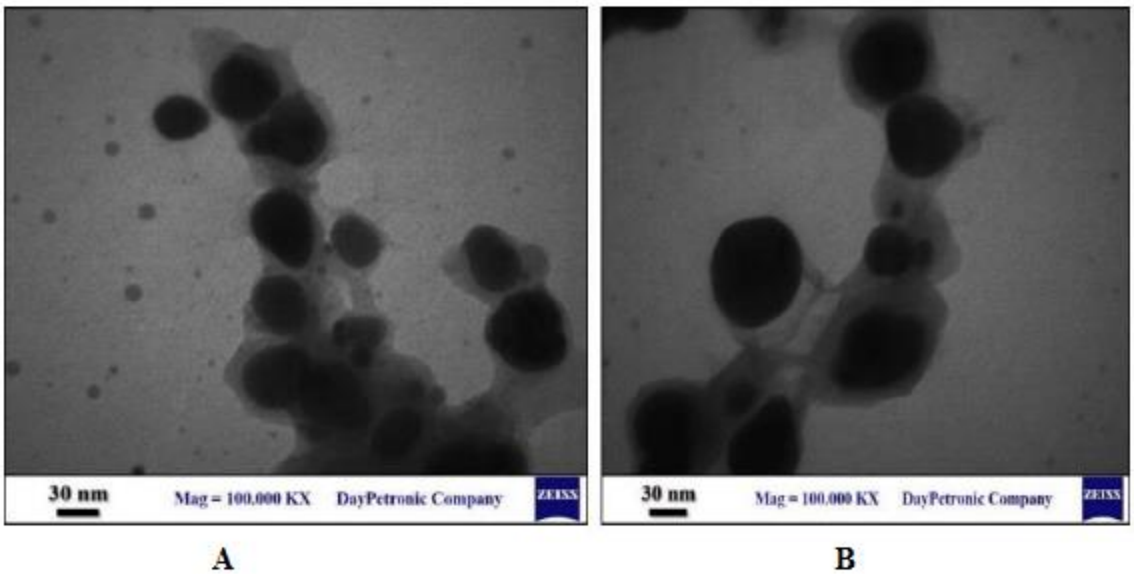


Figure 4: TEM image of siver nanoparticles formed using arctium lappa extract

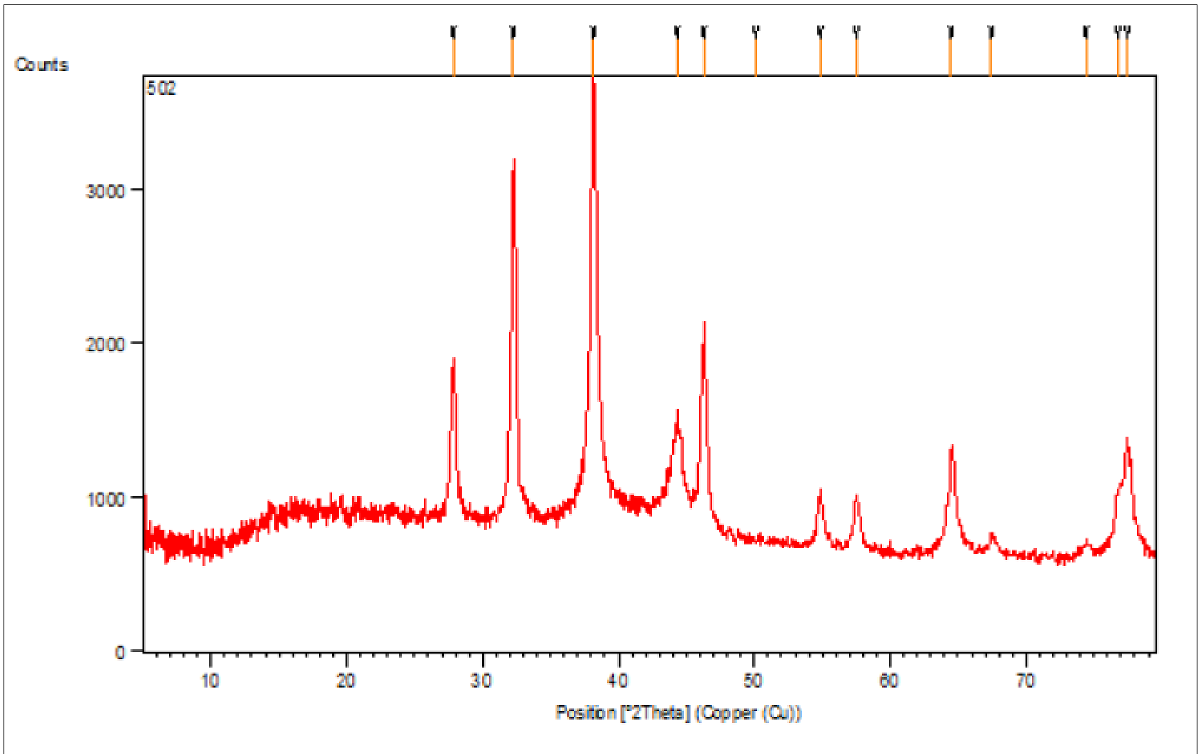


XRD Spectrum Results: XRD spectrum of the silver nanoparticles has been shown in figure 5. The appeared strong peaks match with diffraction in table 1 and it has also been portrayed in the diagram, as well. The results mean that the intended silver nanoparticle has been synthetized successfully.

Table 1: The information required for XRD Spectrum

Pos.[°2Th.]	Height [cts]	FWHML eft[°2Th.]	d-spacing [Å]	Rel. Int.[%]
27.843	726(19)	0.40(2)	3.20170	38.95
32.259(2)	1624(23)	0.380(8)	2.77279	87.16
38.155(2)	1864(19)	0.544(9)	2.35677	100.00
44.279(8)	407(9)	0.88(3)	2.04398	21.83
46.245(3)	830(14)	0.46(1)	1.96155	44.53
50.102000	11.512430	1.119618	1.81921	0.62
54.842(8)	248(11)	0.50(4)	1.67265	13.31
57.487(7)	246(10)	0.51(3)	1.60183	13.17
64.517(5)	462(9)	0.65(2)	1.44321	24.77
67.49(2)	91(8)	0.6(1)	1.38673	4.86
74.40(2)	66(11)	0.5(1)	1.27405	3.56
76.76(2)	222(12)	0.64(7)	1.24070	11.93
77.44(1)	485(13)	0.62(4)	1.23147	26.01

Figure 5: XRD spectrum of silver nanoparticle



CONCLUSION

Nowadays, bio-nanoparticles' preparation has undergone an increase considering their efficiency in medicine and biological sciences. On the other hand, the increase in the awareness of the green chemistry and biological processes have made it necessary to use methods consistent with the environment for the non-toxic preparation of bio-nanomaterials. Although, there are some biological methods known for the production of metal nanoparticless, the use of living beings or the other intermediates of metal particles are expensive and constrained. Therefore, devising an easy method of nanoparticle production that allows controlling of their size and shape is of great importance. The use of plant matrices for nanomaterial prepartion is a rather new method based on green chemistry principles.

Since methods of nanoparticles' synthesis are not complex and they can be produced even biologically via fungi and bacteria and have been proved to have no toxic effects on the human cells, they have attracted many fans. Furthermore, their antibacterial properties as well as their lack of being followed by development of resistance to m icroorganisms have made them appear as good surrogates for antibiotics. The most distinct feature of these particles is their dual toxicity. Thus, they do not exhibit toxic effects against bacteria and, on the contrary, they are more consistent with the biology of the human body. These features have enabled the vast application of these particles in ostokhani cement, wound repair equipment, vascular catheters and prothesis. These particles are suitable choices for the treatment and diagnosis of cancer. All the aforesiad advantages and applications have caused the considerable growth and development of silver nanoparticles in medicine.

According to the obtained results, it can be stated that arctium lappa is capable of silver nanoparticle synthesis and it was also observed in SEM spectrum that silver nanoparticle are in a range between 20nm and 30nm in size indicating the suitability of arctium lappa for synthesizing silver nanoparticles in desirable dimensions. Based on the fact that no use of this plant for the biological reduction of silver ions has been so far reported and the results are well reflective of the plant's good functioning, it can be for the first time stated that the plant can be utlized as a live factory for the production of silver nanoparticles. Thus, it can be stated that, besides its special medicinal role, arctium lappa can be employed for medical- and pharamaceutical-grade silver nanoparticle production.

SUGGESTIONS

1. Use of other metal nanoparticles and investigation of the effect of metals coordinated with arctium lappa plant
2. Investigation and examination of the treatment effects of arctium lappa-synthetized magnetic nanoparticle surfaces
3. Use of other plants' extracts with treatment properties
4. Use of the derivatives of compounds with medicinal properties and loading them on the metal nanoparticle surfaces for the investigation of their treatment effects
5. Investigation of the applied and biological properties of the manufactured compositions

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