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Original paper

Green Synthesis and Characterization of AgCl Nanoparticle Using *Onopordum acanthium* Extract

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Abstract

Background and aim: Silver nanoparticles can be synthesized by using a variety of methods. Green synthesis of silver nanoparticles makes use of plant extracts or constituents to synthesize silver nanoparticles. *Onopordum acanthium* is used traditionally for the treatment of many diseases and therefore can be a good source for nanoparticles synthesis. The aim of this study was to synthesize AgCl nanoparticles using *Onopordum acanthium* extract.

Materials and methods: After drying the plant flower in the shade, it was crushed to powder. The plant powder was placed in 50% alcohol for 48 hours. The solution was passed through filter paper. The obtained solution was dried with freeze-drying, and the dried and frozen extract of the plant was obtained. Potassium chloride solution was added to the aqueous solution of plant extract. The solution was added to silver nitrate and shaken for 24 hours and as a result, AgCl nanoparticles were synthesized in the solution.

Results: The particle size and surface morphology were investigated by X-ray diffraction (XRD) and field emission scanning electron microscopy. The results showed that the AgCl nanoparticles were agglomerated and had a spherical shape with an average size of 13 nm in diameter. The XRD spectrum confirmed the identity of synthesized nanoparticles.

Conclusion: Our findings indicated that AgCl nanoparticles are successfully synthesized by *Onopordum acanthium* extract.

Keywords: *Onopordum acanthium, Green Synthesis, AgCl nanoparticle*

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Introduction

Today, nanotechnology is used as an important branch of basic science for the synthesis of various nanoparticles. A nanoparticle has a dimension between 1 to 100 nanometers. In addition to the metallic type, nanoparticles include insulators and semiconductors, as well as composite nanoparticles. Nanoparticles in low sizes are considered as nanoclusters. The chemistry of nanoparticles is related to their shape, size, surface charge and surface area. Nanoparticles (NPs) are widely employed in different research areas, ranging from analytical chemistry and environmental science to medicine, the agriculture and pharmaceutical industry. This is mainly due to the unique characteristics of NPs and the novelty they introduce in such applications. In analytical chemistry, the role of NPs can differ depending on the nature of the steps involved in analytical process [1], [2]. Identification and characteristics of biosynthesized nanoparticles are performed using various techniques such as UV-vis spectroscopy, FT-IR, TEM, SEM, AFM, DLS, XRD, zeta potential analysis, etc. [3].

In recent years, silver nanoparticles (AgNPs) have been used in the biomedical field of study according to their antibacterial, antiviral and anticancer properties [4]. Anti-infective, anti-cancer, and tissue repair effects of AgNPs have been reported in a number of studies [5]. AgNPs are nanoparticles with a size of 1 to 100 nanometers and are made of silver. While they are often known as silver, some of them are composed of a large percentage of silver oxide and this is due to the large surface area to silver atoms ratio. Their large size allows coordination of a large number of ligands [3], [4].

There are several methods for nanoparticles synthesis, including coprecipitation, hydrothermal synthesis, inert gas condensation, ion sputtering scattering, microemulsion, microwave, pulse laser ablation, sol-gel, sonochemical, spark discharge, template synthesis, and biological synthesis, among which, biological synthesis (green synthesis) using plant or plant extracts is considered to be safe method for production of nanoparticles, and hence, the green synthesis of silver chloride nanoparticles can be a very important method in the synthesis of silver chloride nanoparticles [1], [5].

Green synthesis of nanoparticles makes use of environmental friendly, non-toxic and safe reagents. Nanoparticles synthesized using biological techniques or green technology have diverse natures, with greater stability and appropriate dimensions since they are synthesized using a one-step procedure [6]. The biosynthesis of nanoparticles has been proposed as an environmentally friendly alternative to chemical and physical methods. Plant-mediated synthesis of nanoparticles is a green chemistry approach that connects nanotechnology with plants. Among the biological synthesis methods of NPs, plants and plant extracts seem to be the best option [7], [8].

Onopordum acanthium, which is also known as Scotch or Scottish thistle, has been used for green synthesizing of Ag NPs [9]. However, the synthesis of AgCl NPs in high yield and in a wide range of shapes are still a challenging task. The aim of this study was to synthesize AgCl NPs using *Onopordum acanthium* extract and characterization of synthesized AgCl NPs.

Material and Methods

Preparation of Plant Extract

After drying the plant flower in the shade, it was converted to powder. The plant powder was placed in 50% alcohol for 48 hours. The solution was passed through filter paper. The obtained solution was dried with freeze-drying, and the dried and frozen extract of the plant was obtained.

AgCl Nanoparticle Synthesis

90 mL of silver nitrate (Merck, Germany) with a concentration of 10 mM was prepaed. 10 mL of

aqueous solution of plant extract (with a concentration of 5 mg/ml) was prepared and a weight equivalent of 10 mM of potassium chloride solution was added. The solution was added to silver nitrate and shaken for 24 hours. The color change of the solution indicated the synthesis of nanoparticles and the resulting purple color was related to the formation of silver chloride nanoparticles.

Characterization of AgCl Nanoparticle

The particle size and surface morphology were investigated by X-ray diffraction (XRD) (X' Pert Pro, Panalytical, UK) and field emission scanning electron microscopy (FESEM) (Philips, Amsterdam, Netherlands, XL30).

Results

The morphological characteristics of the synthesized AgCl NPs were observed under FESEM indicating that AgCl NPs were agglomerated. They had a spherical shape with an average size of 13 nm in diameter. The XRD spectrum confirmed the identity of synthesized NPs. (Figure 1)

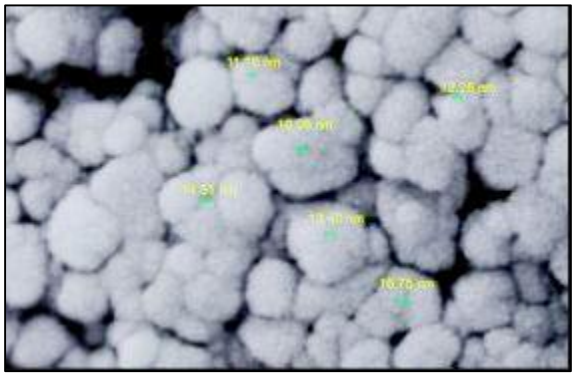

Figure 1. Electron microscopy of AgCl NPs.

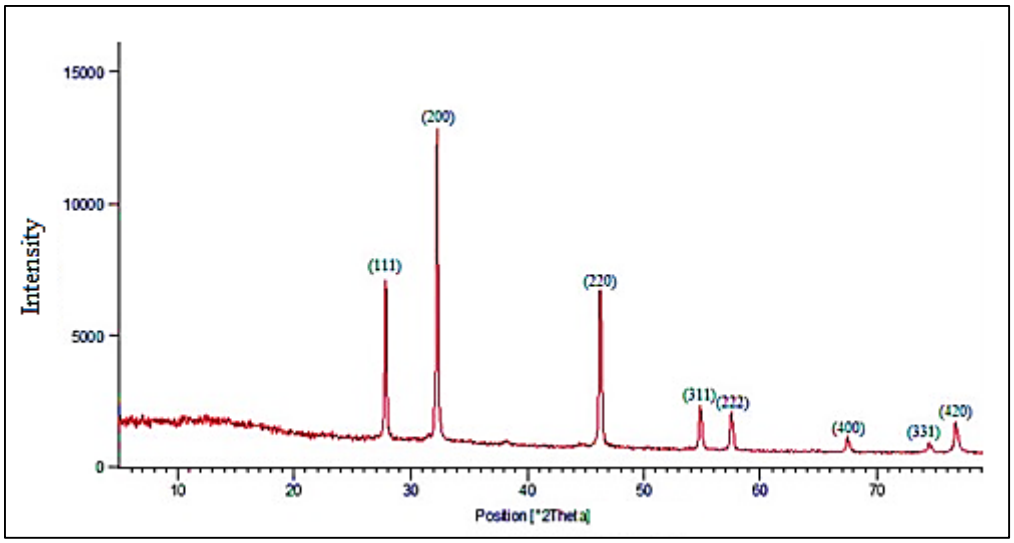

Figure 2. XRD spectrum of synthesized AgCl.

Discussion

The present research was carried out with the aim of synthesizing AgCl NPs using *Onopordum*

acanthium extract and characterization of synthesized AgCl NPs. Green synthesized NPs play significant roles in medicines, clinical applications and *in vitro* diagnostic applications. NPs synthesized via green methods show excellent antibacterial effects, antifungal effects and anti-parasitic activity [6], [7], [8]. The present study showed the eco-friendly, rapid, and affordable synthesis of AgCl NPs by using aqueous extracts of *Onopordum acanthium*. TEM analysis showed that most of the AgCl nanoparticles were spherical with an average size of 13 nm in diameter. Furthermore, the identity of AgCl NPs was confirmed by XRD analysis.

Silver NPs have exceptional chemical, physical, and biological properties. In the last decade, numerous efforts were made to develop green methods of synthesis to avoid the hazardous byproducts [10]. The extracts from various plants and microbial species have been used in many studies as potential agents for the green synthesis of silver NPs [11]. Novel outcomes of green synthesis in the field of nanotechnology are appreciable where the synthesis and design of NPs have proven potential outcomes in diverse fields [12]. Studies have shown that the aqueous extracts of various plants can be used as reducing and stabilizing agents to synthesize NPs. The characteristics of the obtained silver nanoparticles can be studied using X-ray diffraction analysis (XRD), energy-dispersive spectroscopy (EDX), and scanning electron microscopy (SEM). The EDX spectrum of the solution containing silver NPs also can be confirmed by the presence of an elemental silver signal without any peaks of impurities [13].

Silver NPs have been successfully synthesized by a variety plant extracts including mulberry leaves extract [14], *Capsicum annuum* L. extract [15], *Jatropha curcas* [16], *Azadirachta indica* aqueous leaf extract [17], and Ocimum leaf extract [18]. In line with our study, *Onopordum acanthium* L. was used in a very recent study to synthesize the silver NPs and the synthesized NPs were characterized using XRD, and field emission scanning electron microscopy (FESEM) analysis confirming the successful yielding of spherical shape of silver NPs with the range of 1–100 nm [9]. However, further research is required to investigate the physical and chemical properties of AgCl NPs synthesized by *Onopordum acanthium* extract.

Conclusion

The results of this study show that silver chloride nanoparticles synthesized by *Onopordum acanthium* extract had the nanoparticles morphological characteristics under electron microscopy and nanoparticle identity identified by XRD spectrum analysis.

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Conflict of interests

Authors declare that there is no conflict of interests regarding the publication of this paper.

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