Global Conference on Multidisciplinary Research and Innovation
Hosted Online from Berlin, Germany
Date: 2nd May, 2026
Website: https://econferencia.com

SYNTHESIS OF SILVER NANOPARTICLES FROM THE TOTAL EXTRACT OF YETMAK (ACANTHOPHYLLUM GYPSOPHILOIDES)

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ABSTRACT

In this study, it was aimed to isolate silver nanoparticles from the extract of Allochrusa gypsophiloides (Yetmak) plant. This work is carried out based on the green synthesis method. The green synthesis method is considered an environmentally friendly and safe method. Today, due to the rapid development of the fields of nanobiotechnology and nanomedicine, interest in nanosized materials is sharply increasing. In particular, silver nanoparticles (AgNPs) are at the center of scientific research due to their physicochemical and biological properties. Their high surface area, optical properties, chemical stability, and biological activity are widely used in various fields, particularly in medicine, pharmaceuticals, and biotechnology.

Keywords: Allochrusa gypsophiloides (Yetmak), green synthesis, silver nanoparticles, flavonoids, saponins.

Introduction

Today, due to the rapid development of the fields of nanobiotechnology and nanomedicine, interest in nanosized materials is sharply increasing. In particular, silver nanoparticles (AgNPs) are at the center of scientific research due to their

physicochemical and biological properties. Their high surface area, optical properties, chemical stability, and biological activity are widely applied in various fields, especially in medicine, pharmaceuticals, and biotechnology [1, 2]. Conventional methods for nanoparticle synthesis often require the use of high temperature, pressure, and toxic chemical substances. This creates environmental problems and biological safety issues. Therefore, in recent years, particular attention has been paid to environmentally friendly, economically efficient, and safe "green synthesis" methods. In these methods, nanoparticles can be obtained using plant extracts, microorganisms, and biologically active compounds [3, 4]. The method of synthesizing nanoparticles using plant extracts is distinguished particularly by its simplicity, low cost, and high efficiency. The presence of biologically active substances such as phenols, flavonoids, alkaloids, and saponins in plants plays an important role in the reduction of silver ions and stabilization of the formed nanoparticles [5]. Allochrusa gypsophiloides (Yetmak) plant is distinguished by its rich chemical composition, particularly its richness in saponins. These compounds are important in the formation and stabilization of nanoparticles as surface-active substances. Nevertheless, the use of this plant extract in the synthesis of silver nanoparticles has not been sufficiently studied, and conducting scientific research in this direction is considered relevant [6, 7].

Allochrusa gypsophiloides, popularly known as Yetmak, is a perennial plant belonging to the Caryophyllaceae family. It naturally grows mainly in the regions of Central Asia, including the desert and semi-desert regions of Uzbekistan. The most valuable part of the plant is its root, where its medicinal properties are concentrated [8]. The root of Yetmak is rich in chemical composition and is especially distinguished by saponins. These substances possess the property of forming foam when mixed with water and determine the biological activity of the plant. In addition, it also contains flavonoids, organic acids, and other bioactive

compounds [6, 9]. From the point of view of medicinal properties, Yetmak possesses expectorant, anti-inflammatory, and antimicrobial effects. It is mainly considered useful in respiratory tract diseases, cough, and bronchitis. It is also used in cleansing the body and strengthening the general immune system. Infusions and decoctions prepared from its roots are widely used in folk medicine [9].

In modern scientific studies, the Yetmak plant is attracting great interest as a source of biologically active compounds. In particular, the possibilities of creating new medicinal agents based on saponins, as well as the use of plant extracts in nanoparticle synthesis, are being investigated [7, 10]. At the same time, the anticancer properties of some of its components are also being scientifically studied.

✓ Flavonoids are strong antioxidants that protect cellular DNA from oxidative stress [11].
✓ Saponins enhance immunity and stimulate apoptosis in cancer cells [11].
✓ Polysaccharides exhibit antitumor and immunomodulatory effects [11].
✓ Alkaloids possess cytotoxic and antimicrobial activity [11].

Therefore, Allochrusa gypsophiloides (Yetmak) extract may serve not only as a reducing/stabilizing agent in the synthesis of silver nanoparticles but also as an additional factor enhancing their biological activity [11].

In this study, an aqueous/ethanolic extract is prepared from the root part of Allochrusa gypsophiloides (Yetmak) [1, 2]. The prepared extract is poured into a centrifuge apparatus and filtered. The extract is added to a 3.5% $AgNO_3$ solution (Figure 1), and nanoparticles are obtained through green synthesis (Figure 2) [2]. The formed nanoparticles are characterized using UV-Vis, FTIR, TEM/SEM, and DLS methods [1, 2]. Yetmak extract exhibits a certain inhibitory effect against some pathogenic microorganisms, including bacteria and fungi such as

Staphylococcus aureus, Escherichia coli, and Candida albicans. This expands the possibilities of its application as a natural antimicrobial agent [7].

Figure 1.

Figure 2.

In this study, silver nanoparticles obtained through green synthesis based on Allochrusa gypsophiloides (Yetmak) are distinguished by their environmental safety and high biological efficiency [1, 11]. Stable nanosized silver nanoparticles are synthesized using Yetmak extract, where saponins and other bioactive substances contained in the plant serve as reducing and stabilizing agents. The synthesized AgNPs may affect various microorganisms, including bacteria and fungi, by inhibiting their growth and reproduction [1, 2]. They exert antimicrobial effects by disrupting the cell wall and membrane of microorganisms, impairing enzyme systems, and increasing oxidative stress. Saponins and flavonoids, which are found in high amounts in Yetmak, play an important role in enhancing the biological, particularly antimicrobial, activity of nanoparticles. These compounds

affect the cell membrane of microorganisms and disrupt their vital activity. At the same time, detailed investigation of the antimicrobial properties of silver nanoparticles synthesized based on Yetmak is currently considered one of the relevant scientific directions. In the future, this direction may play an important role in the creation of new, environmentally friendly, and effective drugs against infectious diseases [12].

Conclusions

The results of the conducted study show that silver nanoparticles obtained through the green synthesis method based on Allochrusa gypsophiloides are promising nanomaterials that are environmentally safe, economically efficient, and possess high biological activity. Saponins, flavonoids, and other bioactive compounds contained in the plant play an important role in the formation and stabilization of nanoparticles, significantly enhancing their antimicrobial properties. In the study, the synthesized nanoparticles are distinguished by their broad-spectrum effects against bacteria and fungi, which expands the possibilities of their application in the fields of medicine, pharmaceuticals, and biotechnology. The environmental friendliness and biological compatibility of the green synthesis approach fully meet the requirements of modern science.

In the future, in-depth study of the mechanisms of action of nanoparticles obtained based on Yetmak, evaluation of their toxicological properties, and expansion of their practical applications will remain among the important scientific directions.

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