Advances in Biology & Earth Sciences
Vol.6, No.2, 2021, pp.169-173

EFFECT OF pH AND TEMPERATURE ON THE SYNTHESIS OF SILVER NANO PARTICLES EXTRACTED FROM OLIVE LEAF

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Abstract. In this study, silver nanoparticles have been obtained by the biological method that we refer to as green synthesis. For this reason, olive leaf extract has been used as a reducing agent. Then the effects of ambient temperature and pH on the synthesis of silver nanoparticles have been studied.

Keywords: *silver nanoparticles, plant extract, pH, temperature.*

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***Received**: 21 May 2021;* ***Accepted**: 3 July 2021;* ***Published**: 30 August 2021.*

1. Introduction

Nanotechnology has developed intensively as a 21st century technology and has become widely used in many fields. Nanotechnology materials, especially nanoparticles ranging in size from 1 to 100 nm, have been the most widely used materials in medical practice. Recently, nanoparticles, especially metal nanoparticles, have become widely used in medical practice, electronics, photonics, ecology and agriculture, and in many other fields. Therefore, the use of these nanoparticles has aroused great interest in human activities. Although nanoparticle synthesis has long been used to obtain particles of any size in a short period of time through physical and chemical methods, due to the high level of toxicity and the high cost of the technology used, new and more affordable methods are needed. In order to overcome all these shortcomings, more attention has recently been paid to the synthesis of nanoparticles by biological methods. They use bacteria, fungi, extracts from various plant organs, and organic molecules to synthesize nanoparticles biologically. Now the method of biological synthesis is often called "green synthesis" or "green nanotechnology" (Roy & Barik, 2010). In this method of synthesis, mainly extracts from various plant organs are used. Biological methods are used more in the synthesis of metal nanoparticles of special importance (Bali & Razak, 2006), as well as Ag nanoparticles. The antibacterial and antioxidant effects of silver and its salts were already known to science. In addition, the use of silver nanoparticles in electronics is important due to their catalytic and optical properties. Synthesis of silver nanoparticles from plant extracts is considered favorable due to their shorter duration and convenience (Dipankar & Murugan, 2012). Also, the stabilizing and reducing properties of the molecules in the extract make the shape of the obtained nanoparticles more stable. In this case, it is possible to control the size and shape of the obtained nanoparticles by changing the pH, temperature, etc. Studies have shown that the formation of silver nanoparticles occurs more intensively at high pH and temperature, and the resulting nanoparticles are smaller (Fayaz & Balaji, 2009).

In our experiment, the leaves of the olive plant have been used as the object of research. The active biological molecules in the leaves of the olive plant, including phenolic compounds, play an important role in protecting the body from free radicals, which have the ability to extinguish these radicals. Studies have shown that the flavonoids in olive leaves have about 2.5 times more antioxidant effects than vitamins C and E. The leaves of the olive plant contain powerful antioxidants. These antioxidants can play a key role in the conversion of metal ions into nanoparticles. In addition, molecules of these antioxidants can be adsorbed on the surface of nanoparticles, resulting in nanopharmaceuticals of antioxidant nature (Ahmed & Anwar, 2018). Olive fruits and leaves contain rich biologically active molecules and the use of pure forms of these molecules in medicine is important both scientifically and practically.

2. Materials and Methodology

The object of the research is the leaves of an olive plant belonging to the Oleaceae family, collected from olive groves in the Absheron region. The leaves have been collected, first washed with plain water, then with distilled water and dried at room temperature. In the next stage, the leaves have been cut into small pieces and taken in the amount of 5 g and boiled in a magnetic stirrer at 1000C for 15 minutes. The resulting solution has been filtered through filter paper, cooled and stored at room temperature, used for the synthesis of silver nanoparticles. To do this, 50 ml of the extract has been taken, mixed it with 5 ml of 150 ml of $AgNO3$ solution and boiled in a magnetic stirrer at 800C for 1 hour. The color of the solution changes to dark brown, which indicates the synthesis of Ag nanoparticles. The effect of pH and temperature on the formation of nanoparticles has been studied during the experiment.

3. Discussions and Results

In the process of synthesis of nanoparticles, specific physicochemical factors of the reaction medium, such as pH, temperature, etc. significantly affects the size, shape and morphology of Ag nanoparticles. Therefore, it is important to study the effect of these factors in any green synthesis process.

The effect of temperature on the synthesis of Ag nanoparticles

When olive leaf extract is mixed with a solution of $AgNO3$ salt, its color changes from light yellow to dark yellow and finally brown within a few minutes, depending on the temperature. This color change has been observed to occur slowly at low temperatures and rapidly at high temperatures. It is known that Ag nanoparticles in aqueous solution exhibit strong surface plasmon resonance. Ag nanoparticles formed during the reaction emit light in the range of 400-700 nm, depending on their size, shape and morphology. Biomolecules such as flavonoids, terpenoids, and phenolic compounds present in olive leaves are responsible for converting Ag ions into Ag nanoparticles. After a few minutes (hours) of synthesis, a color change occurs in the solution, indicating that all the ions of the silver salt in the solution have decreased. The formation of white nanoparticles is investigated by measuring the absorption spectra at certain times during the reaction.

In our experiments, we have studied the temperature dependence of the rate of formation of Ag nanoparticles in solution during the reaction at both low and high temperatures. To do this, we have made sure that the extract and the AgNO3 salt solution were initially at the same temperature and mixed. Then the temperature of the solution has been recorded in a magnetic stirrer, samples have been taken at each temperature value and UV-vis spectra have been drawn. In the first experiment, the starting temperature of the solution has been increased from 5^0C to 10^0C, and samples have been taken at every 15, 25, and 35^0C temperatures. The results of this experiment are shown in Figure 1A.It is clear from the UV-vis spectra that the formation of Ag nanoparticles accelerates with increasing temperature. Thus, Ag nanoparticles are not formed at 5^0C, but nanoparticles are formed at 15, 25 and 35^0C.

However, at temperatures above 35^0C, nanoparticles began to be synthesized more. Figure 1B shows how much the UV-vis spectra change when the reaction solution is heated to 90^0C. UV-vis spectra show that when Ag nanoparticles are synthesized with olive leaf extract, their size does not change significantly with temperature, but the amount and homogeneity of Ag nanoparticles increase.

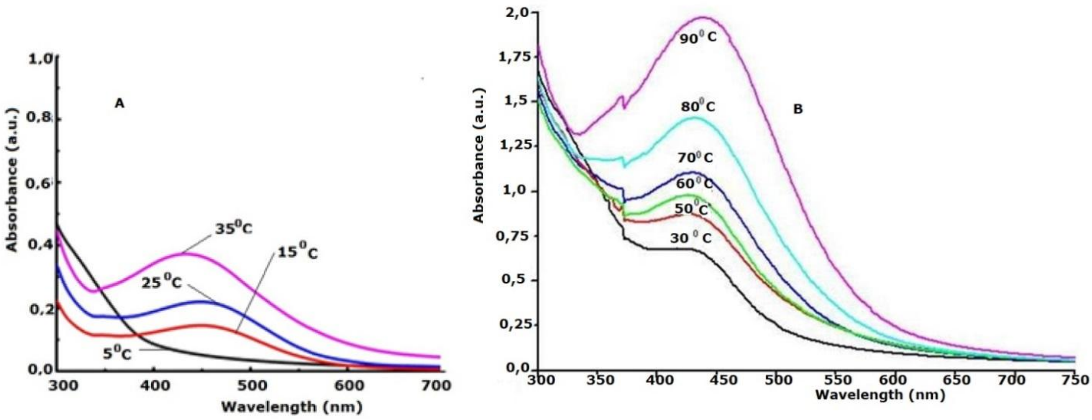

Figure 1.Temperature dependence of UV-vis spectra of Ag nanoparticles synthesized with olive leaf extract on temperature (low temperature range-A or high temperature range-B)

This is confirmed by the increase in the amplitude of UV-vis spectra. It should be noted that even when the solution of synthesized Ag nanoparticles is kept at the same temperature for a long time, the formation of nanoparticles continues and the number of small nanoparticles increases. However, when the temperature remains constant, after a while (approximately 48 hours) the formation of Ag nanoparticles stops and remains stable for a long time. The size and shape of the nanoparticles remain unchanged.

The effect of pH on the synthesis of Ag nanoparticles

The pH of the solution is another important factor influencing the size, shape, and morphology of the synthesized Ag nanoparticles. The main effect of the pH reaction is to change the electrical charges of the biomolecules (mainly flavonoids) in the extract, which can change the reduction and growth of nanoparticles, or rather their stabilizing abilities. Thus, as the electric charges of the biologically active molecules in the extract change, the process of nanoparticle formation changes. In our experiments, the effect of the pH of the solution on the UV-viscosity spectra of Ag nanoparticles synthesized using an extract from the leaves of the olive plant has been investigated. For this purpose, 50 ml of extract and 150 ml of $AgNO_3$ salt solution with a concentration of 5 mM have been mixed in a ratio of 1:3, heated to 80^0C and stored in a magnetic stirrer.

The pH of the solution has been changed to HCl and NaOH. The pH of the reaction solution has been cooled by taking 10 ml of the sample 5 min after each change. After 24 hours, UV-vis spectra of the samples have been taken. In the first variant of the reaction solution has been changed in the range of pH = 2-6, in an acidic environment. In the second variant, the pH has been changed in the range of 7-11. The results of these experiments are given in Figure 2. From the analysis of UV-vis spectra, it is clear that as the pH of the solution changes, the UV-vis spectra become very weak in an acidic environment, at low pH values. Even Ag nanoparticles are not synthesized at pH values 2-3, only begin to be synthesized at pH values 3-6.The best synthesis of Ag nanoparticles is best synthesized at high pH values of the medium, in an alkaline medium. In both variants, the peak of the absorption spectrum with increasing pH changes to a larger wavelength (396 to 411 nm in the case of olive extract), indicating that the size of the synthesized AgNHs is in the range of 25-50 nm.

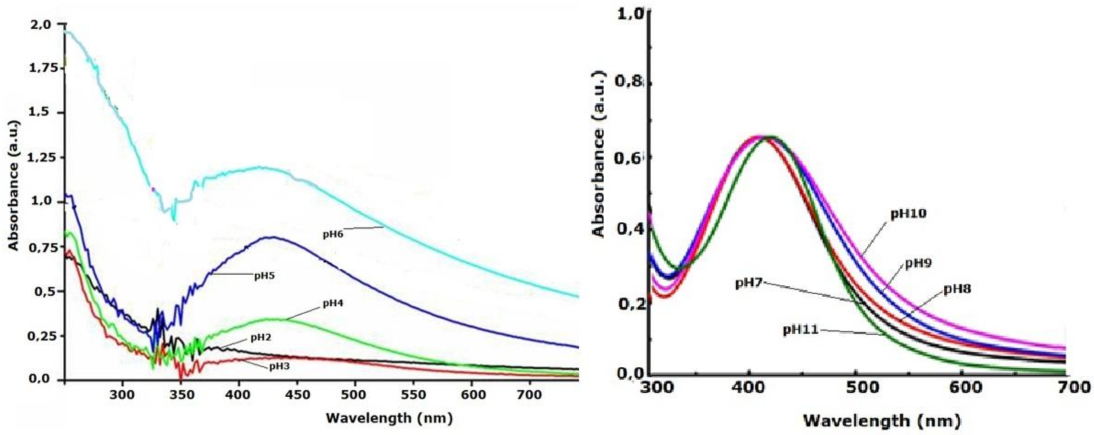

Figure 2. UV-vis spectra of Ag nanoparticles synthesized by olive leaf extract. Absorption spectra have been plotted at different pH values of the reaction solution

At higher pH, the size of Ag nanoparticles synthesized from absorption spectra (pH ~ 10) was approximately 19 nm. As the diameter of the nanoparticles increases, the energy required to excite the surface electrons decreases. As a result, the absorption maximum shifts to a longer wavelength. In addition to the spectral change, an increase in absorption intensity is observed as the pH increases. In addition, it was found that a higher pH increases the recovery rate because the solution turns colloidal brown faster than a solution with a lower pH. Therefore, alkaline pH is more suitable for the synthesis of Ag nanoparticles.

4. Conclusion

The green synthesis method used to obtain nanoparticles is currently the main area of interest for researchers. In the research work, the synthesis of silver nanoparticles has been achieved through an extract from an olive leaf. Then the effect of pH and temperature of the medium on the synthesis of nanoparticles has been studied. As a result of the study, it has been found that the synthesis of silver nanoparticles occurs intensively in high temperature ranges and alkaline environments, and the size of the obtained nanoparticles is smaller.

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