ENHANCED KNOWLEDGE IN SCIENCES AND TECHNOLOGY
e-ISSN: 2773-6385

EKST

Vol. 5 No. 2 (2025) 265-269
https://publisher.uthm.edu.my/periodicals/index.php/ekst

Honey Mediated Synthesis of Silver Nanoparticles and its Optical Characterization

Nur Asyikin Ismail[1], Amira Saryati Ameruddin[1*]

[1] *Department of Physics and Chemistry, Faculty of Applied Sciences and Technology, UTHM Kampus Cawangan Pagoh, Hab Pendidikan Tinggi Pagoh, KM 1, Jalan Panchor, 84600 Pagoh, Muar, Johor, MALAYSIA.*

*Corresponding Author: amira@uthm.edu.my
DOI: https://doi.org/10.30880/ekst.2025.05.02.031

Article Info

Received: 31 December 2024
Accepted: 20 January 2025
Available online: 19 December 2025

Keywords

Honey Mediated Synthesis, Silver Nanoparticles, Characterization

Abstract

This study explores a green method for synthesizing silver nanoparticles (AgNPs) using honey as a natural reducing and stabilizing agent, addressing the environmental concerns of conventional chemical methods. Honey's bioactive compounds enabled effective nanoparticle formation, with optimal results achieved under UV light, producing a surface plasmon resonance (SPR) peak at 420 nm and the highest absorbance of 1.70. Increasing honey concentration enhanced nanoparticle uniformity, with the smallest average size of 34.06 nm obtained at higher concentrations. FTIR analysis confirmed the role of hydroxyl and carbonyl groups in reduction and stabilization. This eco-friendly method offers a scalable alternative for AgNP production, demonstrating potential applications in medicine, catalysis, and environmental remediation.

1. Introduction

Silver nanoparticles (AgNPs) have gained significant attention due to their unique physicochemical properties, such as antimicrobial activity, catalytic efficiency, and tunable optical properties [1]. These characteristics make AgNPs highly valuable for applications in medicine, catalysis, environmental science, and electronics. However, conventional chemical synthesis methods for producing AgNPs rely heavily on toxic chemicals, often leading to environmental pollution and posing health risks. Additionally, these methods lack precise control over nanoparticle size and shape, which are critical for optimizing their performance in specific applications [2].

Green synthesis methods have emerged as sustainable and environmentally friendly alternatives. Among these, honey-mediated synthesis is particularly promising. Honey, a natural product rich in sugars, enzymes, and phytochemicals, serves as both a reducing and stabilizing agent, enabling the eco-friendly synthesis of nanoparticles [3]. Honey not only facilitates the reduction of silver ions (Ag^+) into metallic silver (Ag^0) but also stabilizes the nanoparticles, preventing aggregation and ensuring their uniformity. This approach eliminates the need for hazardous chemicals, aligns with green chemistry principles, and offers the additional benefit of producing biocompatible nanoparticles suitable for medical and environmental application [3].

Although silver nanoparticles hold immense potential across various fields, conventional chemical synthesis methods involve toxic chemicals and produce hazardous byproducts, raising environmental and health concerns. Furthermore, these methods often lack the precision needed to control nanoparticle size and shape, limiting their effectiveness in specific applications. There is a clear need for a green and sustainable synthesis method that uses natural and renewable resources, ensures biocompatibility, and allows for precise control over nanoparticle characteristics [4].

This study aims to develop a sustainable synthesis method for silver nanoparticles using honey as a natural reducing and stabilizing agent. It seeks to characterize the synthesized nanoparticles using UV-Vis spectroscopy and FTIR, optimizing parameters such as honey concentration, light exposure, and reaction time to achieve

uniform nanoparticle size and stability [5]. Additionally, the research explores potential applications of honey-mediated silver nanoparticles in fields such as medicine, catalysis, and environmental remediation.

2. Research Method and Material

This study employed a honey-mediated green synthesis method to produce silver nanoparticles (AgNPs) while focusing on optimizing synthesis parameters and analysing the resulting nanoparticles' properties. The process was guided by an analytical framework designed to evaluate the impact of key parameters such as honey concentration, light exposure conditions, and reaction time on the size, shape, and stability of AgNPs. UV-Vis spectroscopy was utilized to monitor the surface plasmon resonance (SPR) peak, indicating nanoparticle formation, while Fourier-transform infrared (FTIR) spectroscopy was used to identify the functional groups involved in the reduction and stabilization processes

The experimental system was carefully designed to ensure precision and reproducibility. Honey, rich in natural reducing and stabilizing compounds, was used as the eco-friendly agent, while silver nitrate ($AgNO_3$) served as the precursor for silver ions. Raw and unfiltered honey was diluted in distilled water to prepare solutions of 1%, 5%, and 10% concentrations, representing varying reducing agent strengths. A fixed volume of 10 mL of honey solution was mixed with 10 mL of $AgNO_3$ solution under continuous magnetic stirring to ensure uniform interaction between the reactants. The reaction mixtures were then subjected to three different light exposure conditions: UV light using a UV lamp, natural sunlight, and darkness created by wrapping the flasks in aluminium foil. The reaction times were varied across intervals of 30 minutes, 1 hour, 2 hours, and 4 hours to examine the effect of duration on nanoparticle formation and stability.

For characterization, UV-Vis spectroscopy was performed in the range of 300–600 nm to identify the SPR peak, typically observed between 400–450 nm, which provided insights into nanoparticle size and uniformity. FTIR spectroscopy was employed to detect functional groups such as O-H, C=O, and C-O vibrations, which play crucial roles in the reduction and stabilization processes. The systematic variation of honey concentration, light exposure, and reaction time enabled a detailed understanding of their influence on the synthesis process. This eco-friendly approach ensures a sustainable, cost-effective, and scalable method for producing silver nanoparticles with potential applications in medicine, catalysis, and environmental remediation.

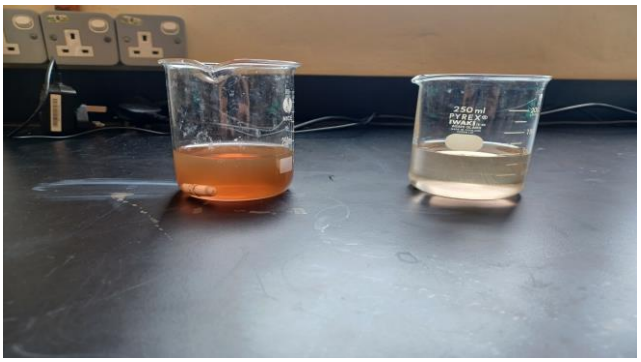

Fig. 1 *Different colors of solution AgNPs*

3. Result and Discussion

Fig. 1 represents the absorbance spectra of a sample under three different lighting conditions: UV light, sunlight, and no light. The x-axis represents the wavelength (nm), and the y-axis indicates absorbance. The UV-Vis spectra confirmed the successful formation of silver nanoparticles (AgNPs) with characteristic surface plasmon resonance (SPR) peaks observed around 400–450 nm. The results showed that UV light produced the highest peak intensity, indicating efficient nanoparticle synthesis due to its high-energy photons accelerating the reduction of silver ions. Sunlight also facilitated nanoparticle formation, though less effectively than UV light, while the dark condition resulted in significantly reduced activity due to the absence of light energy. A 5% honey concentration was chosen as it provided the optimal balance between sufficient reducing agents for nanoparticle synthesis and avoiding aggregation that could occur at higher concentrations, such as 10%. Nanoparticles were confirmed using multiple methods such as UV-Vis spectroscopy, where SPR peaks indicated the nanoscale nature of the particles.

Enhanced Knowledge in Sciences and Technology Vol. 5 No. 2 (2025) p. 265-269

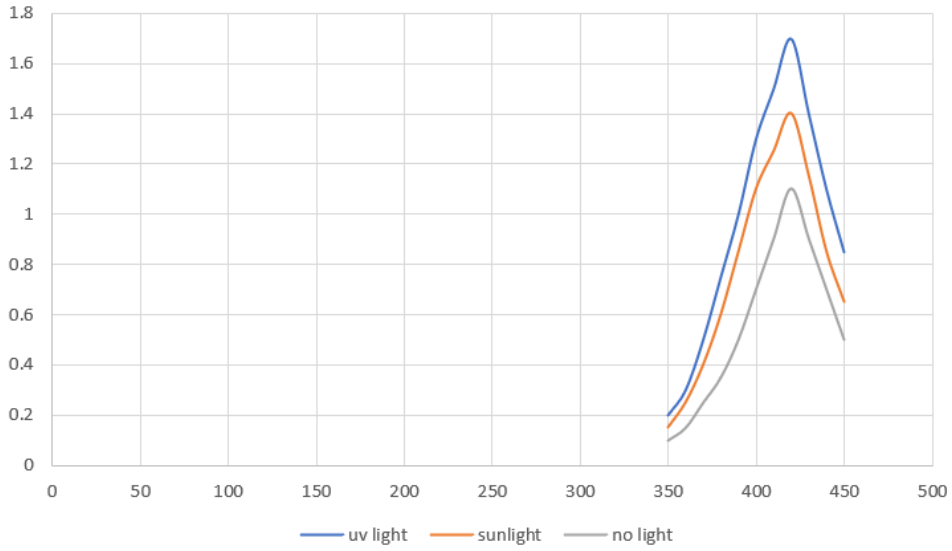

Fig. 2 Graph represent UV-Vis Spectrum of light condition

Fig. 3 represents the absorbance of effect honey solutions at concentrations of 1.0%, 5.0%, and 10.0% on the synthesis of silver nanoparticles (AgNPs), with absorbance peaks between 400–450 nm confirming their formation through surface plasmon resonance (SPR). The 10% honey concentration showed the highest peak intensity, indicating a greater density or size uniformity of nanoparticles due to an abundance of reducing agents. However, high concentrations can also lead to particle aggregation, reducing stability. The 1% concentration resulted in the lowest peak intensity, likely due to insufficient reducing agents. The 5% honey concentration provided a balance, achieving adequate SPR intensity, uniformity, and stability, making it the optimal choice for synthesis. Nanoparticles were confirmed where the SPR peaks indicate nanoscale particles.

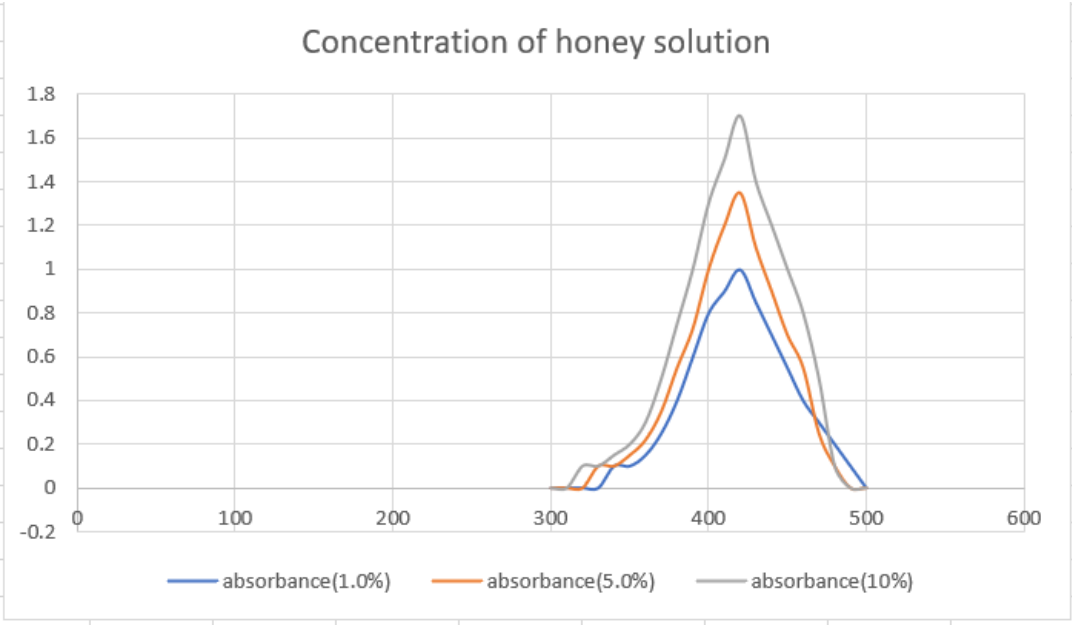

Fig. 3 Graph represent the concentration of honey solution

The FTIR spectrum analysis highlights the functional groups involved in the honey-mediated synthesis of silver nanoparticles. Fig.3 shows the broad absorption peak at 3307.14 cm^{-1} corresponds to O-H stretching vibrations, indicative of hydroxyl groups presents in water, alcohols, or phenolic compounds within honey [1]. These bioactive molecules play a crucial role in reducing silver ions (Ag^{+}) to metallic silver (Ag^{0}) during the synthesis. The peak observed at 1634.76 cm^{-1} is associated with C=O stretching vibrations, commonly linked to carbonyl groups found in organic acids or proteins. These groups contribute to the reduction process and serve as capping agents, stabilizing the nanoparticles. Furthermore, the peak at 1219.13 cm^{-1}, attributed to C-O stretching or C-O-C vibrations from esters,

ethers, or polysaccharides in honey, indicates additional stabilization by forming a protective layer around the nanoparticles, preventing aggregation. The presence of these functional groups confirms honey's dual role as a reducing and stabilizing agent in the synthesis of silver nanoparticles. This stabilization directly influences the nanoparticles' optical properties, including the Surface Plasmon Resonance (SPR) peak detected in UV-Vis spectroscopy [13]. The chemical interactions identified through FTIR analysis provide complementary insights to optical characterization, demonstrating the effectiveness of honey as an eco-friendly and efficient medium for producing stable silver nanoparticles [24]

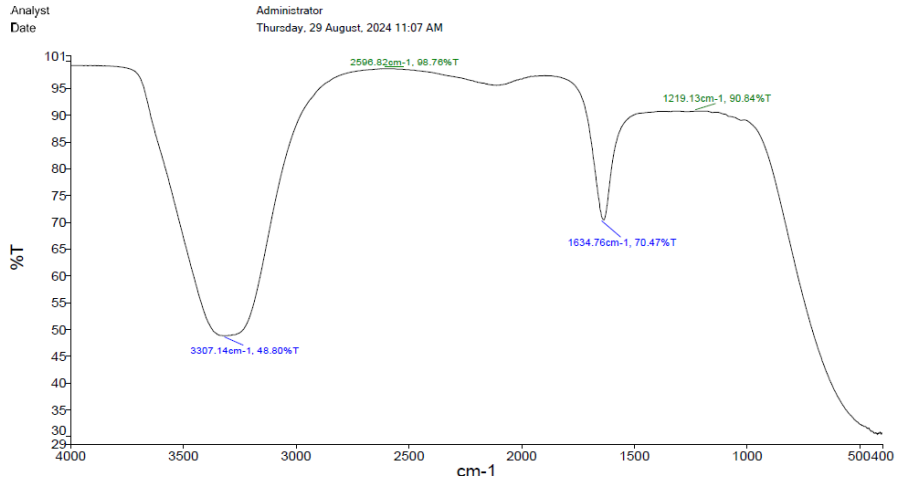

Fig. 4 FTIR of Silver Nanoparticles

4. Conclusion

This study successfully demonstrated the green synthesis of silver nanoparticles (AgNPs) using honey as a natural reducing and stabilizing agent, with the optimal concentration identified at 5% for achieving balanced nanoparticle formation and stability. UV-Vis spectroscopy confirmed the presence of SPR peaks around 400–450 nm, characteristic of nanoscale silver particles, while FTIR analysis highlighted honey's functional groups as key to the reduction and stabilization processes. UV light was found to be the most effective condition for nanoparticle synthesis compared to sunlight and dark environments. This eco-friendly, cost-effective approach addresses current challenges in conventional nanoparticle synthesis by eliminating toxic chemicals and leveraging sustainable resources. The results have significant implications for antimicrobial applications, environmental remediation, and medical advancements, providing a scalable, green chemistry-based solution to meet the growing industrial demand for nanoparticles while reducing environmental impact.

Acknowledgement

The authors would like to express gratitude to the Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, for its support.

Conflict of Interest

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

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Asyikin Ismail, Amira Saryati Ameruddin;* ***solve the governing equation:*** *Nur Asyikin Ismail, Amira Saryati Ameruddin;* ***data collection:*** *Nur Asyikin Ismail;* ***analysis and interpretation of results:*** *Nur Asyikin Ismail, Amira Saryati Ameruddin;* ***draft manuscript preparation:*** *Nur Asyikin Ismail, Amira Saryati Ameruddin. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] Bar, H. C., Bhui, D. K., Poddar, P., & Mukherjee, P. K. (2009). Green synthesis of silver nanoparticles using honey extract.
[2] Ahmad, N., Sharma, S., Singh, S., Shamsi, S., & Siddiqi, M. I. (2019). Green synthesis and characterization of silver nanoparticles using Ocimum basilicum L. leaves extract and their antibacterial activity.
[3] Anuja S. Kumar, Gayathri Madhu, Elza John, Shinoj Vengalathunadakal Kuttinarayanan, and. (2020). Optical and antimicrobial properties of silver nanoparticle synthesize via green route using honey.
[4] Ataabadi, M. R. D., Mahanpoor, K., & Soltani, R. D. C. (2021). Silver nanoparticles as a highly efficient and reusable catalyst for the catalytic reduction of organic pollutants. Environmental Science and Pollution Research
[5] Bar, H. C., Bhui, D. K., Poddar, P., & Mukherjee, P. K. (2009). Green synthesis of silver nanoparticles using honey extract.
[6] Crisan C.M., Mocan T., Manolea M., Lasca L.I., Tăbăran F.-A., Mocan L. (2021). Review on Silver Nanoparticles as a Novel Class of Antibacterial Solutions. Appl. Sci.
[7] D, P. (2010). Honey mediated green synthesis of silver nanoparticles. Spectrochim. Acta Part A Mol. Biomol. Spectrosc. , 75:1078–1081. doi: 10.1016/j.saa.2009.12.058.
[8] Dong, X. Y., Gao, Z. W., Yang, K. F., Zhang, W. Q., & Xu, L. W. (2019). Nanosilver as a new generation of silver catalysts in organic transformations for efficient synthesis of fine chemicals. Catalysis Science & Technology.
[9] Khorshid, S., Zarghami, N., & Rafiei, T. (2020). Green synthesis of silver nanoparticles using clove (Syzygium aromaticum) extract and its antibacterial activity.
[10] Xu, L.; Wang, Y.-Y.; Huang, J.; Chen, C.-Y.; Wang, Z.-X.; Xie, H. (2020). Silver nanoparticles: Synthesis, medical applications and biosafety.
[11] Yaqoob A.A., Umar K., Ibrahim M.N.M. (2020). Silver nanoparticles: Various methods of synthesis, size affecting factors and their potential applications–a review.