IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 15, Issue 6 Ser. I (Nov. – Dec. 2023), PP 11-15
www.Iosrjournals.Org

Microwave Assisted Green Synthesis Of Silver Nanoparticles Using Citrus Aurantifolia Juice: Effect Of Microwave Power And Time Duration

Dian Arum Novitasari, Iis Nurhasanah, Ali Khumaeni*
Department of Physics. Faculty of Science and Mathematics, Diponegoro University, Semarang, Indonesia

Abstract:
This experiment focuses on novel ways of optimizing the microwave-based nanoparticle formation process and using the juice of citrus aurantifolia as a reducing, stabilizing, and capping agent. For the synthesis process, citrus aurantifolia juice and a 1:5 volume ratio of silver nitrate (AgNO3) solution were utilized. Investigations were conducted into the effects of power and time on AgNP production. The dark brown colored biogenic synthesized silver nanoparticles are characterized using UV-Vis. spectroscopy, and XRD. The optimal duration for microwaving citrus aurantifolia juice was 7 minutes at 300 watts. The UV-visible spectroscopy shows a surface plasmon resonance at 478nm. XRD results showed the characteristic silver peaks at (111), (200), and (222) lattice planes, specifically at 2θ values of 38.24, 44.28, and 64.4.
***Background**:*
There are two approaches to synthesizing silver nanoparticles: the chemical method (bottom-down) and the physics method(top-down). Synthetic silver nanoparticles chemical methods can also be done using plant extracts as reductants called biosynthesis or green synthesis. Because this biosynthesis uses little energy and low temperatures, is inexpensive, non-toxic, and ecologically benign, it is advantageous. The Citrus aurantifolia may serve as a substitute bioreactor. Citrus aurantifolia are preferred because they have flavonoids and saponins. The plethora of variations accessible in Indonesia makes it quite likely that citrus aurantifolia can be produced on a large scale. This is the additional reason. The aurantifolia citrus fruit will be microwave-observed as part of the study to alter the manufacturing process of silver nanoparticles. The speed at which nanoparticles develop is one benefit of employing microwaves in this study. To the best of our knowledge, MP reports about a microwave method using the juice of Citrus aurantifolia are yet available.
***Materials and Methods**: Biosynthesis of AgNPs was done using the juice of Citrus aurantifolia. The AgNPs were characterized by color changes, UV-Vis. spectra, and XRD*
***Results**: Colour changes, UV-Vis spectroscopy at 478 nm. The XRD showed the silver peak was determined.*
***Conclusion:** a synthesis with microwave-assisted can optimize the silver nanoparticle formation process*
***Key Word**: Cirus aurantifolia juice, Silver nanoparticle*

Date of Submission: 11-11-2023 Date of Acceptance: 20-11-2023

I. Introduction

Nanotechnology is an emerging area that has shown unprecedented growth that embraces diverse applications (Anjana et al., 2021). This technology mainly employs the use of particles with dimensions of 1 -100 nm (Anjana et al., 2021). The properties of nanoparticles depend mainly on their shape, size, and surface area which is inherently influenced by its mode of synthesis and tentative conditions (Hamouda et al., 2021). The potential biosynthesis is cost-effective, uses nontoxic renewable materials, and low temperatures, and hence considered to be more environment friendly. Biosynthesis is known to generate particles with reasonably good morphology and stability.

Silver nanoparticles differ from all other metal-based nanoparticles in their unique optical, electrical, and biological properties and wide application in bio-sensing, catalysis, etc (Anjana et al., 2021). Silver nanoparticles with biosynthesis processes use parts on plants such as leaves (Francis et al., 2018), flower stems, fruits (Munevver et al. 2017), skins (W.B. Ayinde., 2019), roots, and flowers as reduction agents. The compounds in plants used as bioreductants are terpenoids, phenolics, flavonoids, tannins, steroids, saponins, and alkaloids. Plants that have been used as bio-reductants in silver nanoparticles biosynthesis are *Coleus vettiveroids* extract (Thomas et al., 2018), *mint* leaves (A Thanasakonpong et al, 2018), *Champeria sp*. leaf extract (Muhammad Bagas Ananda et al, 2023), *Entada rheedii* leaf extraction (Anjaly et al., 2022).

With the success described above, the *Citrus aurantifolia* has the potential to be an alternative reductant. is chosen because it contains saponins and flavonoids, including hesperidin, tangerine, naringin, eriocitrin, and eryocitrocide. Hesperidine acts as an anti-inflammatory, and antioxidant, and inhibits prostaglandin synthesis. The additional reason is that it is highly likely that *citrus aurantifolia* can be made on a large scale due to the abundance of varieties available in Indonesia.

The study will modify the method of silver nanoparticle synthesis by observing *Citrus aurantifolia* fruit using microwave. The advantage of using microwaves in this study is the rate of formation of nanoparticles with a power of 300 watts in 7 minutes. However, the silver nanoparticle produced is not pure because the residues from the reaction remain. The influence of power and time on microwaves will be demonstrated by ultraviolet-visible spectroscopy (UV-Vis). To determine the characteristics of silver nanoparticles some tests such as X-ray diffraction (XRD).

II. Material And Methods

Materials:
The chemicals used were analytical grade. Silver nitrate ($AgNO_3$; 99.8%), was purchased from Merck KGaA, Germany.

Preparation of *Citrus aurantifolia* juice and Silver Nitrate Solution:
Fresh *Citrus aurantifolia* was collected and washed well with fresh water and let air dried. Then, Citrus aurantiifolia is divided into four sections. Exorcists should stretch a segment of citrus aurantiifolia. After first filtering the water, Whatman No. 1 filter paper was used to filter it once again. First, mix 0.02 g of agNO3 powder with 117 ml of aquades in a 250 mL beaker glass to create a 1 mM AgNO3 solution.

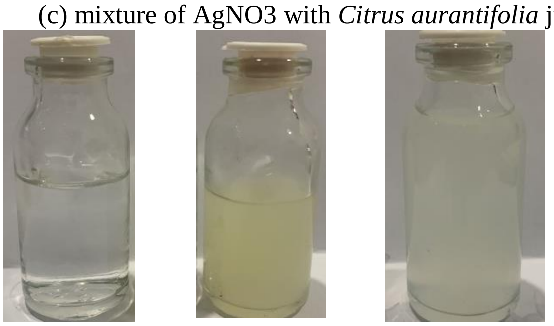
Synthesis of Nano Silver Material:
A total of 10 mL of *Citrus aurantifolia* juice is inserted into a 100 mL beaker glass containing 50 mL AgNO3 1 mM solution. Then the aperture mixture with AgNO 3 solution is homogenized with a magnetic stirrer. These mixtures were subjected to microwave irradiation in an oven operating at variation power 100 W, 180 W, 300 W, 450 W, and 600 W for seven min. The bioreduction of Ag^+ ion to Ag^0 was monitored by analyzing samples at 1,3,5, and 7-minute intervals of reaction time. Several predetermined tests will be used to characterize the outcomes.

Study Location: This experiment-based study was done in the Laser Physics Laboratory and Advanced Nanotechnology (LAN), Diponegoro University Faculty of Science and Mathematics, Semarang, Indonesia.

III. Result and Discussion

Power Effect :
The formation of AgNPs was confirmed by observing the color change of $AgNO_3$ solution. Figure 1 Shows the colloid color of pure $AgNO_3$, *Citrus aurantifolia* juice, and a mixture of AgNO3 with *Citrus aurantifolia* juice before microwave irradiating.

Figure 1: Shows the color before microwave irradiating for each (a) pure $AgNO_3$ (b) *Citrus aurantifolia* juice (c) mixture of AgNO3 with *Citrus aurantifolia* juice.



(a) (b) (c)

Figure 2 shows a comparison of nanoparticle color changes without microwave heating and microwave heating by varying power (100 Watt, 180 Watt, 300 Watt, 450 Watt, 600 Watt).

Figure 2: Shows the comparison of AgNPs without microwave heating (a) and microwave heating (b) by variating power

(a)

(b)

There was a color change of the colloid mixture AgNO3 with water sensing thin orange from white to brown to gray. This indicates the formation of colloids of silver nanoparticles. The color changes occurred according to previous research conducted by Anjaly Mathew. dkk (2022). The change is caused by the absorbed microwave rays causing the atoms of the colloid AgNO3 and the thin orange water to rotate and collide. This is where heating comes from. Homogeneous heating directly affects the nucleation process of nanoparticles' colloid synthesis, thus accelerating the process of reduction.

Figure 3: Shows the graphic spectrum UV-Vis Colloid Silver Nanoparticles at various powers

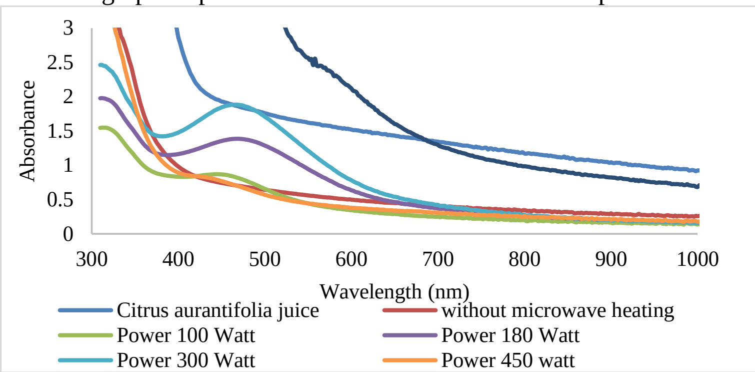


Table 1: Spectrum of absorption of colloids of silver nanoparticles at various powers

Power (Watt)	λ_{maks} **(nm)**	**Absorbannce**
0	320	3.1
100	456	0.858
180	478	1.375
300	478	1.865
450	442	0.801
600	572	2.385

In Figure 3 and Table 1 show the visible spectrum of rays of colloids of silver nanoparticles synthesized with water reductants observed thin orange without microwave heating did not form nanoparticles. This means the heat energy from the indoor air is not enough to drive the lasting Ag^{+} reduction. At Power 100, 180, 300, and 450, watts within 7 minutes the typical peak of the colloid silver nanoparticles is visible clearly. However, the maximum absorption is at 300 watts. The higher the value indicates the more silver nanoparticles are being formed. However, at 100 and 180 watts of power, the absorption peak appears to be widening, indicating an increasingly uneven particle size distribution. At 450 watts, it shows a significant decrease. The 600-watt power underwent a wavelength shift at about 572nm. With the addition of the use of microwaves in the synthesis of colloids of silver nanoparticles, this thin orange water bioreceptor makes inter-particle interactions faster. The larger the power, the shorter the time it takes in the reaction. The shorter it takes to form the colloid of the silver nanoparticles, the greater the frequency of the impact. It's in line with previous research by Bukola et al.(2016).

Time Effect :

Microwave heating is optimized for 1, 3, 5, and 7 minutes, which is different from conventional warming where conventional heating takes hours and hours for a single synthesis, while microwave warming takes only a few minutes.

Figure 4: Shows the graphic spectrum UV-Vis Colloid Silver Nanoparticles at various times.

Figure 5: Spectrum of absorption of colloids of silver nanoparticles at various times

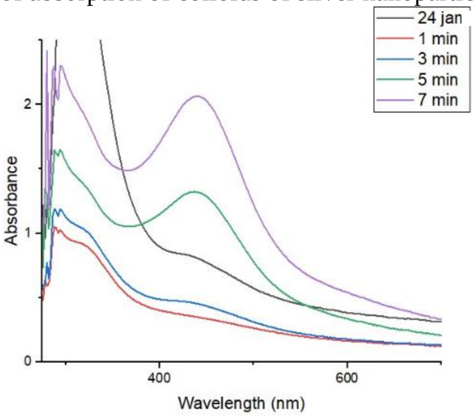


Table 2: Spectrum of absorption of colloids of silver nanoparticles at various times

Times	λ_{maks} (nm)	Absorbance
1 min	288	1.051
3 min	430	0.467
5 min	436	1.322
7 min	478	1.865
24 hour	434	0.834

In table 2 it is shown that a colloid treated without microwave heating by being inhabited within 24 hours is capable of forming silver nanoparticles colloids with a wavelength of 434 nm. A sample with a power of 300 watts and a time of 1 minute has not yet formed a colloid of silver nanoparticles. It is indicated by a wavelength of 288 nm. By 3 and 5 minutes, the silver nanoparticle colloid was already formed, but the absorption values were still weak, so it wasn't much to identify silver nano-particle colloids that were formed. At a time of 7 minutes, the absorption values and wavelengths are 1.865 and 478. It shows that the longer the time of microwave exposure, the more colloids of nanoparticles are formed. The colloid sample with treatment inhabited 24 hours and 7 minutes by heating with the help of microwaves showed an acceleration of reaction time.

Silver Nanoparticle Coloid Structure Analysis with XRD X-ray diffraction:

(XRD) spectroscopy is used to identify the crystalline phase of a silver nanoparticle colloid with *Citrus aurantifolia* juice. Figure 6 represents the X-RD spectrum of AgNP colloids.

Figure 6: XRD Spectrum Coloid Silver Nanoparticles Bioreductant *Citrus aurantifolia* juice.

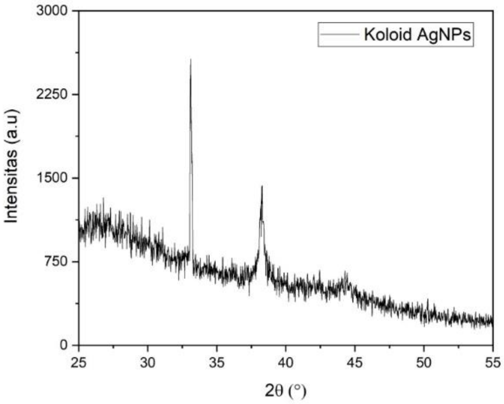


Table 3: Comparison of XRD AgNPs results with reference.

No	AgNP	Silver Reference JCPDS
	2*θ* (º)	**2*θ* (º)**
1	**38.24**	**38.117**
2	**44.28**	**44.279**
3	**64.4**	**64.428**

Figure 6 represents an XRD spectrum of silver nanoparticle colloids of fine orange water observation reductants. Characteristic colloids peak at 38.24°, 44.28°, and 64.4° with grid distances respectively (111), (200), and (220) as in the study Vishwajeet (2015) which has been adjusted to the Joint Committee on Powder Diffraction Standard (JCPDS) number 04-0783. The XRD pattern clarified by Table 1 shows that the colloids of silver nanoparticles formed by the reduction of Ag+ ions by fine orange water (*citrus aurantifolia*) form crystals. The grid (111) shows a peak blur indicated at a smaller d-spacing value compared to the JCPS reference. This may indicate that silver particles are on a nanoscale.

IV. Conclusion

The research on optimization power and time Silver Nanoparticle colloid Synthesis as *Citrus Aurantifolia* juice bioreduction with microwave assistance concludes as follows:

a. This research has successfully carried out the synthesis of silver nanoparticles colloids using Citrus Auranifolia juice with the help of microwaves proved with characterization UV-Vis, XRD
b. Based on UV-Vis, it has succeeded in demonstrating the influence of power and time on the formation of nanoparticle colloids, is the higher power given, will accelerate the reaction time of nanoparticle formation, will also increase its absorption value so that the number of nano-particle colloides formed more.
c. Power and Time optimum is 300 watts and 7 minutes.

References

[1]. A Thanasakonpong, B Ksapabutr and M Panapoy. Microwave-assisted green synthesis of silver nanoparticles using extract of mint leaves.Materials Science and Engineering. 2023.1280.

[2]. V. N. Anjana, Majo Joseph, Sijo Franchis, Alex Joseph, Ebey P. Koshy, and Beena Mathew.Microwave-assisted green synthesis of silver nanoparticles for optical, catalytic, biological, and electrochemical applications.Artificial Cells, Nanomedicine, and Biotechnology.2021;49(1):438-449

[3]. Hamouda HI, Abdel-Ghafar HM, Mahmoud MHH.Multi-walled carbon nanotubes decorated with silver nanoparticles for antimicrobial applications, J Environ Chem Eng. 2015;2(1):1-11

[4]. W. B. Ayinde, W. M. Gitari, Amidou Samile.Optimization of microwave-assisted synthesis of silver nanoparticle by Citrus paradisi peel and its application against pathogenic water strain, Green Chemistry Letters and Reviews. 2019; 12(3):225-234.

[5]. Thomas, B., Prasad, A., dan Vithiya, S.M.Evaluation Of Antioxidant, Antibacterial And Photo Catalytic Effect Of Silver Nanoparticles From Methanolic Extract Of Coleus Vettiveroids – An Endemic Species, Journal Nanostruct. 2018;8(2): 179-190

[6]. Francis S, Joseph S, Koshy EP, et al. Microwave-assisted green synthesis of silver nanoparticles using leaf extract of Elephantopus scaber and its environmental and biological applications. Artif Cell Nanomed Biotechnol. 2018;46(4):795-804

[7]. Anjaly Mathew, Ramesh Analiparambil Ravindran, et al. Microwave-assisted greener synthesis of Silver nanoparticles using Entada rheedii leaf extract and investigation of its anticancer and antimicrobial properties. Int.J.Nano Dimens.2022;13(3):329-334