Studies on Surface Plasmon Resonance of Murdannia loriformis Silver Nanoparticles

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Abstract. In this work, surface plasmon resonance (SPR) was investigated over the effect of concentration of metal precursor, concentration of reducing agent, reaction time and pH on formation of silver nanoparticles (AgNPs) using biological method. In this method, Murdannia loriformis extract (MLE) was used as reducing agent and silver nitrate as metal precursor. SPR of Murdannia loriformis silver nanoparticles (MLE-AgNPs) was measured through UV-vis spectrophotometer over a range of 380 – 800 nm wavelength. It was found that, as the concentration of MLE, pH and reaction time increases, the SPR peak of MLE-AgNPs at 430 - 490 nm also increases. However, for effect of concentration of metal precursor, the result showed that SPR peak of MLE-AgNPs increases when 1 to 5 mM of silver nitrate was used but decreases for 10 and 15 mM. Significant of this study is to identify the optimum conditions for synthesis of MLE-AgNPs.

1. Introduction

Research on silver nanoparticles (AgNPs) has increased extensively in recent years due to their unique chemical, physical and optical properties. Different size and shape of AgNPs were showed sensitive surface plasmon resonance (SPR) peaks and used in specific applications in various fields for example electronics [1], sensors [2], catalyst [3,4], drug delivery [5], optics [6] and medical applications [7]. In order to produce AgNPs, a bottom-up approach via the chemical reduction method always been applied using chemicals as typical reductants for reducing Ag⁺ ions to Ag⁰. While these chemicals have high reducing power, some of them are rather toxic to the environment.

Biological methods which used either microorganisms like bacteria, fungi, yeast or plant extracts have emerged as a simple and sustainable alternative to chemical synthetic and physical methods. The used of fungi, bacteria and algae give drawbacks for this techniques to be apply on large scale due to requirements to maintain the cell culture medium, lead to slower rate of AgNPs synthesis and specific required conditions [8]. The application of plant extract to the biosynthesis reaction is an important branch of biosynthesis of nanoparticles .The use of plants for the synthesis of nanoparticles has gained
attention, because of its rapid, economical, eco-friendly procedure, and the biosynthesis process can be carried out by a single step technique.

Many papers reported the synthesis of silver nanoparticles using plant extracts such as *Albizia procera* [9], *Kyllinga brevifolia* [10-12], *Moringa oleifera*, *Ficus exasperate* [13], *Aaronsohnia factorovskyi* [14], *Graptophyllum cratagus* [15], Carnivorous plant [16] and *Salvia officinalis* [17]. In this work, AgNPs was synthesised using *Murdannia loriformis* extract (MLE) as reducing agent and silver nitrate as metal precursor via biological method. The surface plasmon resonance (SPR) was investigated over effect of concentration of metal precursor, concentration of reducing agent, reaction time and pH on the formation of silver nanoparticles (AgNPs).

2. Methodology

*Murdannia loriformis* was retrieved from Guar Perahu, Pulau Pinang, Malaysia. It was cut into small pieces and blended into fine powder and stored in airtight containers at room temperature for further use. The preparation of 100% concentration of MLE was conducted with some modification using previous method [10]. For brief preparation method, 10 g of the MLE powder was added to 200 mL deionised distilled water in 250 mL of erlenmeyer flask and was boiled for 1 hour at 70 °C. MLE-AgNPs were synthesised based on previous method [11]. In this method, 1 mL of 100% KB extract was added to 9 mL, 2 mM of AgNO₃ for 90 mins at room temperature. The SPR peaks evaluation were investigated using effect of different reaction time (20 – 60 mins), concentration of MLE (25% - 100%), concentration of silver nitrate (1 – 5 mM) and pH (2 – 10) were examined. 0.1 M of NaOH and H₂SO₄ were used to adjust the pH of solution. Furthermore, the stability of MLE-AgNPs was also evaluated based on SPR peak after 24 hrs, 1 week and 1 month contact time.

3. Results and Discussion

3.1. Effect of pH

The influence of pH on the formation of MLE-AgNPs has been investigated using a pH range of 2-10. From Figure 1, it can be seen that the SPR peak are increases when increases a pH from pH 2 to pH 10. In view of the results obtained, the formation of MLE-AgNPs are favourable at basic condition. The addition of NaOH do not bring the negative consequence on formation of MLE-AgNPs. Alas, the SPR peak of MLE-AgNPs are higher than in acidic form. However, the addition of acid solution, the SPR peaks shows lower and broader absorbance compared to pH 8 and 10. It can be observed that the SPR peaks for acidic conditions (pH 2, 4 and 6) appear at a relatively short wavelength of around 390 nm while the SPR peaks are shifted towards a longer wavelength (red shift) at 440 nm in the case of basic medium (pH 8 and 10). The red shift in a basic medium indicates relatively large AgNPs sizes compared with the cases of neutral and acidic conditions.

![Figure 1. Effect of pH on SPR peak of MLE-AgNPs.](image-url)
3.2. Effect of Concentration of Plant Extract

Figure 2 shows the SPR peak for effect of MLE concentration as reducing agent in formation of MLE-AgNPs. As can be seen, the SPR peak at 430 nm are increases when initial concentration of MLE increases from 10% to 100%. The increases of SPR peak with increasing concentration of MLE can be explained by the increase in the amount of active ingredients in higher concentration of MLE. At low concentration of MLE (10% and 50%) , the MLE-AgNPs have not enough reducing agent for synthesis AgNPs as well as failed to stabilize the high surface energy of AgNPs.

![Figure 2. Effect of MLE concentration on SPR peak of MLE-AgNPs.](image)

3.3. Effect of Reaction Time

The effect of reaction time on SPR peak of MLE-AgNPs as shown in Figure 3. The SPR peak increases with increasing the reaction time from 20 mins to 60 mins. It was noted that with increase in contact time, the SPR peak becomes sharper. Formation of MLE-AgNPs started within 20 mins and increased up to 60 mins.

![Figure 3. Effect of contact time.](image)

For stability study, the SPR peak was evaluated for 24 hrs, 1 week and 1 month contact time as shown in Figure 3. However, the SPR peaks shows higher and sharper absorbance compared to initial reaction time (20-60 mins). It can be observed that the SPR peaks are shifted towards a longer wavelength (red shift) at 440 nm. The red shift at longer contact times indicates relatively larger size AgNPs were obtained. This is due to unstable MLE-AgNPs produced and cause agglomeration after longer contact time.
3.4. Effect of Concentration Silver Nitrate

Figure 4 shows SPR peak for effect of different concentration of silver nitrate as metal precursor from 1 to 15 mM. It can be seen that the SPR peak of MLE-AgNPs appears to increase with increasing of silver nitrate concentration until it reached a maximum SPR peak at 430 nm for 5 mM. However, the after the SPR peak decreased for higher concentration. No significant SPR peak for 1, 2 and 4 mM of silver nitrate, indicating that at low concentration of Ag⁺ are not enough to induce the formation of AgNPs. For 10 mM and 15 mM silver nitrate concentration, the SPR peaks were decreases with increasing silver nitrate concentration.

![Figure 4](image)

Figure 4. Effect of concentration.

4. Conclusion

The MLE-AgNPs using eco-friendly and environmentally benign *Murdannia loriformis* extract were successfully carried out. This study shows that the SPR peak of MLE-AgNPs are depends on various experimental operational parameters. It can be concluded that optimum concentration of 5 mM of Ag⁺ solution, reaction time of 60 min, 100% concentration of MLE and basic pH favours the optimum yield of MLE-AgNPs.

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