Biogenic Synthesis of Silver Nanoparticles using Pomegranate Peel Polyphenols and Its Catalytic Action in Reduction of Acid Red 6

Ran Tao[1,a], Ping Yao[1,b*], Jun Zhang[1,c], Lei Xu[1,d], Hui-Ying Wu[1,e], Mao-Mao Ding[1,f] and Xin-Sheng Zhu[2,g]

[1] Suzhou Institute of Trade and Commerce, 287 Xuefu Road, Suzhou City, Jiangsu Province 215009, P.R. China

[2] Faculty of Textile and Clothing Engineering, Soochow University, 178 Eastern Ganjiang Road, Suzhou, Jiangsu 215021, P.R. China

[a]rtao@szjm.edu.cn, [b]pyao@szjm.edu.cn, [c]nanoszjm@163.com, [d]leixu@szjm.edu.cn

[e]why_1220@sina.com, [f]1377807526@qq.com, [g]zhuxinsheng@suda.edu.cn

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Abstract. A biogenic synthesis of silver nanoparticles (AgNPs) was achieved using pomegranate peel polyphenols in this article. The formation of AgNPs was confirmed by UV-vis spectrum and TEM image. The biogenic AgNPs showed Surface Plasmon Resonance (SPR) peak at 433nm as shown from the UV-vis absorption spectrum. The average diameter of AgNPs was around 26nm, which was testified by the particle size distribution analysis. The biogenic AgNPs were utilized for the catalytic reduction of Acid Red 6, and the green synthesized AgNPs showed high catalytic activity on Acid Red 6 reduction in the presence of $NaBH_4$. The present study has brought to a novel method for the reduction of hazardous dyes in the liquid phase.

Introduction

The impact on human health due to environmental pollution has become the global concern. While the usage of noble metal nanoparticles especially silver nanoparticles (AgNPs) for the catalytic degradation of hazardous pollutants in the wastewater has aroused great attention [1-5]. In the same time, plant-mediated bioprocess provides an important opportunity for the green synthesis of AgNPs, and many kinds of plant extracts have been used for the synthesis of AgNPs [6-8]. Pomegranate peel polyphenols, as one kind of the plant extracts, has already used for the phytosynthesis of silver nanoparticles [9].But, to the best knowledge of the authors, the catalytic reduction using pomegranate peel polyphenols synthesized AgNPs for the organic dyes has not been studied yet. In this study, AgNPs will be biogenic synthesized by pomegranate peel polyphenols, and the formation of AgNPs has been characterized by visible observation, UV-vis spectrophotometer, TEM and particle size distribution analysis. Furthermore, the catalytic activity of green synthesized AgNPs has be discussed by catalytic degradation of Acid Red 6 in the presence of $NaBH_4$ in the aqueous solution.

Materials and Methods

Materials

$AgNO_3$(99.8%) and $NaBH_4$(98%) was purchased from Aladdin Industrial Corporation. pomegranate peel polyphenols (98%) was purchased from Xi'An Bai Chuan Biotech Co., Ltd. The Aicd Red 6 dye was provided by the Zhejiang Runtu Co., Ltd. All the chemicals and reagents used in the paper were of analytical grade.

Synthesis and characterization of AgNPs

10mL silver nitrate (0.01M) was added to 90mL of freshly prepared pomegranate peel polyphenols solution in the ratio of 1:5. Progressively, formation of AgNPs was observed by visual color change to yellowish brown, which was further confirmed by UV-vis spectrophotometer.

Characterization

The reduction of silver ions was recorded by measuring the UV-visible absorption spectra of the liquid solutions in the beginning and after the synthesis reaction. The UV-visible absorption spectrum analysis was done by using UV-visible spectrophotometer (Shimadzu UV-3600) in the wavelength of 200-800nm. The size and morphology of AgNPs were determined by a TecnaiG220 (FEI, USA) at an accelerating voltage of 300kv. Particle size distribution of bio-reduced AgNPs in the aqueous solution was measured by the Zetasizer Nano series (Malven, UK) at 25℃.

Evaluation of catalytic activity of AgNPs

Catalytic activity of synthesized AgNPs was performed by degradating Acid Red 6. 3mL Acid Red 6 (50mg/L) solution was added with 0.1 mL $NaBH_4$ (0.2M) and 0.1ml AgNPs (100μg/mL) solution The reduction process was monitored by recording spectra using UV-vis spectrophotometer at certain time intervals.

Results and Discussion

Upon the addition of silver nitrate to pomegranate peel polyphenols solution, the solution turned to yellowish brown after 30 mins reaction. This was indicated the formation of AgNPs [10]. The Surface Plasmon Resonance (SPR) peak appeared sharply at the wavelength of 433nm (Fig.1) for AgNPs, which was similar to the result by T.J.I. Edison [9]. The particle size distribution and morphology of AgNPs were characterized by Zetasizer Nano series and transmission electron microscope (TEM). As shown from Fig.2, the particle size of AgNPs distributed in two ranges of 1~10 nm and 10~100nm, and the average diameter of AgNPs was around 26 nm obtaining from the measuring result by the Zetasizer Nano series. The TEM image from Fig.3 also verified the great synthesis of AgNPs by pomegranate peel polyphenols, and TEM image also confirmed a typical spherical and an ellipsoidal morphology of AgNPs.

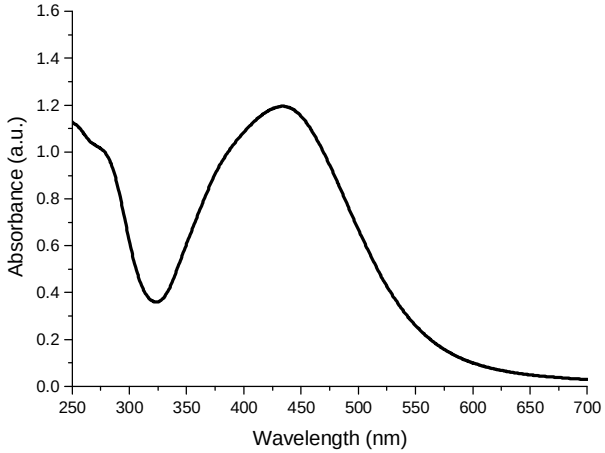

Fig.1 UV-Vis spectrum of biosynthesized AgNPs after 30 mins reaction.

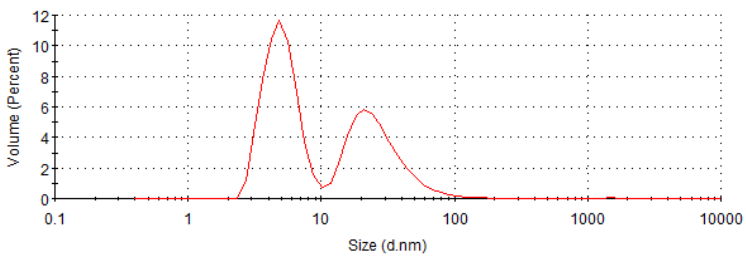

Fig.2 Particle size distribution of biosynthesized AgNPs.

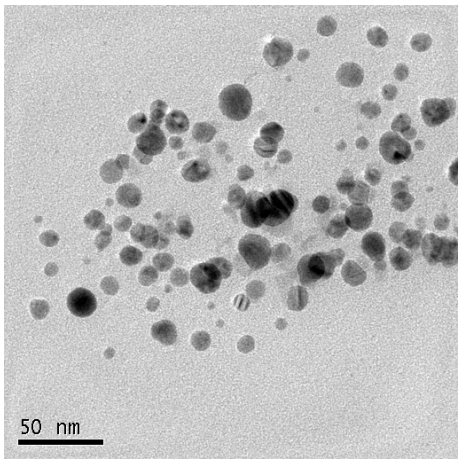

Fig.3 TEM image of biosynthesized AgNPs

AgNPs are well known for their catalytic activity and many reports are available on AgNPs as catalyst for the reduction/degradation of environmental pollutants such as 4-nitrophenol, MB and dyes [11]. The reduction of Acid Red 6 by $NaBH_4$ was carried out using biogenic synthesized AgNPs as catalyst. The reduction process was monitored by using UV-Vis measurements at room temperature and the results were shown in Fig.4. As shown in Fig.4, the λ_{max} of Acid Red 6 was 525nm, and the intensity of the peak at 525nm gradually decreased within 20mins. Experiments were also done for the reduction of Acid Red 6 by $NaBH_4$ without of AgNPs (data was not shown), and there was no significant decrease after 40mins reaction. The results mentioned above demonstrated the great catalytic activity of biogenic synthesized AgNPs on the reduction of Acid Red 6 by $NaBH_4$.

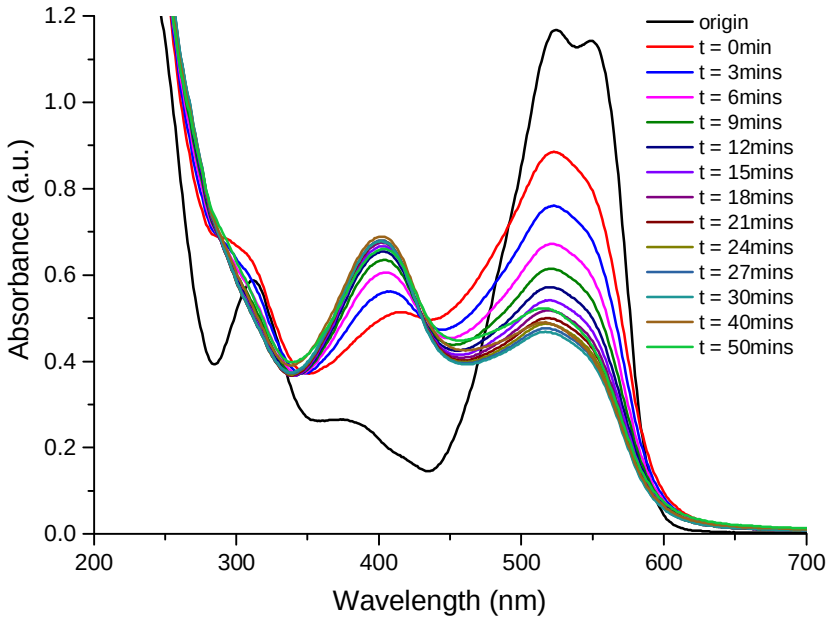

Fig.4 Reduction of Acid Red 6 by $NaBH_4$ in the presence of AgNPs as catalyst.

Conclusions

The results from the study verified the possibility of biogenic synthesis of silver nanoparticles using pomegranate peel polyphenols. The biogenic AgNPs showed SPR peak at 433nm obtaining from the UV-vis absorption spectrum. The average diameter of AgNPs was around 26nm, which was testified by the particle size distribution analysis. The biogenic AgNPs showed high catalytic activity on reduction of Acid Red 6 by $NaBH_4$. Thus the present study has brought to a novel method for the reduction of hazardous dyes using biogenic AgNPs.

Acknowledgements

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