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Using pomegranate peel extract green synthesize of AG nanoparticles: characterization and antibacterial activity

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Abstract

In this research, the eco-friendly biogenesis of silver nanoparticles from 2 mM AgNO3 using the extraction of pomegranate peel (EPP) as the agent of reduction was explored. Analysis of the Fourier transform infrared spectrum (FT-IR), UV-visible spectrum, and scanning electron microscopy (SEM) were used to characterize Ag nanoparticles. At 425 nm, UV-visible spectra show a significant resonance on the surface of silver nanoparticles (AgNPs). A spectrum investigation using FTIR spectroscopy revealed that EPP operated as a reduction agent. SEM analysis reveals nanoparticles with average particle sizes ranging between 30 and 50 nm. AgNPs' antibacterial activity was also tested against Staphylococcus aureus. X-ray diffractometer (XRD), using Scherrer's equation and the refraction peak in the XRD pattern, the average particle diameter of the silver nanoparticles was determined to be 80. The silver nanoparticles formed in the brown-colored stable samples according to SEM analysis, and well-dispersed nanoparticles could be seen in the silver nitrate-treated samples. Ag nanoparticles produced by pomegranate peel extract show the maximum antibacterial activity against *S. aureus* (0.1, 0.2, 0.3 and 0.4 mol). This technique produces Ag NPs with effective antibacterial action against harmful microorganisms. One of these is silver nanoparticles, which have a substantial influence on nanotechnology and the field of nanomedicine.

Keywords: Silver; Nanoparticales; XRD; SEM; Extract; Green synthesis

1 Introduction

Nanotechnology is a rapidly expanding area that is being used in technology and research to generate innovative materials at the nanoscale [1]. Recently, biosynthetic techniques using either living bacteria or other biological microorganisms [2], fungus [3], or plant extract [4] have developed as a straightforward and practical replacement for more intricate chemical synthetic processes to produce nanomaterials. Various nanomaterials, including copper, zinc, and titanium [5], magnesium, gold [6], alginate [7], and both silver and silver nanoparticles, have been developed, but nanoparticles have proven to be the most effective since they are effective antibacterial, antiviral, and antimicrobial against other eukaryotic microorganisms [8]. One of these is silver nanoparticles, which have a substantial influence on nanotechnology and nanomedicine. Colloidal silver is of great interest due to its unique properties, such as superior conductivity, catalytic activity, chemical stability, and antibacterial activity [9]. The utilization of extracts from plants in the biosynthesis process is an important aspect of nanoparticle biosynthesis.

Using pure apiin components, which were derived from henna leaf under ambient circumstances, we were able to create quasi-spherical silver nanoparticles [10]. Au nanoparticles and Ag nanoparticles were generated in aqueous media under ambient conditions by using green tea and Camellia sinensis extracts as reducing and stabilizing agents [11].

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Green reactants have been used in the production of Ag NP by using plant extracts from living alfalfa, lemongrass broths, geranium leaves, and other sources [12].

After 24 hours, the reaction between aqueous AgNO3 and an extract of leaves from the pomegranate peel produced Ag NPs [13].

In this work, we synthesized silver nanoparticles through an environmentally friendly method that involves the in situ reduction of Ag by pomegranate peel extracts

2 Material and methods

2.1 Chemicals

Silver nitrate is purity (AgNO3 99%), from Merck, and D. W.

2.2 Prepared extract plant solution

This experiment's pomegranate peel trash was obtained from a local store. Each 200-gram fruit peel waste was broken into small pieces and dried in full sunshine for 2 days. The dry components were then ground to powder and placed in a sample vial. SNP is made using this aqueous peel solution.

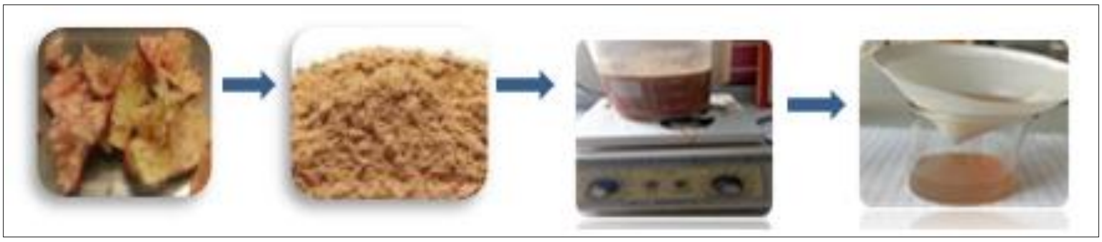

Figure 1 Steps of extract pomegranate peel

2.3 Green production of silver nanoparticles

We created SNP by adding about 3 ml of pomegranate to 22 ml of 0.2 mM AgNo3 solution and thoroughly mixing the solution. Quickly, the color of the solution changed, indicating that the reduction was finished in a short amount of time (5 min) at 25 °C, and the appearance of a yellowish brown color confirmed the creation of SNP.

2.4 Characterized of Ag nanoparticles

Nanoparticles' physicochemical properties influence Their behavior, biodistribution, safety, and effectiveness are all important considerations. As a result, AgNP characterization is critical to examining the functional properties of the produced particles. A number of analytical methods, including Fourier transform infrared (FTIR), UV-visible, X-ray diffractometry (XRD), and scanning electron microscopy (SEM), are used to investigate the materials.

2.4.1 Analysis using a UV-visible spectrophotometer

A UV-visible spectrophotometer (exactly, Lambda 25, England) was used to monitor the production of the reduced Ag nanoparticles in colloidal solution. Using a UV-visible spectrophotometer, the supernatant absorption spectra were measured between 300 and 700 nm.

2.4.2 Infrared spectroscopy using the Fourier transform

An FTIR instrument mode 6700 spectrometer was used to capture the FTIR spectrum of a biosynthesized Ag product at a resolution of 4 cm1. All measurements were made with a resolution of 4 cm1 and in the 400–4000 cm1 range.

2.4.3 Antibacterial activity of silver nanoparticles

AgNPs appear to be an alternative antibacterial agent to antibiotics that can combat bacterial antibiotic resistance. As a result, AgNPs must be created as antibacterial agents. They are distinguished by their high surface-to-volume ratios and crystalline surface structure. AgNPs promise to be feasible antibacterial agents among the numerous promising nanomaterials. The antibacterial activity of Ag nanoparticles produced by pomegranate peel extraction was investigated using the disc diffusion technique against Staphylococcus [14].

3 Results and discussion

3.1 Synthesis of silver nanoparticles

The change in color of the silver solutions (dark brown) was utilized to track the conversion of Ag+ to Ag0 nanoparticles. The intensity of brown grew with time, and the UV-Vis spectrum was used to validate that NPs formed and were stable, while SEM was used for morphological study.

Silver nanoparticles have been created using a variety of techniques, including chemical and biological ones.

In this work, the reaction medium's color quickly changed from colorless to brown when pomegranate peel extract was added to the silver nitrate aqueous solution. Early researchers demonstrated comparable findings. The control AgNO3 solution did not exhibit any color change, but the brown color suggested the formation of silver nanoparticles with the reduced Ag ion.

3.2 X-ray Diffraction of Ag nanoparticles

The diffraction peaks at 2 = 39.0°, 44.0°, 65.13°, and 78.17° correspond to (111), (200), (220), and (311), which may be attributed to the face-centered cubic (fcc) lattice of metallic Ag, as shown in Figure 2. Previous researchers found similar findings [15, 20].

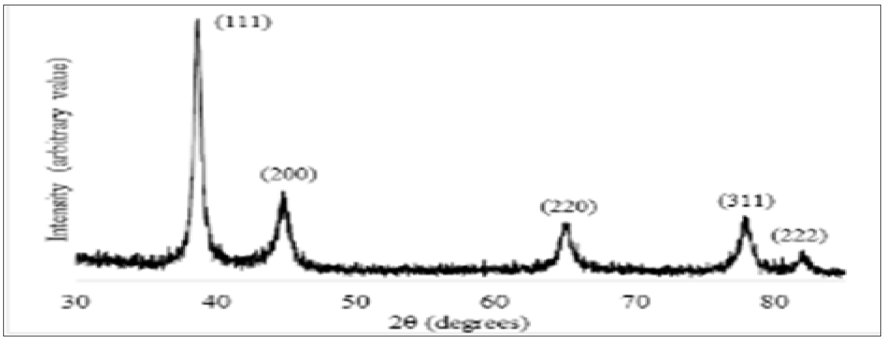

Figure 2 The XRD pattern of product Ag nanoparticles

3.3 Silver Nanoparticles' UV Spectrum

Figure 3 depicts the UV-Vis spectrum of Ag nanoparticles generated with pomegranate fruit peel extracts as a reduction agent. No absorbance peak was seen in the control.

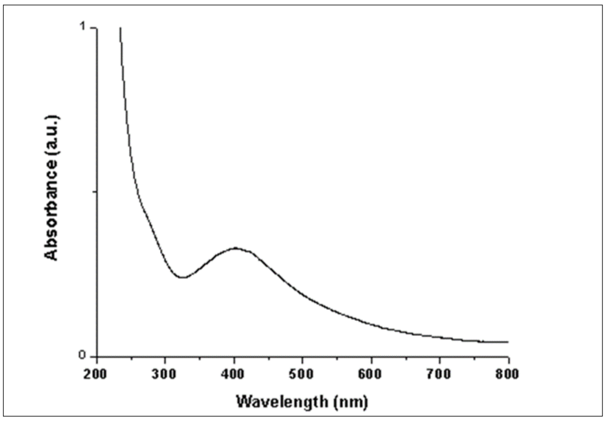

Figure 3 UV-Visible Absorption spectra of Silver Nanoparticle

3.4 Fourier-transform infrared (FTIR) spectrum of Ag nanoparticles

The FT-IR studies were performed to pinpoint the potential biomolecules behind the pomegranate fruit peel extract's conversion of Ag+ ions into AgNPs. The spectra depicted in Figure 4 showed that the main peak was at 3365 cm-1, and that other peaks were observed at 1620 cm-1, 1360 cm-1, and 2912 cm-1, respectively. The stretching of primary and secondary amines, respectively, was attributed to the bands at 3365 cm-1 and 2912 cm-1, whereas their corresponding vibrations were seen at 1620 cm-1. The band seen at 1360 cm-1 can be categorized as the aromatic group vibrations that extend along the C-N axis 20.

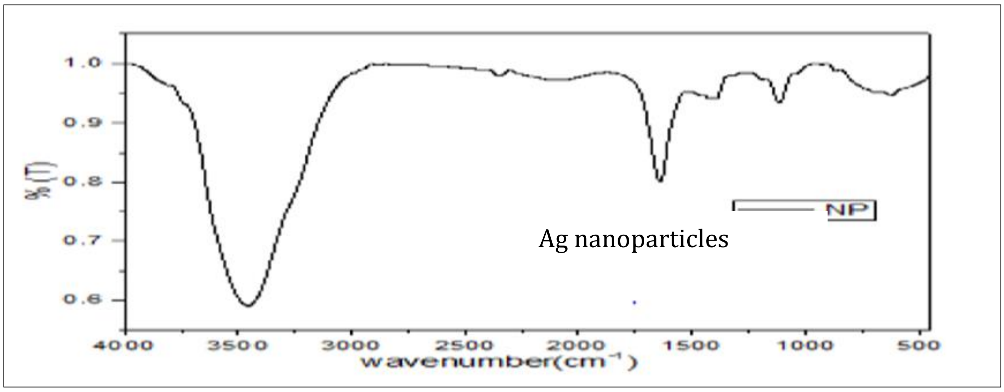

Figure 4 FTIR analysis of Ag nanoparticles

3.5 Analysis of silver nanoparticles using a scanning electron microscope (SEM).

When creating silver nanoparticles from pomegranate fruit peel extract, SEM was used to see the size and form of the particles. A copper-coated grid was used to install the dried silver nanoparticles. The SEM study's analysis of silver nanoparticle forms and their morphological dimensions showed that their average size was 30–50 nm (Figure 5).

3.6 Bio-Synthesized Nanoparticle Antibacterial Assay

The pomegranate fruit peel extract used in the study's AgNP synthesis as a reducing agent showed moderately substantial antibacterial activity against *S. aureus*. The positive control was streptomycin. Silver nanoparticles at a dosage of 0.1, 0.2, 0.3 and 0.4 mg/ml against *S. aureus*, with a maximal zone of inhibition that is 20 mm for 0.4 mg/ml (Table 1).

According to Shrivastava et al., the main way that silver nanoparticles exhibit their antibacterial capabilities is by either attaching to or piercing the bacterial cell wall and then altering cellular communication by dephosphorylating the peptide substrate on tyrosine residues show in figure 6.

Table 1 Antibacterial Activity of Staphylococcus at Different Doses

Names	name of bacteria	Subject	Dose	Zone of inhibition
1	Staphylococcus	Ag nanoparticles	0.4	20
2	Staphylococcus	Ag nanoparticles	0.3	15
3	Staphylococcus	Ag nanoparticles	0.2	9
4	Staphylococcus	Ag nanoparticles	0.1	5

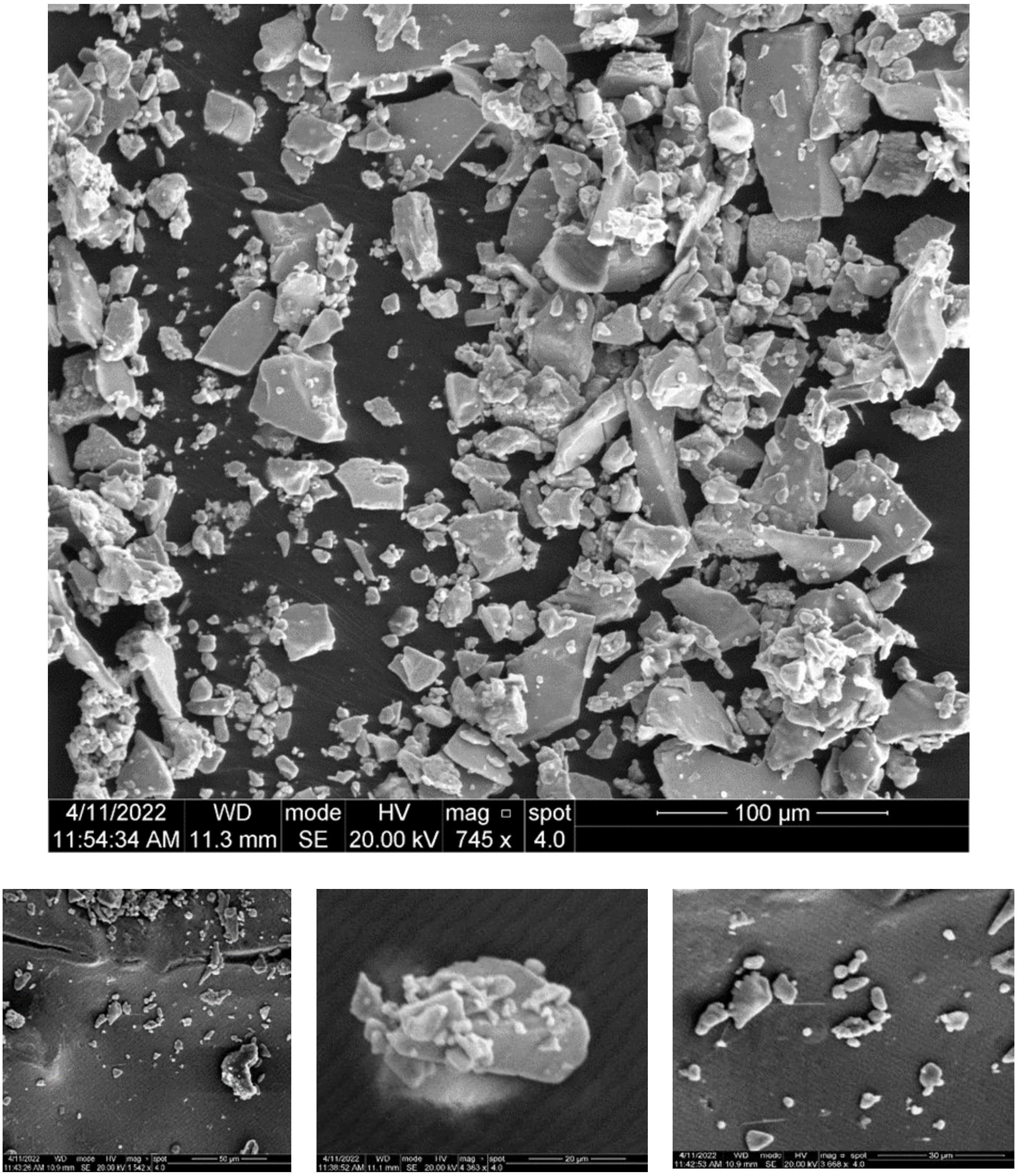

Figure 5 SEM of Ag nanoparticles

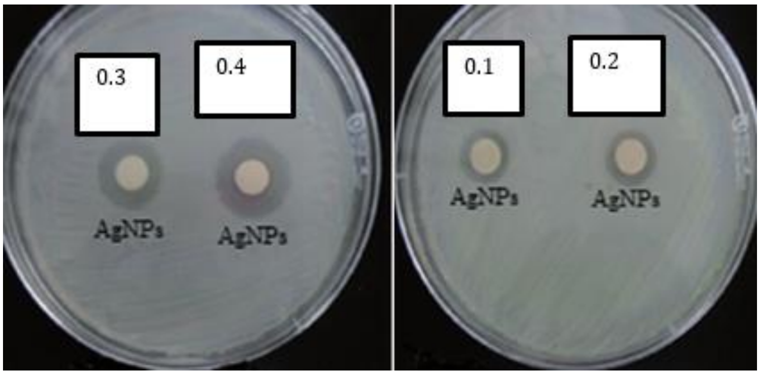

Figure 6 Antibacterial Activity of Staphylococcus at Different Doses

4 Conclusion

An extract of pomegranate peel served as the reducing and capping ingredient in this experiment. The cheap cost, economic feasibility, environmental friendliness, and other benefits of this technique of AgNP synthesis are only a few. Analytical methods including FT-IR, SEM, and UV-visible spectroscopy are used to evaluate the produced nanoparticles. According to the findings, silver NPs with an average size of 30–50 nm were synthesized. The antibacterial efficacy of the silver nanoparticles produced using pomegranate fruit peel extract was greatest against Staphylococcus aureus. The antibacterial properties of bio-synthesised nanoparticles against gram-positive (Staphylococcus aureus) infections were tested using the agar-well diffusion technique.

References

[1] R.G. Saratale, G.D. Saratale, G. Ghodake, S.K. Cho, A. Kadam, G. Kumar, B. Pant,D. Jeon, A. Bhatnagar, H.S. Shin, Wheat straw extracted lignin in silver nanoparticles synthesis: expanding its prophecy towards antineoplastic potency andhydrogen peroxide sensing ability, Int. J. Biol. Macromol. 128 (2019) 391–400.

[2] Q. Chen, G. Liu, G. Chen, T. Chen, T. Mi, Green synthesis of silver nanoparticles with corn straw for the preparation of antibacterial paper, BioResources 12 (4)(2017) 9063–9074.

[3] J. Li, Q. Ma, H. Shao, X. Zhou, H. Xia, J. Xie, Biosynthesis, characterization, and antibacterial activity of silver nanoparticles produced from rice straw biomass, BioResources 12 (3) (2017) 4897–4911.

[4] E. Delshad, M. Yousefi, P. Sasannezhad, H. Rakhshandeh, Z. Ayati, Medical uses of Carthamus tinctorius L. (Safflower): a comprehensive review from traditional medicine to modern medicine, Electron. Physician 10 (4) (2018) 6672–6681.

[5] V. Emongor, O. Oagile, D. Phuduhudu, P. Oarabile, Safflower production, in: Botswana: the Regional Universities Forum for Capacity Building in Agriculture–RUFORUM, 2017.

[6] X. Zhou, L. Tang, Y. Xu, G. Zhou, Z. Wang, Towards a better understanding of medicinal uses of Carthamus tinctorius L. in traditional Chinese medicine: a phytochemical and pharmacological review, J. Ethnopharmacol. 151 (1) (2014) 27–43.

[7] D. Guo, Y. Xue, D. Li, B. He, X. Jia, X. Dong, M. Guo, Overexpression of CtCHS1 increases accumulation of quinochalcone in safflower, Front. Plant Sci. 8 (2017) 1409.

[8] S. Ahmed, M. Ahmad, B.L. Swami, S. Ikram, A review on plants extract mediated synthesis of silver nanoparticles for antimicrobial applications: a green expertise, J. Adv. Res. 7 (1) (2016) 17–28.

[9] J.A. Morales-Del-Rio, M. Guti_errez-Lomelí, M.A. Robles-García, J.A. Aguilar, E. Lugo-Cervantes, P.J. Guerrero-Medina, S. Ruiz-Cruz, F.J. Cinco-Moroyoqui, F.J. Wong-Corral, C.L. Del-Toro-S_anchez, Anti-inflammatory activity and changes in antioxidant properties of leaf and stem extracts from Vitex mollis kunth during in vitro digestion, Evid. Base Compl. Alternative Med. (2015), 2015.

[10] D. Jini, S. Sharmila, Green synthesis of silver nanoparticles from Allium cepa and its in vitro antidiabetic activity, Mater. Today: Proceed. (2019).

[11] A. Aljawish, I. Chevalot, J. Jasniewski, A.M. Revol-Junelles, J. Scher, L. Muniglia, Laccase-catalysed functionalisation of chitosan by ferulic acid and ethyl ferulate: evaluation of physicochemical and biofunctional properties, Food Chem. 161(2014) 279–287.

[12] Daabool F.S. , Emad, K.; Ali, H. Synthesis Of Selenium Nanoparticles. Eurasian Journal of Physics,Chemistry and Mathematics.2022;7(3):67-71.doi:10.1038/s41598-019-57333-7.

[13] Daabool F.S. And Hussein FH. Synthesis and Characterization of Active Carbon-Titanium Dioxide Composite, Asian Journal of Chemistry, 31, 5, pp1176-1180, 2019. https://asianpubs.org/index.php/ajchem/article/view/265/265

[14] Daabool F.S. And Hussein FH. Photocatalytic Degradation of Phenol Using TiO^ sub 2^/Active Carbon, Asian Journal of Chemistry,, 282,pp 455,2016.

https://cdnx.uobabylon.edu.iq/research/repository1_publication7711_18_2455.pdf

[15] F.Y. Ibrahim, A.Y. El-Khateeb, A.H. Mohamed, Rhus and safflower extracts as potential novel food antioxidant, anticancer, and antimicrobial agents using nanotechnology, Foods 8 (4) (2019) 139.

[16] H.M. Ibrahim, Green synthesis and characterization of silver nanoparticles using banana peel extract and their antimicrobial activity against representative microorganisms, J. Rad. Res. Appl. Sci. 8 (3) (2015) 265–275.

[17] M. Ponce, Synthesis and characterization of Ni and NiMo nanoparticles in aqueous medium". Graduate Thesis. Altamira, Tamaulipas, M_exico, Advanced Technology Research Center, National Polytechnic Institute-Altamira Unit, 2011.

[18] J. Singh, T. Dutta, K.H. Kim, M. Rawat, P. Samddar, P. Kumar, 'Green' synthesis of metals and their oxide nanoparticles: applications for environmental remediation, J. Nanobiotechnol. 16 (1) (2018) 84.

[19] C.G. Kumar, S. Pombala, Y. Poornachandra, S.V. Agarwal, Synthesis, characterization, and applications of nanobiomaterials for antimicrobial therapy, in: Nanobiomaterials in Antimicrobial Therapy, William Andrew Publishing, 2016, pp. 103–152.

[20] M.M. Khalil, E.H. Ismail, K.Z. El-Baghdady, D. Mohamed, Green synthesis of silver nanoparticles using olive leaf extract and its antibacterial activity, Arab. J. Chem. 7 (6) (2014) 1131–1139.