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Biosynthesis of silver nanoparticles using extract of fig (*Ficus carica* L.) leaf by microwave extraction

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Abstract: Silver nanoparticles (AgNPs) were synthesized using extract of fig (*Ficus carica* L.) leaf and $AgNO_3$ solution by microwave method in this study. Freshly leaves of fig (*F. carica.*) were collected from the Eastern Black Sea region (Akçaabat-TRABZON) in Turkey and then dried. 25 g of dried sample was shaken in 500 mL of distilled water- citric acid (0.1 M) mixture (1:1) for 120 min at room temperature and extracted in a laboratoary microwave device at 5 minutes, 600 W and left cooling. Various volume of leaf extract (0.5,1,2,3 mL) was added $AgNO_3$ solution (1 mM-3 mM) and the mixture was exposed to a household microwave at 180W for 1–60 min for the biosynthesis of AgNPs. Silver nanoparticles were characterized using UV-visible absorption spectroscopy . The synthesis of AgNPs was observed by its colour changing from light yellow to dark brown and the characteristic plasmon resonance peak of silver nanoparticles was observed at around 400-500 nm.

Keywords: Silver nanoparticle, fig (*Ficus carica* L.) leaf, Green synthesis, MAE

1 Introduction

Nanotechnology is preferred technologies in recent years. Nanotechnology is interested of a size varying from 1 to 100 nm. Nanoparticles are significiant as they are common utilized in medical fields owing to their antibacterial activities nowadays. By means of their small size does it simple to permeate samples. Most researchers give importance to nanoparticles due to biomedical and environmental applications (Álvarez-Paino M et al. 2017;Muñoz-Bonilla et al.2019; Matar and Andac, 2020). Nanoparticles demonstrate broad utilize horizon in environmental preservation and other fields (Rónavári et al. 2017; Matar and Andac, 2020).The Nanostructures have various applications according as their distribution, size and morphology. It has implementations in different fields containg chemical industries, catalysis, biomedical, electronics, environment, cosmetics, health care, mechanics, photo-electrochemical and optics. There are two approaches, top-down and bottom-up for the synthesis of nanomaterials (Das et al. 2017). The use of toxic chemicals in the chemical and physical methods used ın order to biosynthesis of nanoparticles may pose potential hazards such as toxicity, carcinogenicity and environmental toxicity (Gupta and Xie 2018). Toxicity affairs are quite evident owing to the employ of danger substances such as organic solvents, stabilizers and reducing agents. The utilize of chemical contaminations and toxic solvents limits the use of nanoparticles in different biomedical and clinical applications (Hua et al. 2018). For this reason, It is necessary to use clean, reliable, biologically suitable and environmentally techniques, to biosynthesize nanoparticles. (Jain et al. 2010; Thakkar et al. 2010;Kulkarni and Muddapur 2014). There are two categories for "Natural" biogenic synthesis metallic nanoparticles; (a) Bioreduction, (b) Biosorption. The election of biological methods for synthesis of nanoparticles is releted to a few variables (Zhang et al. 2020).Fungi, bacteria and plant leaves are utilized so as to the biosynthesis of gold and silver nanoparticles (Ulug et al. 2015). Nowadays, Biological methods using plants and microorganisms are preferred than Physical and chemical methods which were expensive and toxic (Horsfall, 2014; Matar and Andac, 2020). Plant leaves has important advantages such as, simplicity, ease of preparation, health, environmental care and nanoparticle formation rate. Plant leaves used for the formation of silver nanoparticles (AgNPs) display fast growth and diversity. These extracts comprise the necessary agents for capping the reduced NPs and the reduction of silver ions (Ulug et al. 2015). Silver nanoparticles (AgNPs) which were different sizes, charges and properties can be used in different applications toxic (Matar and Andac, 2020).Silver nanoparticles (AgNPs) have obtained important interest owing to their application towards biomolecular, therapeutics, waste management, catalysis

(Joseph and Mathew 2015), drug delivery, (Jagtap and Bapat 2013; Mashwani et al. 2015) and cost effective synthesis. these properties usually subjected to the surface area, morphology, capping sheet, and particle size of nanoparticles (Zheng et al.; Oh et al. 2009; Courty, 2010). Hence, it is essential to improve environmental friendly ,a cost effective and synthetic route to prepare AgNPs. Nowadays, the silver nanoparticles (AgNPs) have point out attention owing to their active sensor and optical properties (Ghosh and Pal 2007; Han and Li 2010). Furthermore, AgNPs display well antimicrobial potential activity and biocompatibility than other nanoparticles (Jagtap and Bapat 2013; Mashwani et al. 2015). The fig is the fruit of fig (*Ficus carica*) leaf, a species of family Moraceae. It is now widely grown throughout the world and ıts native to the Mediterranean and western Asia. Figs include various phytochemicals containing polyphenols, such as chlorogenic acid, gallic acid, (+)-catechin, (−)-epicatechin, syringic acid and rutin (Vinson, 1999; Veberic et al. 2018). The microwave-assisted synthesis method produces NPs with lower dispersion, which is arranged in a more regular pattern. It is noteworthy that the shape and morphology of the formed nanostructures can be controlled in this procedure (Parveen et al. 2020;Torabfam and Yüce,2020). I used this plant in this study because it acts as a bioreductant and it is also that readily available from anywhere in the world. The aim of this work was to synthese the AuNPs by using Fig (*Ficus carica*) leaves extract as a reducing agent which were processed in MAE method.

2 Materials and Method

2.1 Materials

Fig (*F. carica*) Leaves were collected from Trabzon city, Turkey. Respectivelly the leaves were washed with deionized water, air-dried for 3-5 days, and then the dried leaves were pulverized in a grinder and stored for use. Silver nitrate was provided from Sigma Aldrich. Before the experiments, glasswares were cleaned with deionized water.

2.2 Preparation of extract

Fig (*F. carica*) leaves were wash using deionized water and cut into small pieces. The Fig leaves pieces were dried and ground to powder later. Then, 25 gram of dried Fig (*F. carica*) leaves powder was shaken in 500 mL of distilled water- citric acid (0.1 M) mixture (1:1) for 120 minutes at 25 ºC and then extracted in a laboratoary microwave device at 5 minutes, 600 W. The mixture was filtered Whatmann No. 1 filter paper, then the filtrate was kept at 4 °C so as to be utilized for the synthesis of AgNPs experiments.

2.3 Synthesis of silver nanoparticles

To obtain AgNPs, various volume of leaf extract (0.5,1,2,3 mL) was added $AgNO_3$ solution (1 mM, 2 mM, 3 mM). The mixture was subjected to a household microwave at 180W for 1–60 minutes for the biosynthesis of AgNPs to find the optimum reaction parameters. The prepared nanoparticles solution was stored at room temperature for the further experiment. The color variation from colorless to light yellow/brown following application of the microwave is an indication of colloidal AgNP in solution. The volumes of extract and concentrations of silver nitrate solutions were optimized for synthesis of silver nanoparticles (AgNPs). Each procedure was attempted three times. The concentrations and volumes of the substances used in the synthesis of silver nanoparticles are given in Table 1.

Table 1: Composition of AgNPs

Fig leaf Extract(mL)	$AgNO_3$(mM)
0.5	1
1	1
2	1
3	1
0.5	2
1	2
2	2
3	2
0.5	3
1	3
2	3
3	3

2.4 Characterization

The reduction of Ag^+ to Ag^0 was carried out by taking a certain amount of each reaction mixture in the range of 300 to 800 nm at 1 nm resolution via the spectral data of the UV-vis spectrophotometer (Shimadzu UVP-1240). The spectra of Fig (*F. carica*) leaves extracts and $AgNO_3$ solution were taken. Deionised water was used to adjust the baseline as a blank. A characteristic surface plasmon resonance (SPR) band absorption peak of silver nanoparticles came out between 410 and 480 nm (Mulvaney 1996; Das et al. 2010). The intensity and width of the peak are related to the particle size distribution. So far as the theory, merely a single SPR band peak is expected for the absorption spectra of spherical nanoparticles, however anisotropic nanostructures of spherical nanoparticlesmay result to two or more SPR bands according as the shape of the particles (Sökmen et al. 2017).

2.5 Statistical analysis

The values which were derived from experiments are exhibited in the study as means ± standard deviation (SD)

3 Results and Discussion

The color change of the solutions from pale yellow to yellowish brown is a powerful sign of nanoparticle (Fig 1.)
Spectrophotometric screening of fig *(F. carica)* leaf extract (0.5,1,2,3 mL) and $AgNO_3$ solution (1 mM, 2 mM, 3 mM) mixture) after a household microwave treatment were realized for several periods. The UV-visible spectrum of AgNPs is exhibited in figure 2,3,4 between 300–800 nm. SPR absorption spectra of silver nanoparticles generated from 1 mM (Fig.2), 2 mM (Fig.3) and 3 mM (Fig.4) $AgNO_3$ concentration.

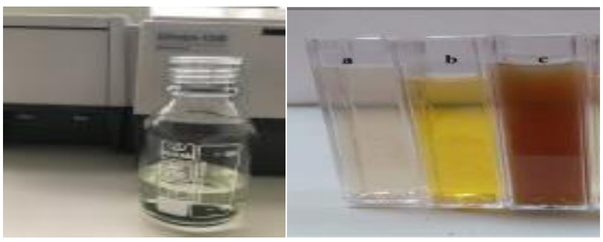

Fig 1. (a) First **c**olor variation of $AgNO_3$ and fig *(F. carica)* leaves extract mixture, **(b and c)** color change after microwave treatment.

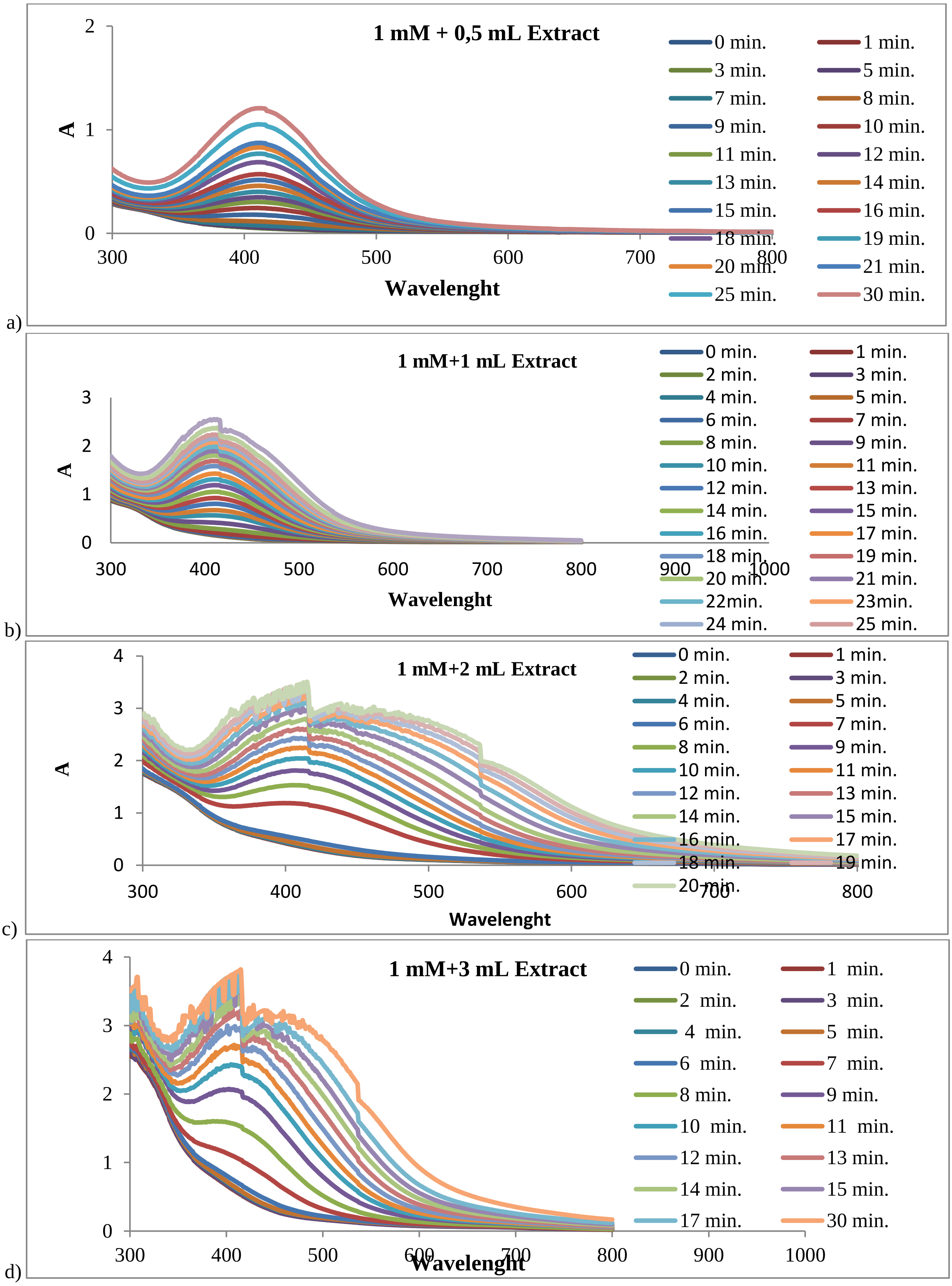

Fig 2 (a),(b),(c),(d). SPR absorption spectra of silver nanoparticles produced from different volume of 1 mM $AgNO_3$

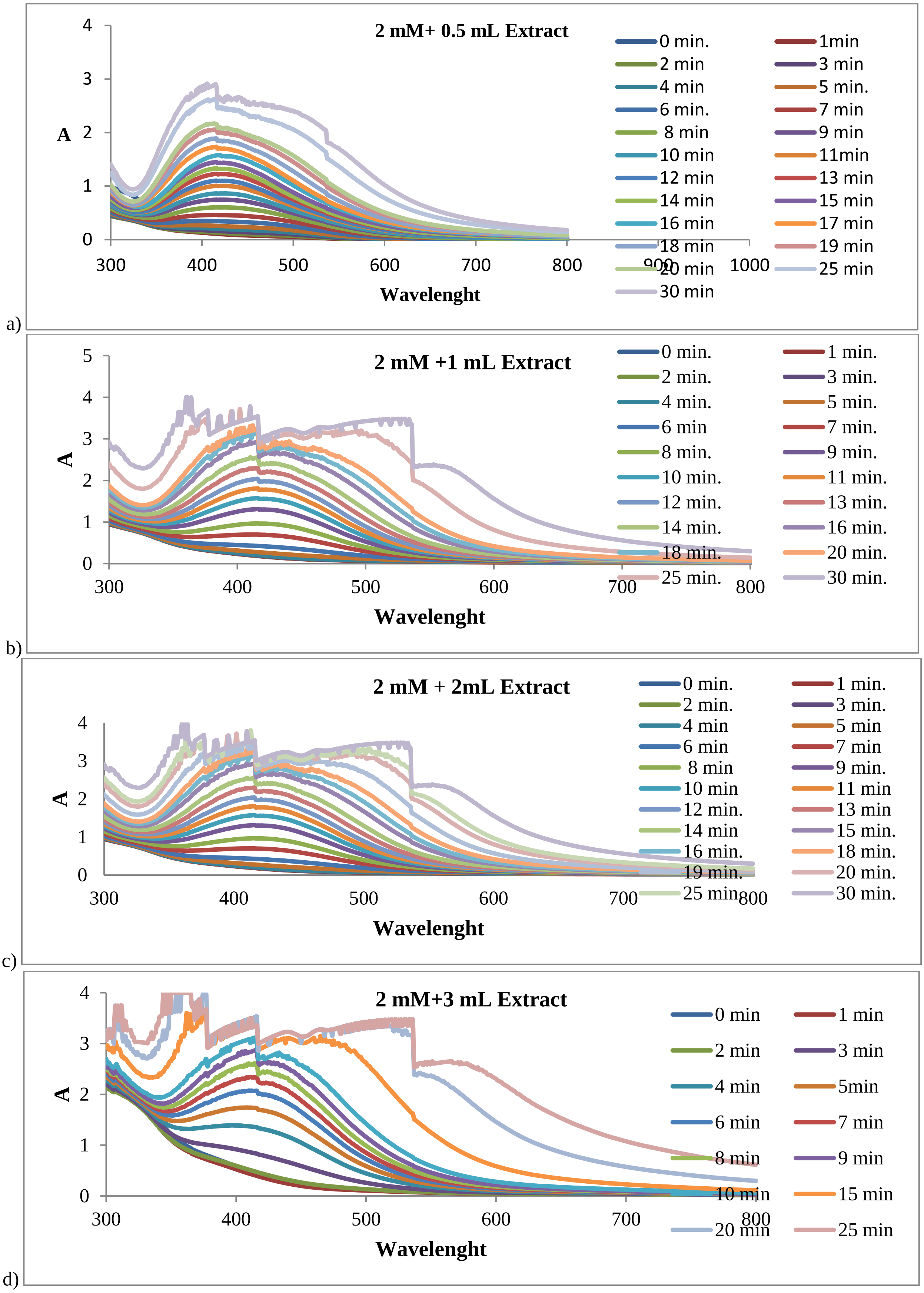

Fig 3 (a),(b),(c),(d). SPR absorption spectra of silver nanoparticles produced from different volume of 2 mM $AgNO_3$.

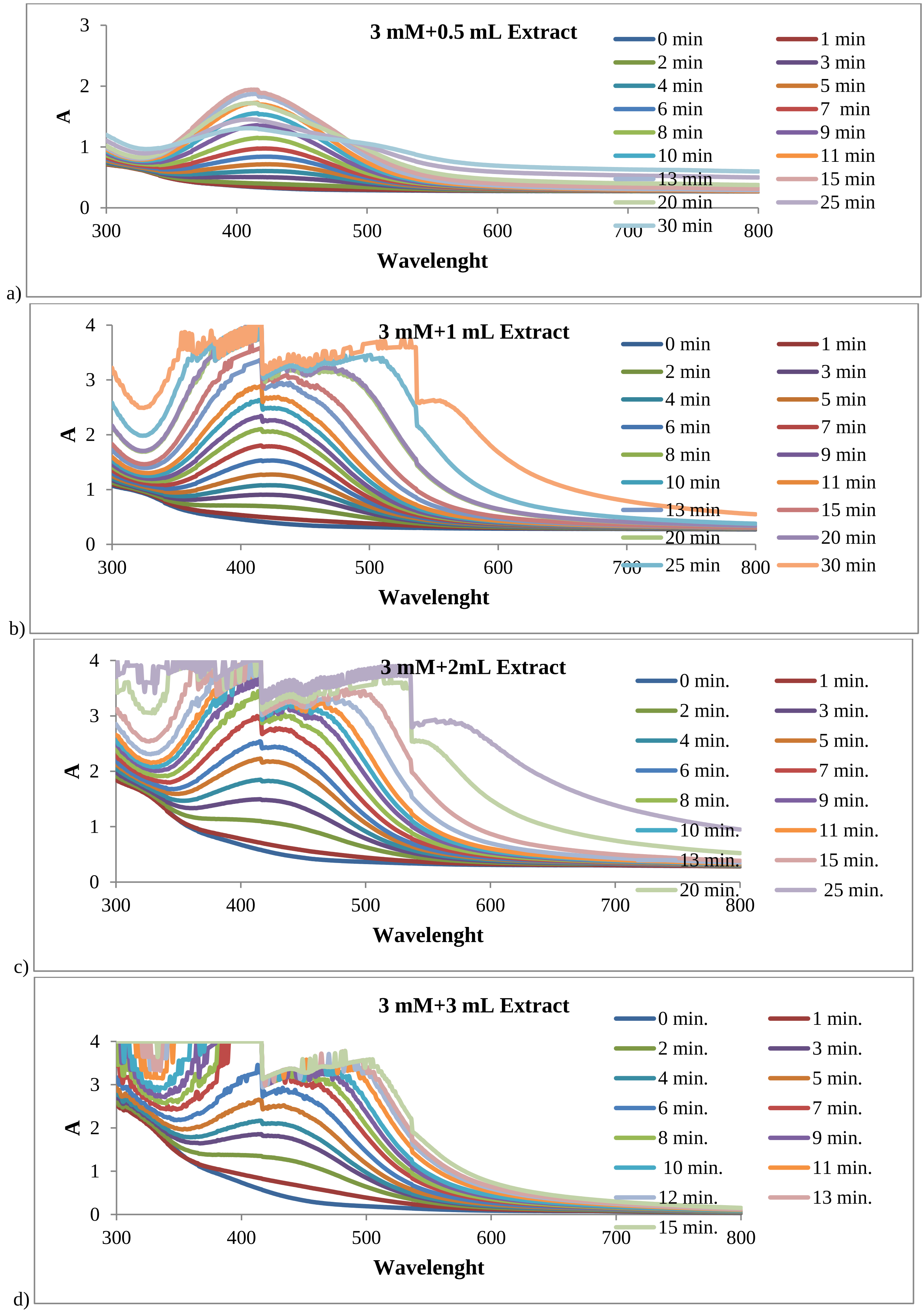

Fig 4 (a),(b),(c),(d). SPR absorption spectra of silver nanoparticles produced from different volume of 3 mM $AgNO_3$.

The formation of silver nanoparticles as color change is owing to the excitation of surface plasmon vibration of silver nanoparticles (Sökmen et al. 2017). According to Fig. 2., AgNPs were produced with 0.5 and 1 mL of fig leaf extract (Fig. 2a and b) as specific resonance band observed between 400-500 nm after 18 and 15 minutes of microwave, respectively. The band attained maximum height after 30 minutes of microwave processing at 180 W (Fig. 2a). High extract volume (2 mL and 3 mL) increased the number of nanoparticles. Particle size as a consequence of agglomeration is seen from the brownish, cloudy color of the reaction mixture and from the spectra given in Fig. 2c and d. The same production procedure was repeated for 2 mM and 3 mM $AgNO_3$ concentrations. Findings are given in Figure 3 (2 mM) and Figure 4 (3 mM).

AgNPs were successfully produced as seen in Fig. 3 and Fig. 4. The wider resonance band showed the formation of larger nanoparticles. AgNO3 concentration was increased and other parameters were kept the same. Furthermore, 3 mL of fig *(F. carica)* extract appears to produce AgNPs even after 4 min of microwave treatment (Fig. 3d and 4d) and a band peak shift was observed in the 500 nm region. The peak intensity and full width at half maximum subjects to extent and size of aggregation of particles. Thus, the broadness of the peak in all cases may be predicated to the broad particle size distribution

4 Conclusions

An economical, simple and fast production of AgNP was descriped in our work. Utilizing fig *(F. carica)* leaf extracts, fabricated stable silver nanoparticles. No capping agent was needed as aggregation was prevented by the extract. Using the microwave process makes nanoparticle production easier. biomolecules present in fig *(F. carica)* extract are able to reduce silver ions to silver nanoparticles. Fig *(F. carica)* extract contains biomolecules and thus can reduce silver ions to silver nanoparticles. This study showed a simple green synthesis of AgNPs by effective biological reduction of Ag+ using *F. carica,* reducing agents. Microwave irradiation was utilized as a good energy source by place of other time-consuming energy supplies. Alongside the significant progress in nanobiotechnology, more futuristic opinions in nanoscience inclueds of the broad utilize of NPs in biomedical and pharmaceutical applications.

References

Álvarez-Paino M, Muñoz-Bonilla A, Fernández-García M (2017) Antimicrobial polymers in the nano-world. Nanomaterials 7(2):48

Courty A (2010) Silver nanocrystals: self-organization and collective properties. J Phys Chem C 114:3719–3731.

Das RK, Pachapur VL, Lonappan L, Naghdi M, Pulicharla R, Maiti S (2017) Biological synthesis of metallic nanoparticles:plants, animals and microbial aspects. Nanotechnol Environ Eng 2:18.

Dwivedi P, Narvi SS, Tewari RP (2014) Phytofabrication characterization and comparative analysis of Agnanoparticles by diverse biochemicals from Elaeocarpus ganitrus Roxb., Terminalia arjuna Roxb., Pseudotsuga menzietii, Prosopisspicigera, Ficus religiosa, Ocimum sanctum, Curcuma longa. Ind Crops Prod 54: 22–31.

Gupta R, Xie H (2018) Nanoparticles in daily life: applications,toxicity and regulations. J. Environ. Pathol Toxicol Oncol 37: 209–230.

Ghosh SK, Pal T (2007) Interparticle coupling effect on the surface plasmon resonance of gold nanoparticles: from theory to applications. Chem Rev 107:4797–4862.

Han CP, Li HB (2010) Host-molecule-coated quantum dots as flurescent sensor. Anal Bioanal Chem 397:1437–1444.

Horsfall L (2014) Biological synthesis of metallic nanoparticles by bacteria, fungi and plants. J

Nanomed Nanotechnol 5(5):1

Hua S, de Matos, MBC, Metselaar, J M, Storm G (2018) Current trends and challenges in the clinical translation of nanoparticulate nanomedicines:pathways for translational development and commercialization. Front Pharmacol 9:790.

Jagtap UB, Bapat VA (2013) Green synthesis of silver nanoparticles using Artocarpus heterophyllus Lam. seed extract and its antibacterial activity. Ind Crop Prod 46:132–137.

Jain, N., Bhargava, A., Majumdar, S., Tarafdar, J., and Panwar J (2010) Extracellular biosynthesis and characterization of silver nanoparticles using aspergillus flavusNJP08: a mechanism perspective. Nanoscale 3:635–641.

Joseph S, Mathew B (2015) Microwave-assisted green synthesis of silver nanoparticles and the study on catalytic activity in the degradation of dyes. J Mol Liquids, 204:184–191

Kalam A, Al Sehemi AG, Alrumman S, Du G, Pannipara M, Assiri M, Almalki H, Mahmoud F, Moustafa (2017) Colorimetric Sensing of Toxic Metal and Antibacterial Studies by Using Bioextract Synthesized Silver Nanoparticles. J Fluoresc 27:2045–2050.

Kulkarni N, Muddapur U (2014) Biosynthesis of metal nanoparticles: a review. J Nanotechnol 2014:510246.

Mashwani ZU, Khan T, KhanMA, Nadhman A (2015) Synthesis in plants and plant extracts of silver nanoparticles with potent antimicrobial properties: current status and future prospects. Appl Microbiol Biotechnol 99:9923–9934.

Matar GH, Andac, M (2020) Antibacterial efficiency of silver nanoparticles-loaded locust bean gum/polyvinyl alcohol hydrogels. Polymer Bulletin,2020, 78, 6095–6113.

Muñoz-Bonilla A, Echeverria C, Sonseca Á, Arrieta MP, Fernández-García M (2019) Bio-based polymers with antimicrobial properties towards sustainable development. Materials 12(4):641

Oh N, Kim JH, Jin S, Yoon CS (2009) Reversible size-tuning of self-assembled silver nanoparticles in phospholipid membranes via humidity control. Small 5:1311–1317.

Parveen M, Ahmad F, Malla AM, Azaz S (2016) Microwave-assisted green synthesis of silver nanoparticles from Fraxinus excelsior leaf extract and its antioxidant assay. Appl Nanosci 6:267–76.

Rónavári A, Kovács D, Igaz N, Vágvölgyi C, Boros IM, Kónya Z, Pfeiffer I, Kiricsi M (2017) Biological activity of green-synthesized silver nanoparticles depends on the applied natural extracts: a comprehensive study. Int J Nanomed 12, 871–883.

Sökmen, M., Alomar, S.Y., Albay, C., Serdar, G (2017) Microwave assisted production of silver nanoparticles using green tea extracts. J Alloys Compd 725: 190-198.

Thakkar KN, Mhatre SS, Parikh RY (2010) Biologicalsynthesis of metallic nanoparticles. Nanomedicine 6: 257–262.

Torabfam M and Yüce M, 2020.Microwave-assisted green synthesis of silver nanoparticles using dried extracts of Chlorella vulgaris and antibacterial activity studies. Green Processing and Synthesis, 9: 283–293.

Ulug B, Turkdemir MH, Cicek A, Mete A (2015) Role of irradiation in the green synthesis of silver nanoparticles mediated by fig

(Ficus carica) leaf extract Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 135:153–161.
Veberic R, Colaric M, Stampar F (2008) Phenolic acids and flavonoids of fig fruit (Ficus carica L.) in the northern Mediterranean region. Food CheM 106 (1): 153–157.
Vinson JA (1999) The functional food properties of figs. Cereal Food World 4: 82-87.
Zhang D, Ma X-l, Gu Y, Huang H and Zhang G-W (2020) Green Synthesis of Metallic Nanoparticles and Their Potential Applications to Treat Cancer. Front Chem 8:799.
Zheng J, Nicovich PR, Dickson RM (2007) Highly fluorescent noble-metal quantum dots. Annu Rev Phys Chem 58:409-431.