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ORIGINAL PAPER

Stachys lavandulifolia and *Lathyrus* sp. Mediated for Green Synthesis of Silver Nanoparticles and Evaluation Its Antifungal Activity Against *Dothiorella sarmentorum*

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Abstract In this study, silver nanoparticles (AgNPs) were biosynthesized using *Stachys lavandulifolia* and *Lathyrus* sp. The first sign of the reduction of silver ions to AgNPs was the change in color of *S. lavandulifolia* and *Lathyrus* sp. extracts changed into dark brown and auburn after treating with silver nitrate, respectively. The UV–Vis spectroscopy of reaction mixture (extract+silver nitrate) produced by *S. lavandulifolia* and *Lathyrus* sp. showed the strong adsorption peaks at $\simeq$440 and 420 nm, respectively. The transmission electron microscope images showed the synthesis of AgNPs using *S. lavandulifolia* and *Lathyrus* sp. with an average size of 7 and 11 nm, respectively. The result of X-ray diffraction pattern showed four diffraction peaks at 38°, 44°, 64°, and 77° for both types of biosynthesized AgNPs. Fourier transform infrared spectroscopy showed the possible role of involved proteins and polyhydroxyl functional groups in the synthesis process of AgNPs. Inductively coupled plasma analysis determined the conversion rate (percentage) of silver ions to silver nanoparticles in reaction mixtures of *S. lavandulifolia* and *Lathyrus* sp. 99.73 and 99.67 %, respectively. In addition, antifungal effect of AgNPs, synthesized by both extracts, was studied separately on mycelial growth of *Dothiorella sarmentorum*, in a completely randomized design on potato dextrose agar (PDA) medium. The inhibition rate of mycelial growth was strongly depended on the density of AgNPs and it strongly increased with increasing the density of

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AgNPs in the PDA medium. AgNPs more than 90 % of them inhibited from the mycelia growth of the fungus at the concentration of 40 μg/mL and higher.

Keywords Inhibition rate · *Stachys lavandulifolia* · *Lathyrus* sp. · *Dothiorella sarmentorum* · X-ray

Introduction

Particles with at least one dimension have a size between 1 and 100 nm are called nanoparticles (NPs) [1]. NPs show different and novel chemical, physical and biological properties and activities in comparison to the bulk materials [1]. A wide range of top-down and bottom-up approaches were used for the synthesis of different types of NPs [2]. For example, milling method (top-down) used for the synthesis of metal nanoparticles [3], also a large number of physical and chemical (top-down and bottom-up) methods such as laser ablation [4], microwaves [5], chemical reduction [6], electrochemical [7] and nanolithography [8, 9] were used to synthesis tellurium, gold, silica, titanium, silver, zinc oxide, and palladium nanoparticles [10]. In addition to the aforementioned physicochemical methods, various natural resources such as fungi [11], actinomycetes [12, 13], bacteria [14, 15], plant [1, 16] and even recently cobweb [17] were used for synthesis an spherical, triangular, square and rod like shape NPs. AgNPs is one of the most widely used nanoparticles especially in medical science. A great deal of research has been done on different applications of AgNPs in various fields of science, especially in the health area [18–21]. Some of the most important applications of AgNPs are their usage in cancer treatment [22], drug delivery [23], and the sensor science [24]. Silver is a non-organic and non-toxic antimicrobial agent that inhibits microbial growth of 650 microbial species [25, 26]. AgNPs can be used in the production of antibacterial products such as shampoo, toothpaste, toothbrush [27], plastic containers (food, pharmaceutical, cosmetic), house appliances (refrigerators, vacuum cleaner, dishwasher, air conditioner system and humidifier) etc. to make them antibacterial. The use of AgNPs in dyeing led to prevent from the growth of pathogens in closed area [28]. In fact, nano-science has affected all areas of science such as earthquakes, energy, engineering, and biology science [29, 30]. Production of novel and efficient materials, development in production of new things and designing new methods are the purposes of this science.

Some of disadvantages in most physicochemical methods are the use of harmful chemical compounds and high-energy consumption on the one hand, could be potentially hazardous to environment and human health and on the other hand are highly cost in industrial-scale production [1, 16]. Therefore, syntheses of NPs with the use of eco-friendly natural resources are taken into consideration, especially in cases such as biomedical applications [6]. Synthesis of NPs using bioresource not only considered for its eliminating destructive environmental impact, but also can be used for industrial-scale production of stable NPs with desirable shape and size and without using chemical compounds as redaction and stabilization agent, which have [6, 31]. Although the mechanism of NPs synthesis in green methods (Synthesis

of NPs using bioresource) is still not well understood, but because of their simplicity, low cost, saving energy consumptions, and use of natural resources have attracted the attention of many scientists. In the other hand, the use of plant extracts for the synthesis of NPs in comparison with microbial resources is much more cost-effective because it does not need the complex and expensive steps of building the medium and culture. Variable combination of molecules and macro-molecules in different herbal extracts led to different abilities of them in the synthesis of NPs with different size, shape and stability. The type of herbal extracts, metal ion concentration, pH, temperature, and time affect the synthesis process of NPs [31–34]. In this study the biosynthesis of AgNPs was done using *S. lavandulifolia* and *Lathyrus* sp. and then their antifungal effects was evaluated against *D. sarmentorum*, a member of Botryosphaeriaceae family, which was isolated from the urban environment of Shiraz, Iran in 2014 [35]. Species residing in the fungal family Botryosphaeriaceae (Ascomycota, Dothideales) are known as important groups of fungi which are capable to infect a wide range of plant species [10, 36]. Botryosphaeriaceae species are saprophytic, endophytic, and parasitic in a wide range host species [37]. *D. sarmentorum* is a plurivorous species of the family Botryosphaeriaceae and has been isolated from 34 different host species [37].

In this study, for the first time in the world, the green synthesis of AgNPs was investigated using *S. lavandulifolia* and *Lathyrus* sp. which are available abundance in Iran. The following information about the analysis and the results of UV–Vis spectroscopy, X-ray diffraction, transmission electron microscope, inductively coupled plasma, Fourier transform infrared spectroscopy of synthesized AgNPs was described. Finally, according to the antimicrobial property of AgNPs, the antifungal effects of both biosynthesized AgNPs were studied in potato dextrose agar (PDA) medium against *D. sarmentorum* cultures.

Materials and Methods

Used Materials

Silver nitrate ($AgNO_3$) and PDA medium were obtained from Merck, Germany. The sepals of *S. lavandulifolia* and seed of *Lathyrus* sp. were prepared from Pakanbazr, Co, Esfahan, Iran.

Decontamination and Preparation of Herbal Extracts

At first, 5 g sepals of *S. lavandulifolia* and 5 g seeds of *Lathyrus* sp. were measured separately using sensitive scales (Keran and Gmbh. D-72336) and the dust was removed from their surface, then samples were rinsed with sterile deionized water (DW) and then each of them were added separately into an Erlenmeyer glass flasks containing 100 mL of boiling DW [38] and the glass door covered with aluminum foil to prevent the outflow of water vapor from Erlenmeyer flasks. The samples were boiling for 1200 s, then seeds and sepals were discarded and the supernatant phase

were cooled and filtered using Watman paper grade No. 40 to separate any insoluble particles from supernatant phase. The Filtered extract was used to synthesis AgNPs.

Biosynthesis of AgNPs

At first, 50 mL of silver nitrate solution with the density of 0.1 M was prepared to synthesis the suspension of AgNPs with desired concentration, and then the required amount of silver nitrate was evaluated using following formula (Eq. 1) to prepare final desire concentrations of AgNPs.

$$C_1V_1 = C_2V_2 \quad (1)$$

"C_1" is the initial concentration of $AgNO_3$ (stock solution, 0.1 M), "V_1" is the initial volume of $AgNO_3$ (50 mL saved stock), "C_2" is the final concentration (1, 2, 3 mM) and "V_2" is the final volume of the reaction mixture (100 mL).

The required amount of $AgNO_3$ to prepare the final concentration of 1, 2, and 3 mM was taken from stock solution and was added separately to 25 mL of herbal extract and then the final volume was reached to 100 mL by adding DW. Moreover, the control sample was prepared without any treatment with $AgNO_3$. The reaction mixtures and control samples were kept in the dark at 303°K.

Physicochemical Properties of AgNPs

The reaction mixtures were studied over a period of 1 month after treatment with silver nitrate, by using UV–Vis spectroscopy (Analytic gena, Germany) at a wavelength of 300–700 nm [39].

Transmission Electron Microscopy (TEM)

TEM (LE9, LEO012-AB) was used to evaluate size, shape and distribution and of AgNPs. At first, by using form var, a thin layer was prepared and drops of both reaction mixtures were added separately on a thin layered and dried at ambient temperature [38].

X-ray Diffraction (XRD)

100 mL of each reaction mixture centrifuged (LADNET, America) separately at 18,000 (rpm) for 1200 s. Then the supernatant phase was removed and DW was added to the sediments (AgNPs) until volume reached to the initial volume (100 mL), and this was repeated two times. The remaining deposits were analyzed after drying with X-ray diffraction (PANalitical, XPERTPRO, Holland) [20].

Inductively Coupled Plasma (ICP)

ICP (Varian BV, ES-700 Australia) was analyzed to survey the remaining silver ions, which remained in the reaction mixtures after synthesis of AgNPs. The

reaction mixture of each extract was analyzed separately and finally the conversion of silver ions to silver nanoparticles was evaluated by using following formula (Eq. 2) [40]:

$$Q = (C_0 - C_f/C_o) \times 100 \quad (2)$$

"C_0" and "C_f" are the initial and final concentration of silver ion (μg/mL) and Q is the conversion rate (percentage) of silver ions to AgNPs.

Fourier Transformation Infrared Spectroscopy (FTIR)

FTIR was used to investigate the possible roll of functional groups of plants extracts in the mechanism of the synthesizing process of AgNPs. To analyze each extracts before and after adding $AgNO_3$ (before and after the synthesis of nanoparticles), each of the extracts were centrifuged separately for 600 s at 10,000 (rpm), and then the supernatant liquid was removed and the sediments were studied with FTIR, BRUKER,TENSOR27, Germany [41].

Fungal Strain

In this study, the antifungal assays were done on *D. sarmentorum* (Botryosphaeriaceae). This isolate was isolated from the urban environment of Shiraz, Iran in 2014. The strain was identified based on morphological and molecular characteristics including amplification and sequencing the ITS region by using primers ITS [42] and ITS4 [43] as well as amplification and sequencing of a part of translation elongation factor 1−α (EF-1α) with two primers of EF1-728F and EF1-986R [44]. According to pathogenicity tests, this strain was pathogenic on elm trees. The strain used in this study has been registered as IRHNM-DOSKB33, with two accession numbers of KM433837 (for ITS) and KU095810 (for EF-1α gene) in GenBank.

Antifungal Effect of AgNPs on Mycelial Growth of *D. sarmentorum*

The antifungal effect of both types of AgNPs which synthesized using *S. lavandulifolia* and *Lathyrus* sp. have been studied by agar dilution method, separately. The required volume of AgNPs to produce culture medium with desired concentrations (0, 10, 20, 40, 80 ppm) was calculated by using the formula: Eq. 1.

Then calculated amount of AgNPs was added to PDA medium after autoclaving and when the medium was still liquid (temperature 313–323 K). After addition of AgNPs the liquid medium was slowly shaken to distribute AgNPs homogenously throughout the medium. Finally, the medium was poured to the Petri dish and was placed under laminar flow hood for 48 h. Then a mycelial plug (4 mm) was taken from the edge of 4-day-old colonies on PDA and placed in the center of each Petri plate containing different concentrations of AgNPs [38]. Plates were incubated at 301 K and in the dark. Mycelia radial growth rates were measured after 24, 48, and 3 days. The extracts (alone and without $AgNO_3$) was added in PDA medium in order to investigate the antifungal effects of extracts. In the control treatments, only

sterile water was added to the culture medium. The following formula was used to evaluate the inhibition rate (percentage).

$$\text{Inhibition rate (percentage)} = \text{RG} - \text{rg}/\text{RG}$$

where "RG" is the radial growth of fungal mycelia on the control plate and "rg" is the radial growth of fungal mycelia on the plate treated with $AgNO_3$. The experimental plan of this study was a completely randomized design with three replicates. The MSTAT-C statistical software was used to analyze variance (ANOVA) of the data analysis and the least significant difference was utilized to compare the means of the obtained data ($\alpha = 0.05$ %).

Results

Visual Observation of the Synthesis of AgNPs

Changing in the color of the reaction mixture of *S. lavandulifolia* sepals extract from brown to dark brown and the *Lathyrus* sp. seeds extract from bright yellow to brown were the first visible sign of the synthesis of AgNPs (Fig. 1). The observed color changing is depended on the excitation of surface Plasmon vibrations of AgNPs surface [45].

UV–Vis spectroscopy

Observing the strong absorption peaks in *S. lavandulifolia* and *Lathyrus* sp. extracts were at 440 and 420 nm, respectively, represented the synthesis of AgNPs. The observed absorption peak refers to the surface Plasmon vibration of AgNPs [45].

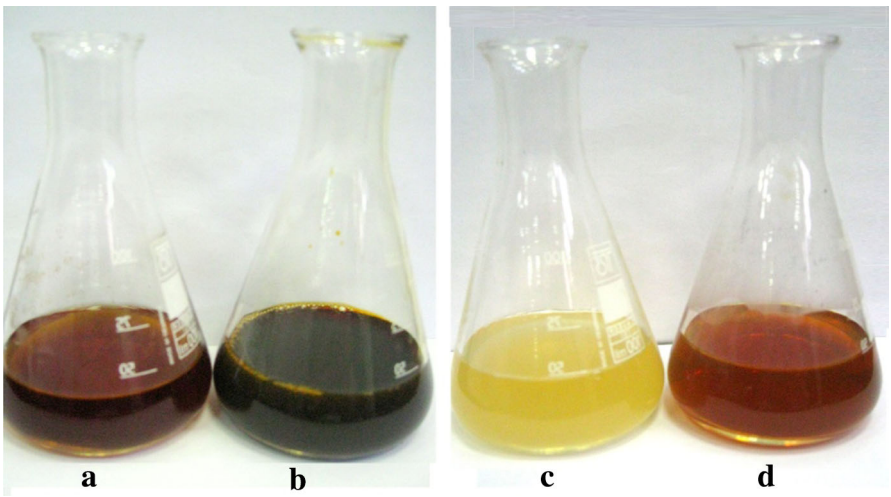

Fig. 1 The change in the color of *S. lavandulifolia* extract from *bright brown* (**a**) to *dark brown* (**b**), and *Lathyrus* sp. extract from *bright yellow* (**c**) to *reddish brown* (**d**) after treatment with $AgNO_3$ is the first sign that represent the synthesis of AgNPs (Color figure online)

An increase in the intensity of absorption peaks of UV–Vis spectrophotometer (Fig. 2a, b) is due to the reduction of silver ions to AgNPs in over the time (Fig. 2a, b). The study of time effects on the synthesis of NPs in both plants showed that conversion of silver ions into AgNPs in both extracts occurs slowly and during the period of 1 month. After 1 month, no increase was observed in the intensity of absorption peak that represents the completion of synthesis process. Also increase in time lead to shift in amount of absorption to higher wavelengths (*S. lavandulifolia*) and lower wavelengths (*Lathyrus* sp.), and this shift is due to the effect of time on the shape and size of particles.

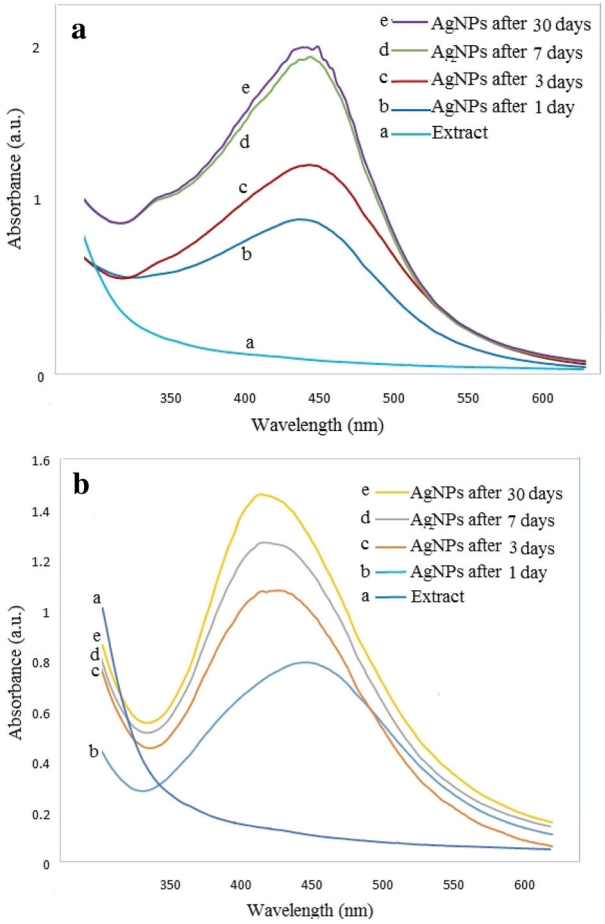

Fig. 2 UV–Vis spectra of synthesized of AgNPs using *S. lavandulifolia* and *Lathyrus* sp. extract. The absorption peak at region of 400–450 nm is due to the presence of AgNPs in the sample. **a** UV–Vis spectra of *S. lavandulifolia* extract before (*a*) and after synthesis of AgNPs in the period of 1 month (*d–e*). **b** UV–Vis spectra of *Lathyrus* sp. extract before (*a*) and after synthesis of AgNPs in the period of 1 month (*d–e*)

Transmission Electron Microscope (TEM)

The AgNPs which were synthesized with both plant extracts had a relatively spherical shape and but had different distribution and an average size (Figs. 3, 4).

AgNPs were synthesized using *S. lavandulifolia* extract with size ranges from 1 to 40 nm with an average size 7.08 nm.

AgNPs were synthesized using *Lathyrus* sp. extract, which had a size range from 1 to 35 nm with an average particle size of 11.5 nm. In comparison with synthesized AgNPs, using *S. lavandulifolia* had a limited size but a larger average size.

Inductively Coupled Plasma (ICP)

The conversion rate (%) of silver ions to AgNPs in reaction mixtures of *S. lavandulifolia* and *Lathyrus* are calculated (Eq. 2) 99.73 and 99.67 %, respectively, which indicated a high conversion of silver ions to AgNPs in these plants extract (Table 1). In continuation, we studied the antifungal effects of both types of biosynthesized AgNPs. Therefore, we calculated the conversion rate (percentage) of

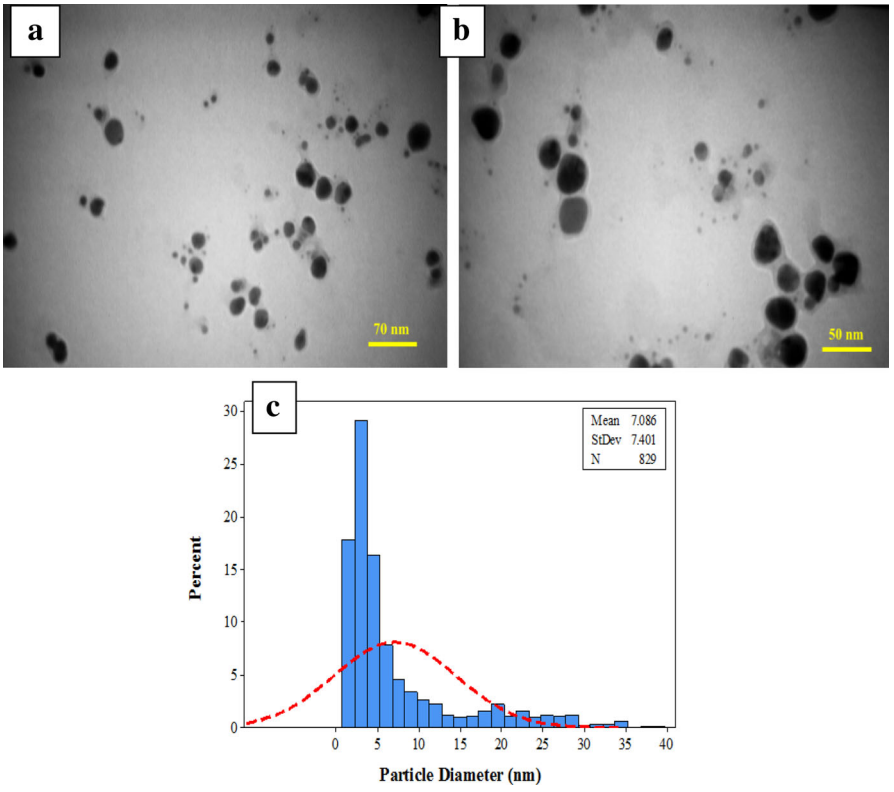

Fig. 3 TEM Images of AgNPs, which synthesized using *S. lavandulifolia* extracts at different scales (**a**, **b**) and a histogram of particle size distribution (**c**)

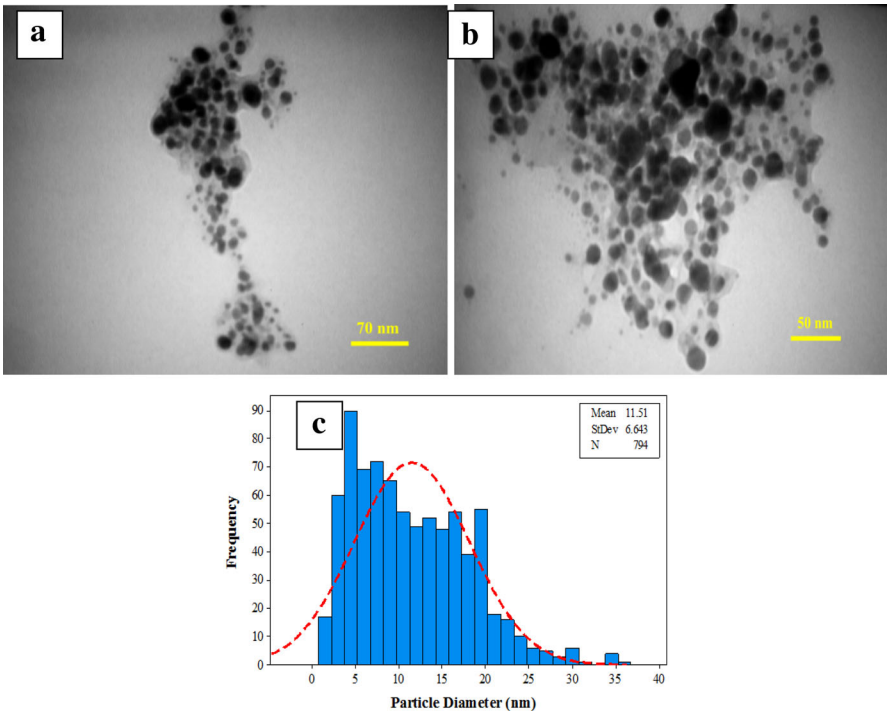

Fig. 4 TEM Images of AgNPs, which synthesized by *Lathyrus* sp. extract at different scales (**a**, **b**) and a histogram of particle size distribution (**c**)

Table 1 The inductively coupled plasma results showed conversion rate of silver ions to AgNPs which biosynthesized using *S. lavandulifolia* and *Lathyrus* sp.

Reaction mixture of	C_0 (mg/L)	C_f (mg/L)	Q (%)
S. lavandulifolia	502	1.635	99.73
Lathyrus sp.	497	1.635	99.67

silver ions to AgNPs, to be sure that the observed antifungal effect is due to the presence of AgNPs not in the effect of silver ions.

The ICP results also indicated that the presence of silver ions in the reaction mixture was almost close to zero (Table 1).

X-Ray Diffraction (XRD)

The XRD analysis of AgNPs which synthesized using *S. lavandulifolia* (Fig. 5a) showed four strong absorption peaks at angels of 38.17, 42.27, 64.55 and 77.43 which assigned to (111), (200), (220) and (311) crystalline plane of AgNPs, respectively. Similar absorption peaks (38.17, 42.26, 64.50, and 77.99) observed for AgNPs, which synthesized using *Lathyrus* sp. (Fig. 5b). These spectrums confirm

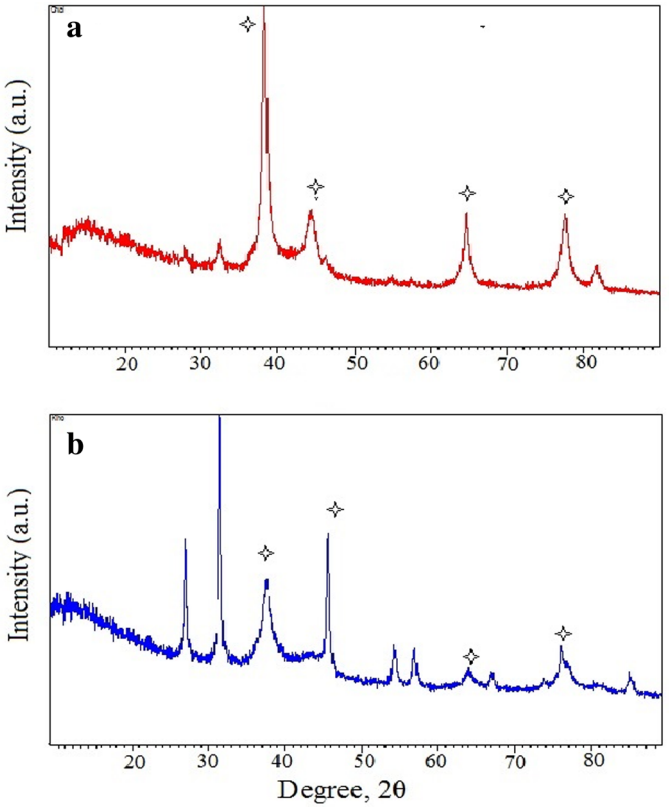

Fig. 5 XRD patterns of AgNPs which biosynthesized using *S. lavandulifolia* and *Lathyrus* sp. extract

the existence of crystalline structure of silver on both of the reaction mixtures. The observed crystalline plane indicates that structure of AgNPs is face-centered cubic.

Fourier Transforms Infrared Spectroscopy (FTIR)

FTIR analysis in both studied plant extracts have same peaks of absorption before and after the synthesis of AgNPs and only have a minor differences with each other. The FTIR spectrum of *Lathyrus* sp. (Fig. 6a) showed absorption bands at 1072, 1460, 1637, 2928, 3445 cm^{-1}. Similar absorption bands (1067, 1458, 1634, 2931, 3435 cm^{-1}) were observed in FTIR spectrum of *S. lavandulifolia* (Fig. 6b). The bands at 1072 and 1067 cm^{-1} were dedicated to the amino group [32]. The band at 1460 cm^{-1} refers to the methyl group of proteins. The band at 1637 cm^{-1} corresponding to amid I and the band at 2928 cm^{-1}, this is because of aromatic compounds traction refers to a group of alkanes, which from its compounds, we can point at methane, ethane, and hexane. The bands at 3435 and 3445 cm^{-1} related to the OH group [32]. The band at 1458 cm^{-1}, which is the scattered methyl vibration that has its certain absorption [32]. It is clear that proteins can easily bind to the NPs through free or residual amino groups of proteins. The results indicate a potential and

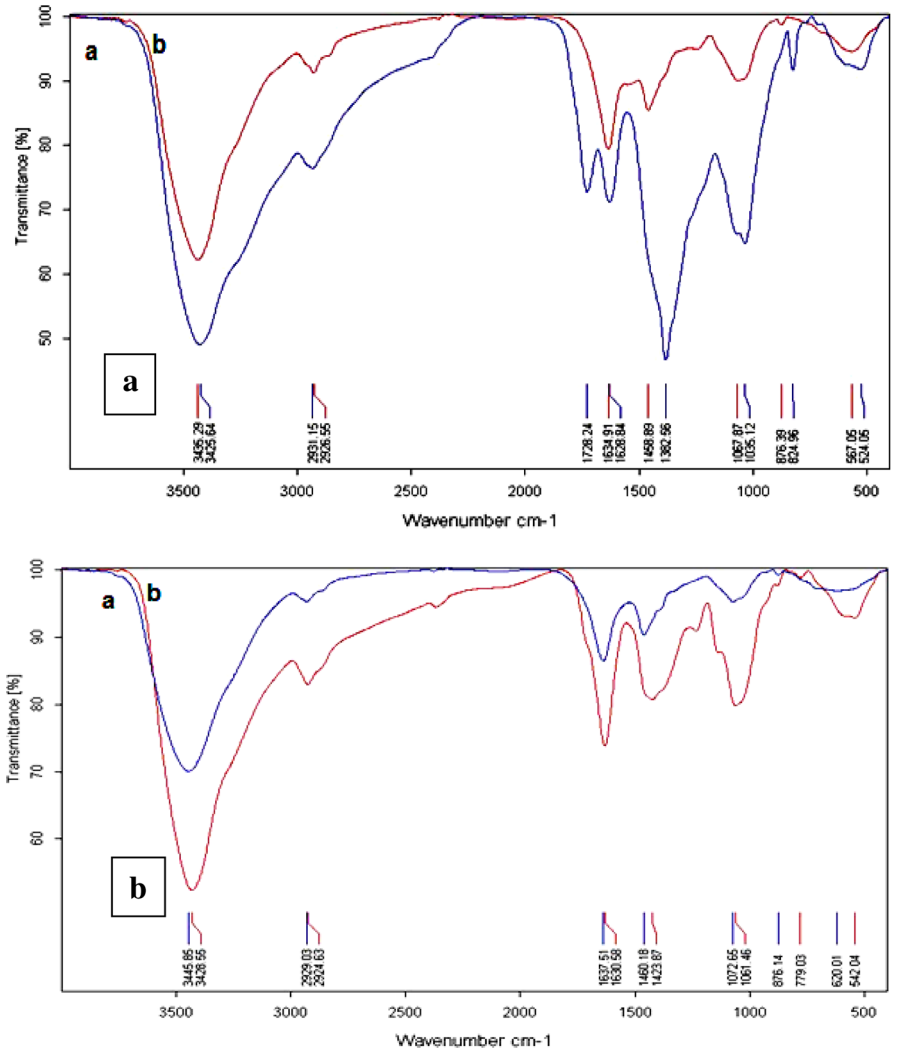

Fig. 6 FTIR spectrum of the *S. lavandulifolia* and *Lathyrus* sp. extract before and after the synthesis of NPs. **a** FTIR spectrum of *S. lavandulifolia* extract before (*a*) and after (*b*) treatment with silver nitrate. **b** FTIR spectrum of *Lathyrus* sp. extract before (*a*) and after (*b*) treatment with $AgNO_3$

effective role of proteins in the synthesis process of AgNPs. Therefore, it can be concluded that the presence of some water-soluble polyhidroxy compounds such as sucrose polyester and terpenoids, flavonoids, and alkaloids act as ligand cover for NPs.

Antifungal Effect of Both Types of Silver Nanoparticles Against *D. Sarmentorum*

The inhibitory effect of both types of biosynthesized AgNPs was studied separately on mycelia growth of fungus *D. Sarmentorum*, and the results showed the significant

antifungal effect of both types of AgNPs in PDA media containing different concentrations (10, 20, 40, and 80 µg/mL) of AgNPs in vitro (Fig. 7).

Antifungal effect of *S. lavandulifolia* and *Lathyrus* sp. extract were studied separately (without treated with silver nitrate) and with a concentration exactly as the same as the one which was used for the synthesis of AgNPs, and results did not show any inhibitory effect against the fungus mycelium growth. More than 90 % of inhibition in fungus mycelia growth was observed at 40 µg/mL of both types of AgNPs. The lowest level of growth inhibition was observed at the concentration of 10 µg/mL of AgNPs which synthesized using *Lathyrus* sp. seeds extract with 3 % of growth inhibition (Table 2). The mycelia growth inhibition of 75, 90 and 99 % were found for the 20, 40 and 80 of µg/mL AgNPs (which synthesized using *Lathyrus* sp. seeds extract), respectively. The mycelia growth inhibition of synthesized AgNPs using the extract of *S. lavandulifolia* extract at the concentrations of 10, 20, 40 and 80 µg/mL were found 17, 78, 91, and 99 %, respectively. The results clearly showed that the mycelia growth inhibition is strongly depended on the concentration of AgNPs and greatly increased by increasing the concentration of AgNPs.

The result of statistical analysis (at 5 %) showed a significant effect of both types of AgNPs on radial growth of *D. sarmentorum* after putting mycelia plug in the center of Petri dish and in three consecutive days is shown in Fig. 8. The time and an increase in concentration of AgNPs had a significant effect (at 5 %) on reducing the mycelial growth of the fungus.

Discussion

More physical and chemical methods that are commonly used in the synthesis of NPs require chemical compounds and high-energy consumption. In addition, have irreparable effects on environment and human health. In synthesis techniques, using

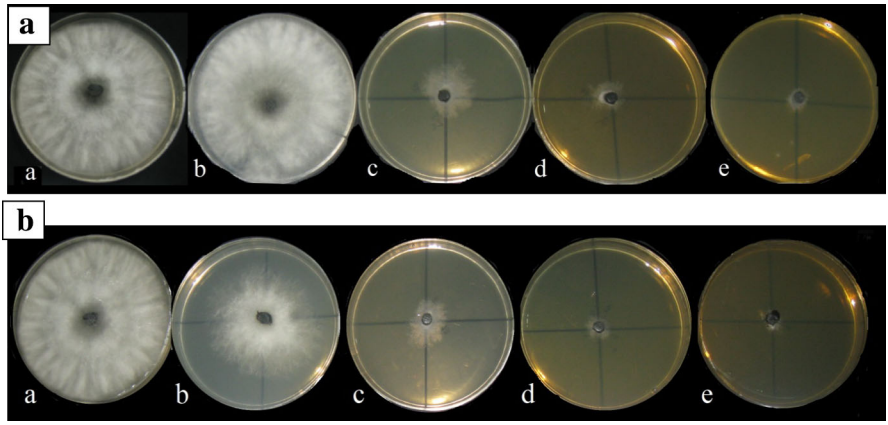

Fig. 7 The mycelia growth inhibition effect of AgNPs which were synthesized using extracts of *Lathyrus* sp. seeds extract (**a**) and *S. lavandulifolia* extract (**b**) on PDA containing different concentrations (*a*: 0, *b*: 10, *c*: 20, *d*: 40 and *e*: 80 µg/mL) of AgNPs against *D. sarmentorum*

Table 2 Inhibitory rate (percentage) of different concentrations (a: 0, b: 10, c: 20, d: 40 and e: 80 μg/mL) of AgNPs which were synthesized using extracts of *Lathyrus* sp. and *S. lavandulifolia* against *D. sarmentorum*

Reaction mixture of	The inhibitory percentage rate (%) of different concentrations of AgNPs (μg/mL)				
	0	10	20	40	80
Lathyrus sp.	0	3	75	90	99
S. lavandulifolia	0	17	78	91	99

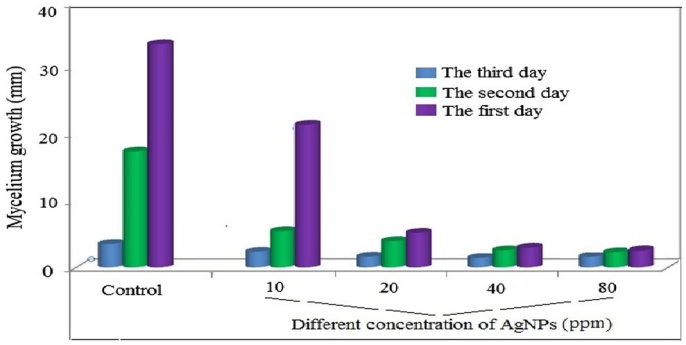

Fig. 8 The mycelium growth of fungus *D. sarmentorum* in three consecutive days after putting the mycelia plug in the center of the Petri dish containing PDA media+different concentrations (0, 10, 20, 40 and 80 μg/mL) of AgNPs

bio resources such as plants with high potential to produce stable NPs can be replaced with complex and expensive chemical and physical methods. Development of green methods is a step toward green chemistry and reducing the use of chemicals and energy in the process of synthesizing NPs. So cheap, simplicity, reducing the need to use chemicals, and reducing the risks on human health and environment are the benefits of using natural resources rather than chemical methods for the synthesis of AgNPs. *S. lavandulifolia* and *Lathyrus* sp. were used for the first time to synthesis AgNPs and so far, no report has been released about the synthesis of AgNPs using these plants. The growth inhibitory effect of both synthesized AgNPs was studied separately in the growth of mycelium fungus, which was isolated from the nature. The study showed the meaningful effect of both types of AgNPs in preventing the growth if mycelium fungus. More than 90 % of growth inhibition in mycelium fungus was observed at the concentrations of 40 μg/mL of AgNPs. So far, nothing has been reported about the antifungal effect of AgNPs or silver nano composites on the inhibition of fungus *D. sarmentorum*. Kumar et al. have reported that the mycelia inhibitory effect of silver nano composites at concentration of 100 μg/mL was 94, 78 and 67 % against *Aspergillus flavus*, *Alternaria alternaria* and *Rhizoctonia solani*, respectively [46]. Khatami and Pourseyedi were synthesized AgNPs with an average size of 17 nm using Palm kernel and studied their antifungal and antibacterial effects. They reported the growth inhibition of AgNPs on *R. solani*

about 83 % at the concentration of 25 μg/mL, and also showed that minimum inhibitory concentration against *Acinetobacter baumannii* recorded as 1.56 μg/mL [38]. The antifungal effects obtained in their studies are very similar to the obtained results of this study. The exact mode of action of AgNPs is still not well understood, but published researches stated the antifungal mechanism of AgNPs against *Aspergillus niger* fungus due to enzyme inactivation and thus impairs the replication of DNA and prevent fungal growth [47]. Our result is far similar with some finding published previously that they showed increases in AgNPs concentrations lead to increment in the inhibitory effect [48].

Conclusion

The results obtained using UV–Vis, TEM, XRD, ICP indicate the high potential of *S. lavandulifolia* and *Lathyrus* sp. for the synthesis of AgNPs with the average size of less than 15 nm. The results showed that it requires 1 month completing the process and converting more than 99 % of silver ions to AgNPs. The extracts of *S. lavandulifolia* and *Lathyrus* sp. have the ability to synthesize the stable AgNPs with no need for any reducing and stabilizing compounds. The results indicate that extracts containing AgNPs has a high ability to prevent the mycelia growth of fungus *D. sarmentorum*, while plants extracts have no antifungal effects. Therefore, it can be said that synthesis of AgNPs can significantly cause a high antifungal ability in extracts of *S. lavandulifolia* and *Lathyrus* sp. The inhibition rate of mycelia growth was 3, 75, 90, and 99 %, which were found for biosynthesized AgNPs by using *Lathyrus* sp. at concentrations of 10, 20, 40, and 80 μg/mL, respectively. The mycelia growth inhibition rate of AgNPs was 17, 78, 91, and 99 %, which were biosynthesized using *S. lavandulifolia* at concentrations of 10, 20, 40, and 80 μg/mL, respectively. The results clearly showed that the inhibition of mycelia growth is strongly depended in the concentration of AgNPs and growth inhibition increases by the increase of AgNPs concentration.

Compliance with Ethical Standards

Disclosure The authors report no conflicts of interest in this work.

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