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Research Article

Green Synthesis of Gold Nanoparticles Using Extract of *Pistacia chinensis* and Their *In Vitro* and *In Vivo* Biological Activities

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The synthesis of metal nanoparticles by using plant extracts is previously explored in phytomedicines. Nanobiotechnology has many applications, including cosmetic, packing, coating, biomedicine, and enhanced biological activity. Keeping in view the importance of *Pistacia chinensis*, its gold nanoparticles (AuNPs) have been synthesized by the eco-friendless and cost-effective method. In this study, the synthesized nanoparticles were characterized by advanced techniques such as UV-visible spectroscopy, Fourier transform infrared (FT-IR), and atomic force microscope (AFM) analysis. The biological activities of these synthesized nanoparticles were examined *in vitro* by measuring the enzymatic inhibition potential on urease and carbonic anhydrase and *in vivo* by determining the analgesic and sedative activities. The UV spectrum indicated various peaks at the range of 530-550 nm, showing nanoparticles formation. The FT-IR spectroscopy of the extracts and AuNPs indicated the presence of NH, C=N, and N=O in the extract involved in the nanoparticles synthesis. The size of nanoparticles was determined by AFM analysis. The AFM showed that the nanoparticles range from 10 to 100 nm and are almost spherical in shape. The synthesized AuNPs exhibited significant urease inhibition potential with an IC_{50} value of 44.98. Similarly, the nanoparticles exhibited good carbonic anhydrase inhibition with an IC_{50} value of 53.54 against acetazolamide having IC_{50} 0.13. *Pistacia chinensis* extract and its AuNPs exhibited excellent attenuation $p < 0.01$ in acetic acid-induced writhing model at a dose of 15 mg/kg. The synthesized nanoparticles showed a significant sedative effect $p < 0.001$ compared to the standard drug. This research work has developed a green method to synthesize nanoparticles by using *Pistacia chinensis* extract and directed the researcher to purify active phytochemicals from *Pistacia chinensis* involved in nanoparticles synthesized.

1. Introduction

Application of nanotechnology has found to be of significant importance in different fields such as imaging, sensing, and biomedical sciences [1–4]. It has also a broad-spectrum usage in several areas including cosmetics, energy, electronics, food, agriculture, and biomedicine [5–7]. Nanotechnology has attained attention in medical sciences because of its role in plant, animal, and human health which led to many applications in the field of medicine [1, 8]. Examples of these include controlled delivery of drugs, electroluminescent, imaging, detection, destruction of tumor, cancer diagnosis, and tissue engineering [9–15].

Nanoparticles (NPs) are a novel technique used in the field of medical sciences which has been shown to have promising results [16]. Extensive researches have revealed the importance of NPs in medicine owing to their role in catalytic degradation [17], antiviral [18], antibacterial [19], anticancer [20], antidiabetic [21], and wound healing [22].

Different physical, chemical, and biological approaches are used to synthesize NPs [16]. The most commonly used metals to synthesize NPs are platinum, palladium, silver, and gold [23]. Among these common metals, gold is possessing a high ionic conductivity, and synthesized gold nanoparticles (AuNPs) can be adjusted based on their surface state, shape, and size [18, 21, 23–27].

Biological derived NPs are shown to be sustainable, effective, safe, and cost-efficient [28–30]. Metals are used for the synthesis of NPs [26, 31, 32] from different resources such as bacteria, algae, fungi, and plant extracts [33–38].

Among these resources, metallic NPs prepared from natural plant materials have different biological activities, owing to their altered features such as small particle size, enhanced surface area, and varied shape [30, 33, 34, 39, 40].

Pistacia chinensis Bunge, also known as Chinese pistache, is a well-known member of the family Anacardiaceae [41]. It is distributed in many places such as Pakistan, India, China, the Philippines, North America, and Taiwan [42]. It is a deciduous tree having characteristics of a rounded crown [43]. Foliage comprises of compound, dark green leaves, which are aromatic when bruised [44]. Pistacia genus consists of 11 species. It has previously been showed that *Pistacia chinensis* can be used to treat various diseases such as asthma, fever, cough, and respiratory disease [44, 45]. In various countries, its seeds are used as an oil material [46]. Various secondary metabolites such as flavonoids and phenolic compounds have been reported from various parts of *Pistacia chinensis* [46]. Two 4-arylcomarin moieties (neoflavone) dimers have been reported from *Pistacia chinensis* with excellent estrogen-like properties [47]. Various phenolic compounds such as digallic acid, gallic acid, quercetin, quercetin-3-O(6″-galloyl)-β-D-glucosides, and 6-O-galloyl arbutin-quercitrin have been documented from the leaves of *Pistacia chinensis* [48]. Tender burgeons of *Pistacia chinensis* also reported the presence of a new pyrrolidone derivative [46]. *Pistacia chinensis* plant has been reported for excellent anti-inflammatory potency [49]. The compounds isolated from aerial parts of Pistacia *chinensis* have been reported for promising anti-HCV activity [50]. The chemical, which is isolated from the leaves of *Pistacia chinensis*, also possesses excellent antimicrobial potency [51].

Thus, keeping in view the significance of NPs in drug delivery and medicinal importance of *Pistacia chinensis*, the present work was aimed for the development, characterization, and evaluation of the biological efficiency of *Pistacia chinensis*-based gold nanoparticles (AuNPs). Purposely, both *in vitro* (enzyme inhibitory activities) and *in vivo* (sedative and antinociceptive properties) investigations were conducted in this study to determine the biological effectiveness of prepared *Pistacia chinensis* extract and its AuNPs.

2. Material and Method

2.1. Plant Collection. Pistacia chinensis Bunge seeds was kindly gifted from Dr. Abdur Rauf, Department of Chemistry, University of Swabi, KP, Pakistan. These plant seeds were collected from the ground of Hostel 2, University of Peshawar, KPK, Pakistan. The plant specimens were recognized by Dr. Muhammad Ilyas at Department of Botany, University of Swabi, KP, Pakistan. The voucher specimens were stored in Department of Botany, University of Swabi, KP, Pakistan.

2.2. Preparation of Extract. The obtained seed was dried in the shade for 20 days and was with water to remove the dust. After that, the dried seed was subjected to the grinder to obtain a powder. The powder plant material (1 kg) was soaked in methanol for 10 days to obtain a maximum number of polar secondary metabolites. The extract obtained was concentrated at low temperature and pressure with the help of a rotary evaporator, which afforded 18.9 g extract.

2.3. Synthesis of Nanoparticles. To synthesize gold nanoparticles, 2 mg of extract was transferred to 100 mL distilled water and dissolved to prepare stock solution of extract. Similarly, 1 mM stock solution of gold salt ($HAuCl_4$) was prepared for synthesizing nanoparticles of *Pistacia chinensis* seed extract. To reduce Au+3 into Au0, the extract solution was combined with a syringe to the slat solution in various ratios. The gold salt solution ($HAuCl_4$) was kept constant, and the extract concentration was changed (1 : 1; 1 : 2; 1 : 3; 1 : 4; 1 : 6; 1 : 8; 1 : 10; 1 : 12, etc.) and then stirred for 30 minutes at 40°C. Then, the solution was kept for stirring continuously for a period of 5 hours to optimize condition for formation on nanoparticles. The change in color indicates the formation of gold nanoparticles.

2.4. Characterization of Gold Nanoparticles. The synthesis of nanoparticles by reaction gold solution (1 mM) and *Pistacia chinensis* extracts at various concentrations was characterized by ultraviolet visible spectrophotometer spectroscopy (SP-3000 Plus, Japan), Fourier transform infrared (FT-IR), Prestige-21 (Shimadzu, Japan), atomic force microscope (AFM) (Agilent technology, USA), and clear change in color. Changes in the ration of plant extracts and gold salt intensity of the peaks changed to the visible region.

2.5. Animals. BALB/c mice were used in this study for *in vivo* screening with range of weight from 20 to 26 g. The mice were obtained from animal house facility of King Saud University, Saudi Arabia. After transferring the mice, they were reserved at room temperature in standard laboratory conditions at the College of Applied Medical Sciences, Qassim University, Saudi Arabia. They were served with standard food and water ad libitum. All the experiments were performed in this study following the guidelines of the National Research Council (US) Guide for the Care and Use of Laboratory Animals after being reviewed and approved by the Committee of Research Ethics, Deanship of Scientific Research, Qassim University, Saudi Arabia (Ethical Approval No. 21-09-07).

2.6. Enzyme Inhibitory Screening. Pistacia chinensis extract and its AuNPs were assessed for urease and carbonic anhydrase inhibitory by following the recently published method [52–57]. For urease inhibitory activities, the ammonia production after treating the samples with urea was measured via indophenol method. Thiourea was used in the urease inhibitory evaluation as a standard inhibitor. Concentration of *Pistacia chinensis* extract, gold nanoparticles of *Pistacia chinensis*, and standard inhibitor used in this experiment was 0.2 μg. Data were recorded after 50 minutes of incubation, and the formula used to determine the percent inhibition was the following:

$$\%\text{Inhibition} = 100 - (\text{OD test well}/\text{OD control}) \times 100 \quad (1)$$

Pistacia chinensis extract and synthesized AuNPs of *Pistacia chinensis* were tested also for carbonic anhydrase

inhibitory potential. A yellow-colored compound (4-nitrophenol) was produced during the test. The assay was done at room temperature, and acetazolamide was used in this experiment as a standard inhibitor. Concentration of *Pistacia chinensis* extract, gold nanoparticles of *Pistacia chinensis*, and standard inhibitor used in this experiment was 0.2 mM.

2.7. Analgesic Activity. *Pistacia chinensis* extract and its AuNPs was screened for analgesic activity by following the recently published procedure using a standard method [58–60]. Mice were divided into different groups in this study, and each group comprised six mice ($n = 6$). The weight of the mice ranged from 20 to 26 gram. One of the mice groups was treated with a standard drug called diclofenac as a dose of 10 mg/kg, i.p. Another group of the mice was administrated with normal saline at concentration (10 mL/kg i.p.), while the other groups of mice in this study received *Pistacia chinensis* extract at different doses (25, 50, and 100 mg/kg (i.p.)) and gold nanoparticles at different doses (5, 10, and 15 mg/kg (i.p.)). After the completion of treatment (40 minutes), acetic acid (0.9%) (*v*/*v*, 0.1 mL/10 g body weight) was used to induce the pain in the mice by intraperitoneal injection (i.p.). The muscle contraction was noted for every mouse in this experiment for a period of 10 minutes after injection of acetic acid.

2.8. Sedative Activity. *Pistacia chinensis* extract and its AuNPs were screened for sedative activity by following the recently published procedure [58, 59, 61]. The sedative activities of the extract were investigated in this study by using an open-field screening technique which was performed in a room with light and sound attenuated. All mice groups in the study were adapted and familiarized with the red light (40 W red bulb) with also water and food accessible ad libitum for 2 weeks before starting of the experiment. Normal saline was used as a negative control, and diazepam was used as a reference drug. One of the mice groups was treated with the plant extract at different doses (25, 50, and 100 mg/kg (i.p)), and another mice group was treated with gold nanoparticles at doses of 5, 10, and 15 mg/kg i.p. After that, each mouse in the current experiment was kept in the white wood arena in the center, and then, the number of lines crossed was counted for every mouse in each group of mice.

2.9. Statistical Analysis. Outcomes of the current research were presented as mean ± SEM (standard error of the mean). The level of significant differences ($p \leq 0.05$) between all the groups in this study was evaluated using one-way analysis of variance (ANOVA). Dunnett's multiple comparison test was performed for comparison purpose.

3. Results

3.1. Characterization of Gold Nanoparticles

3.1.1. UV-Spectroscopy. The results of UV-visible spectra indicate that gold nanosized nanoparticles were prepared successfully at various rations by recording peaks in the definite region for gold nanoparticles. Figure 1 indicates various peaks at the range from 530 to 550 nanometer showing different absorbance as a result of the different sizes of the synthesized AuNPs. In addition, the sharpness of the peak indicated the uniformity of AuNPs, and based on this information, it was observed that the peak for AuNPs (1 : 4) showed the highest absorbance by considering the peak height from the baseline of the spectrum. This was the indication to the presence of greater concentration of AuNPs in the solution, while other peaks presented also in Figure 1 showed lower peak height (measured from the baseline of spectrum) and broadness which can reveal the presence of a greater number of nonuniform AuNPs in the solution. Thus, the ratio (1 : 4) was used in the current study for the preparation of the bulk solutions for further investigations.

3.1.2. Kinetic Study of AuNPs. Results for the kinetic study of the synthesis of AuNPs are indicated in Figure 2. It was observed that the number and uniformity of nanoparticles increased with the passage of time.

3.1.3. Stability towards pH. The pH of AuNP solution was adjusted in the current study between 1 and 14 to evaluate the effect of varied pH on the stability of AuNPs as shown in Figure 3. The solution was kept at room temperature for 24 hours, and its affect was determined by recording UV-visible spectrum. Results of the stability towards pH showed that AuNPs were more stable in pH between 3 and 12, while less stability was observed in pH between the range from 1 to 2 and from 13 to 14 indicating lower stability of the AuNP solution in acidic and basic conditions. Maximum stability was detected in this experiment at alkaline pH range of 8-10, while moderate stability of the AuNPs was noticed at pH range of 3 to 4 as in this range, the gold nanoparticles showed peak broadening. However, the removal of plant extract, considered as the stabilizer, from the gold surface to destabilize the nanoparticles can be the reason for the instability of AuNPs found at lower and higher pH. In addition, very low pH may cause the reoxidation of neutral AuNPs.

3.1.4. Stability towards NaCl. The effects of salt (NaCl) on AuNPs of *Pistacia chinensis* were examined in this current study by using varying concentration of the salt from 0.1 to 0.5 M on synthesized AuNPs. During the assay, the AuNPs (2 mL) were mixed with NaCl solution (1 mL) which have concentrations ranging from 0.1 to 0.5 M in order to find the salt effect. The UV-vis spectra were recorded after keeping the intermixed solution of salt and AuNPs for 24 hours. Results showed that the AuNPs start precipitating by increasing the salt concentration, and the solution becomes colorless at a high concentration of the salt as shown in Figure 4.

3.1.5. FT-IR Spectral Analysis. In the FT-IR spectrum (Figure 5) of *Pistacia chinensis*, multiple peaks were observed between 563 cm^{-1} and 3417 cm^{-1}. Furthermore, the green synthesis of AuNPs was confirmed by Fourier transform infrared (FT-IR) spectroscopy analysis in Figure 6, which exhibited different secondary metabolites present in extracts involved in the synthesis of gold nanoparticles (AuNPs). The FT-IR spectrum of extract and

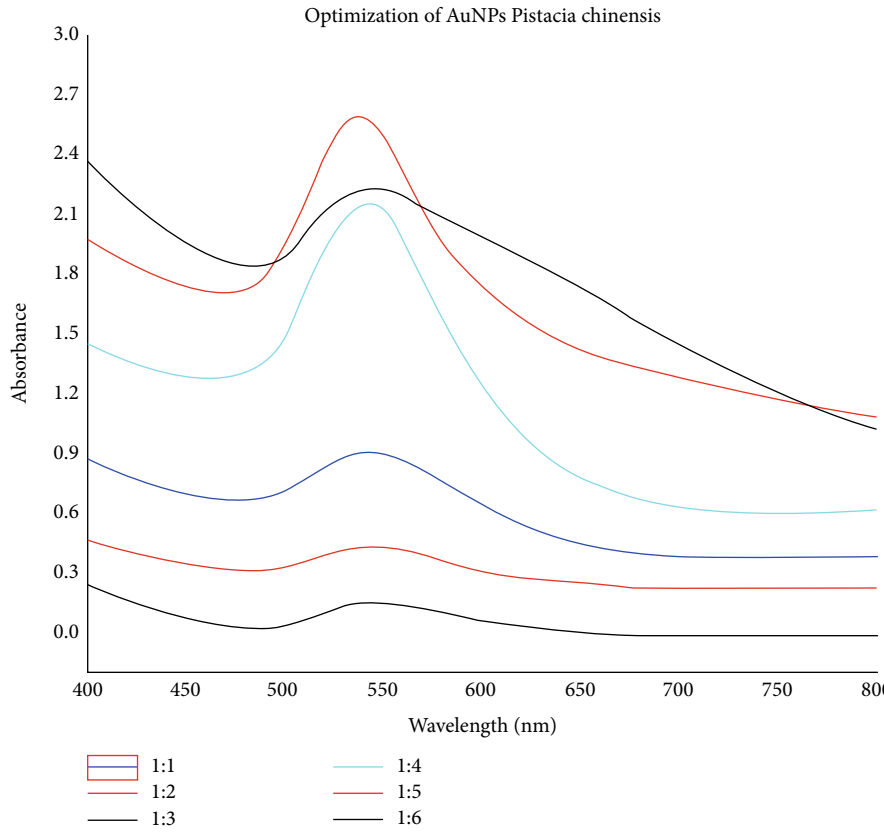

Figure 1: UV-visible spectra of gold nanoparticles prepared from *Pistacia chinensis* extract.

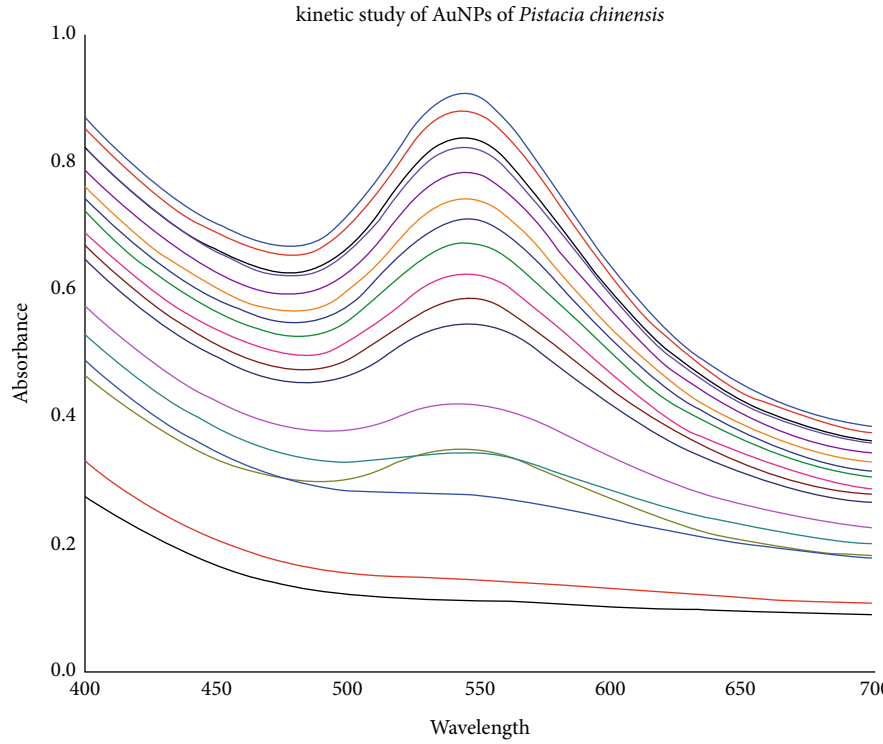

Figure 2: UV-visible data of kinetic study of AuNPs of *Pistacia chinensis*.

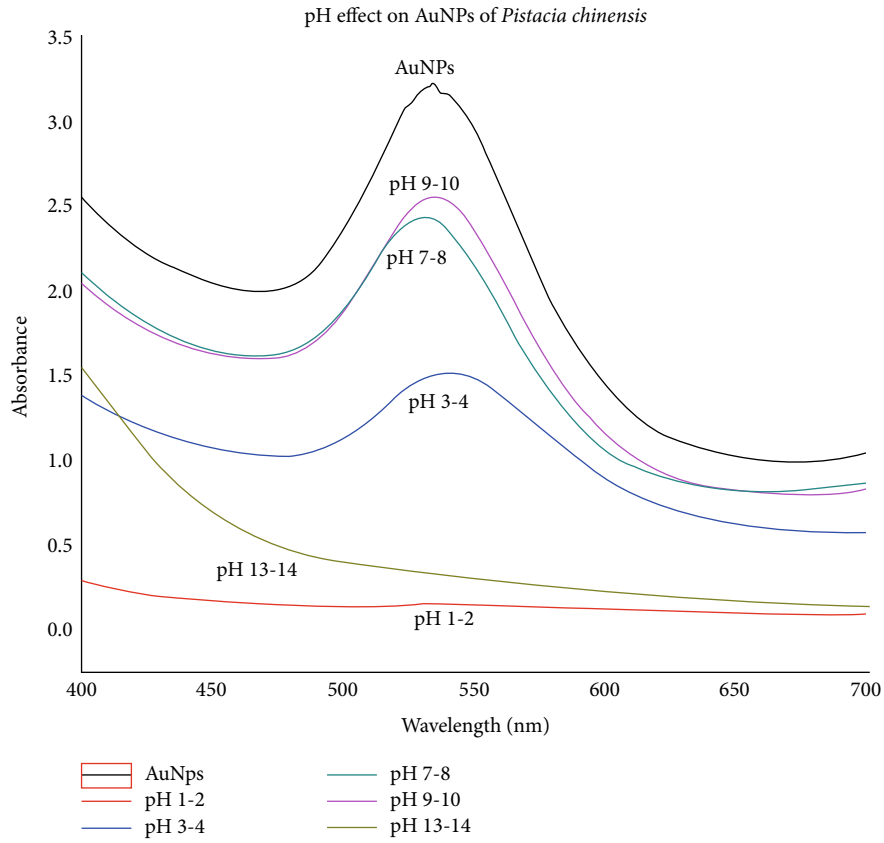

Figure 3: UV-visible data of pH effect on AuNPs of *Pistacia chinensis*.

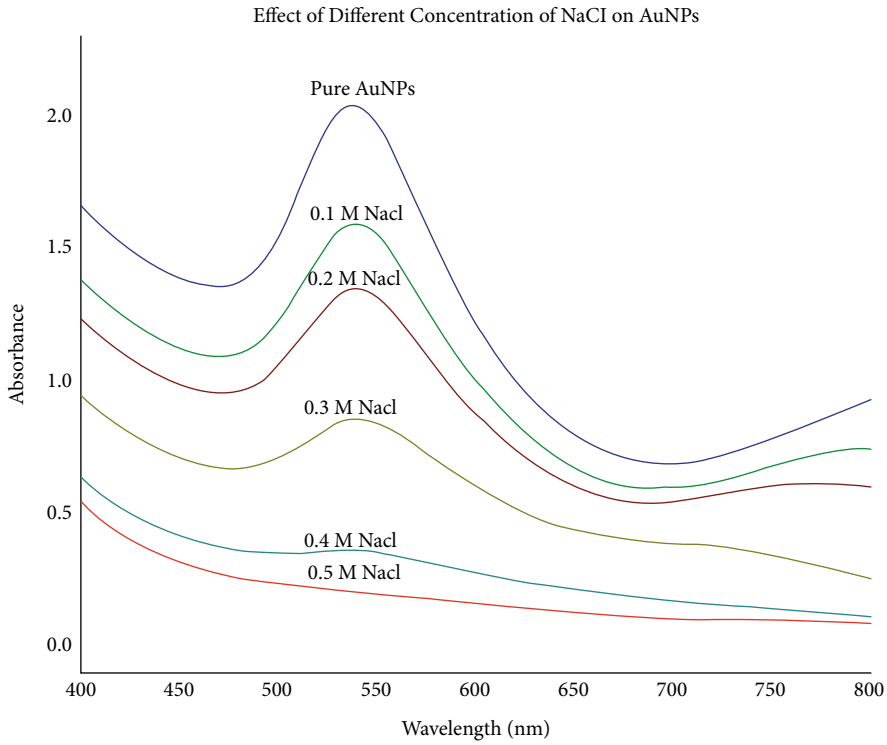

Figure 4: UV-visible data of effect of NaCl on *Pistacia chinensis* AuNPs.

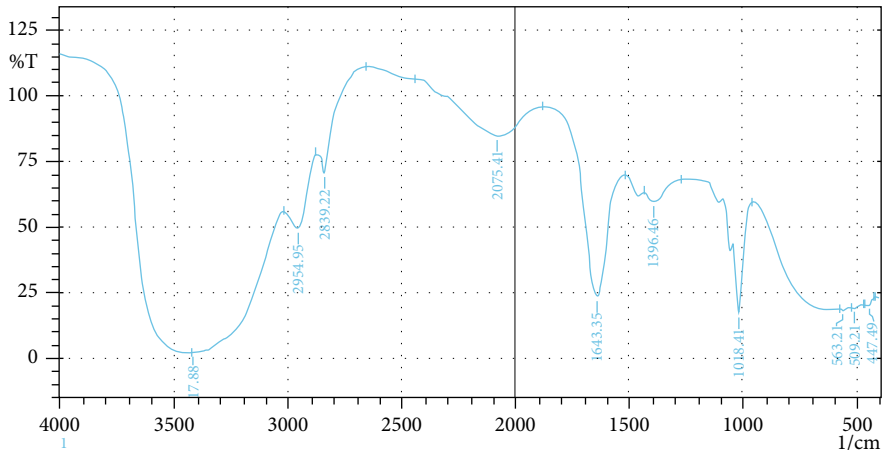

Figure 5: FT-IR spectral analysis of crude extract of *Pistacia chinensis*.

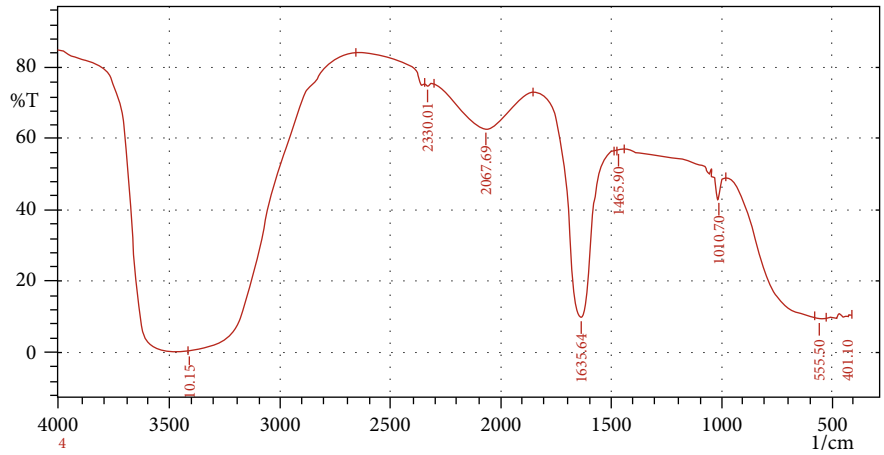

Figure 6: FT-IR spectroscopy of synthesize AuNPs of *Pistacia chinensis*.

synthesized nanoparticles exhibited a broad peak at 3417, 1643, 1386, and 1018 cm^{-1}, which indicated the presence of NH, C=N, and N=O in the extract. In AuNPs, these peaks change toward higher frequency, showing that these functional group are involved in the synthesis of nanoparticles.

3.1.6. Atomic Force Microscope (AFM) Imaging. Atomic force microscope (AFM) indicated the synthesized nanoparticles' morphology and size. The size range of gold nanoparticles of *Pistacia chinensis* ranges from 10 to 100 nm and is almost spherical in shape as shown in Figure 7.

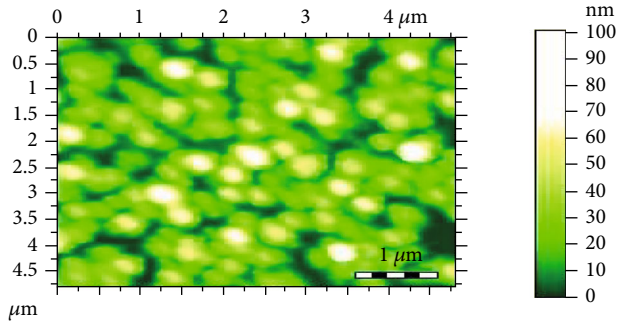

Figure 7: AFM image of AuNPs of *Pistacia chinensis* extract.

3.2. Enzyme Inhibitory Potential. The results of urease and carbonic anhydrase enzyme inhibitory potential of *Pistacia chinensis* extract and its AuNPs are given in Tables 1 and 2. The synthesized AuNPs exhibited significant urease inhibition potential with an IC_{50} value of 44.98 μg/mL and activity 92% as shown in Table 1.

Also, the extract and AuNPs exhibited moderate carbonic anhydrase enzyme inhibitory potential as compared to standard (acetazolamide). The nanoparticles exhibited carbonic anhydrase inhibition with an IC_{50} value 53.54 μg/

Table 1: Urease inhibitory activity of extract and AuNPs of *Pistacia chinensis*.

Tested samples	Concentration	% activity	IC_{50} (μg/mL)
P. chinensis extract	0.2 μg	47.65 ± 1.40	—
Gold nanoparticles (AuNPs)	0.2 μg	92.09 ± 1.54	44.98 ± 1.02
Thiourea	0.2 μg	97.87 ± 1.21	21.54 ± 0.12

Table 2: Carbonic anhydrase activity of extract and AuNPs of *Pistacia chinensis*.

Tested samples	Concentration	% activity	IC_{50} (μg/mL)
P. chinensis extract	0.2 mM	26.98 ± 1.32	—
Gold nanoparticles (AuNPs)	0.2 mM	76.43 ± 1.09	53.54 ± 0.32
Acetazolamide	0.2 mM	89.76 ± 1.00	0.13 ± 0.32

Table 3: Analgesic effect of *Pistacia chinensis* extract and its AuNPs.

Treatment	Dose (mg/kg)	No. of writhing in 10 mints
Saline	10 ml/kg	146.98 ± 3.09
Diclofenac sodium	10	83.00 ± 0.51***
	25	25.32 ± 1.98
P. chinensis extract	50	34.23 ± 2.09
	100	45.76 ± 1.76**
	5	58.09 ± 1.30**
Gold nanoparticles (AuNPs)	10	69.65 ± 1.08***
	15	78.09 ± 1.00***

Table 4: Sedative effect of *Pistacia chinensis* extract and its AuNPs.

Treatment	Dose (mg/kg)	No. of lines crossed in 10 mints
Saline	10 mL/kg	125.23 ± 1.09
Diazepam	0.5	5.23 ± 0.03***
	25	60.98 ± 2.66
P. chinensis extract	50	51.92 ± 2.34
	100	42.03 ± 2.98**
	5	56.65 ± 1.87**
Gold nanoparticles (AuNPs)	10	44.32 ± 1.34***
	15	35.54 ± 1.05***

mL, while the standard drug acetazolamide showed to have IC_{50} value 0.13 μg/mL (Table 2).

3.3. Analgesic Activity. The analgesic effect results of *Pistacia chinensis* extract and its AuNPs are given in Table 3. The AuNPs exhibited excellent attenuation ($p < 0.01$) in the acetic acid-induced writhing model at dose of 15 mg/kg. The extract also exhibited excellent effect ($p < 0.001$) at a higher dose as compared to standard drug (diclofenac sodium).

3.4. Sedative Activity. The results of the sedative effect for the different doses of *Pistacia chinensis* extract and its AuNPs are presented in Table 4. The synthesized nanoparticle showed a significant sedative effect ($p < 0.001$) compared to the standard drug (diazepam).

4. Discussion

Synthesized nanoparticles have multiapplication in cosmetics, packing, coating, biomedicine, etc. [3, 62]. These applications depend on prepared nanoparticles having uniform composition, size, shape, and stability [24, 63–65]. Medicinal plant-prepared nanoparticles gain key importance throughout the globe due to its eco-friendless and simplicity [8, 66, 67]. The plant contains bioactive compounds which have a strong capacity to reduce heavy metals [66, 68]. Many plants, including *Salix alba*, *Allium cepa*, *Crocus sativus*, and *Tropaeolum majus*, have been documented to synthesize metal nanoparticles [25, 64, 69–71]. In the present investigation, it is proved that the extracts of the title plant contain various classes of compounds that possess the capacity to reduce gold ion and produce stable nanoparticles.

The plant extract is acting as both reducing and stabilizing agents during the synthesis of nanoparticles and mixed with solutions of the metal precursor at different reaction conditions. The phytochemicals present in plants are responsible for bioreduction of nanoparticles. Sugars in plant extract can be responsible for the formation of metallic nanoparticles. Proteins found in plant extract with functionalized amino groups ($-NH_2$) can participate in the reduction of metal ions. The capping ligands play important role to stabilize the nanoparticles and prevent uncontrolled growth and agglomeration [72].

The synthesis of nanoparticles when the gold ion is exposed to extracts of title plant could be observed by changing color, followed by UV-visible spectroscopy. UV-visible spectroscopy is the preliminary technique to determine the formation and stability of NPs in an aqueous solution [8, 24, 27, 64]. The results of UV-visible spectra indicated that gold nanosized nanoparticles were prepared successfully at various ration by recording peaks in the definite region for gold nanoparticles. The UV spectrum indicated various peaks ranging from 530 to 550 nanometer showing different absorbances, which designated different size of synthesized AuNPs. The sharpness of the peak exhibited the uniformity of AuNPs. It was reported that UV-vis spectra for the AuNPs of alcoholic seed extract of black pepper exhibited many peaks at the range of 530 to 550 nanometer [24]. In addition, UV-vis spectra of saffron stigma-based AuNPs showed broad peaks and lower intensities at the wavelength of 540 nanometer [64].

Kinetic study of the synthesized nanoparticles showed that the number and uniformity of nanoparticles increased with the passage of time. This result is consistent with other data obtained from a recent study performed using AuNPs prepared from *Opuntia dillenii* aqueous extracts [8]. Furthermore, the prepared nanoparticles were more stable between the range of pH from 3 to 12, whereas lower stability of these prepared nanoparticles was noticed more in acidic and basic conditions, for example, in pH 1-2 and pH 13-14. The instability of AuNPs found at lower pH and higher pH in the current study can be attributed to the removal of stabilizer (extract) from the gold surface to destabilize the prepared NPs. Previous study showed that AuNPs had maximum stability at pH 10 using the extract of

Momordica charantia [73]. Salt effect on prepared nanoparticles showed that by increasing the concentration of salt, the stability of nanoparticles decreased. Similarly, Alhumaydhi et al. identified similar effects of salt stress on synthesized AuNPs prepared from saffron stigma [64]. Bawazeer et al. have also described similar stability findings of black pepper-based AuNPs in different concentrations of NaCl [24].

The FT-IR spectroscopy of the extracts and AuNPs indicated the involvement of the various functional group in the reduction of gold ions and formation of stable nanoparticles. FT-IR spectra of the extracts showed the presence of NH, C=N, and N=O in extract that are completely or partially involved in reducing gold ion and preparation of nanoparticles [74, 75]. The size AFM analysis showed that the nanoparticles range from 10 to 100 nm and are almost spherical in shape. Similar to this study, Uz-Zaman et al. described uniform distribution of AuNPs prepared using the *Trillium govanianum* Wall. Ex. Royle crude extract, reporting the spherical shape of NPs having a particle size between 6.5 and 65.5 nanometer [76]. Similarly, Sadeghi et al. revealed that the size of synthesized stevia leaf extract-based AuNPs was between 21 and 45 nanometer and was spherical in shape [77].

Pistacia chinensis extract and synthesized nanoparticles showed excellent urease and carbonic anhydrase enzyme potential. The synthesized AuNPs exhibited significant urease inhibition potential with an IC_{50} value of 44.98. Similarly, the nanoparticles exhibited good carbonic anhydrase inhibition with an IC_{50} value 53.54 against acetazolamide having IC_{50} 0.13. Many previous studies have reported different enzyme inhibition activities of different plant extracts and their AuNPs as compared to the standard [66, 69].

Pistacia chinensis extract and its AuNPs exhibited excellent attenuation ($p < 0.01$) in acetic acid-induced writhing model at dose of 15 mg/kg. The synthesized nanoparticle showed a significant sedative effect ($p < 0.001$) compared to the standard drug. Findings of the current work are in accordance with the outcomes of other recently published findings showing promising *in vivo* activities for different plant extract-based AuNPs [24, 64].

5. Conclusion

Synthesized NPs from natural products has gained significant importance in the field of nanotechnology because of their ecofriendly, safe, and efficient nature. The current study has developed a raid and green methods to synthesize nanoparticles by using *Pistacia chinensis* extract and evaluated the effectiveness of these biosynthesized AuNPs by conducting different *in vitro* and *in vivo* experiments. The size of prepared nanoparticles was from 10 to 100 nm and almost spherical in shape. The synthesized AuNPs exhibited significant urease and carbonic anhydrase inhibition potential with an IC_{50} values of 44.98 and 53.54, respectively. In addition, outcomes of this work concluded that biosynthesized AuNPs from *Pistacia chinensis* extract exhibited excellent attenuation $p < 0.01$ in acetic acid-induced writhing model at a dose of 15 mg/kg and also showed a significant sedative effect $p < 0.001$ compared to the standard drug. This research work directed the researcher to purify active phytochemicals from *Pistacia chinensis* involved in nanoparticles synthesized. More investigations should be performed to study and understand the probable mechanism of action associated with these activities.

Data Availability

The data produced has been included all in the main text of this paper.

Conflicts of Interest

The author declares no potential conflict of interest.

Acknowledgments

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