Research Article


Enhancement efficacy of omeprazole by conjugation with silver nanoparticles as a urease inhibitor

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Abstract: Omeprazole, a proton pump inhibitor, is used for gastric and duodenal ulcers, gastroesophageal reflux disease, Helicobacter pylori infection, etc. Current research is based on the loading of omeprazole on surface silver nanoparticles by chemical method. The appearance of an absorption peak at 421 nm confirmed the synthesis of nanoparticles. The FT-IR further confirmed the conjugation of functional groups present in omeprazole moiety with silver. The size and morphology were elucidated by transmission electron microscopy and X-ray diffraction which revealed a spherical shape with an average particle size of 16–20 nm. To know enhancement in their efficacy, the omeprazole-loaded nanoparticles were evaluated against antibacterial, urease inhibition, and antioxidant activities. Nanoparticles showed significant antibacterial potential against Staphylococcus aureus and Escherichia coli with $12 \pm 0.41$ and $13.6 \pm 1.02$ mm zones of inhibition, respectively. Almost 2.43 times enhanced urease inhibitory activity was found for nanoparticles ($IC_{50}=2.17 \pm 0.10 \mu g\cdot mL^{-1}$) as compared to omeprazole ($IC_{50}=5.28 \pm 0.14 \mu g\cdot mL^{-1}$). The radical scavenging activity of nanoparticles also increased significantly. The synthesized nanoparticles were docked in the active site of urease to investigate their binding mode. Due to excellent urease and bacterial inhibition, these nanoparticles can be used for ulcers.

Keywords: omeprazole, nanoparticles, chemical synthesis method, radical scavenging activity, urease inhibition

1 Introduction

Peptic ulcers are one of the most common gastrointestinal conditions affecting approximately 10% of the population across the globe. An imbalance between the gastro-protective factors such as mucus and antioxidant enzymes bicarbonate and secretion of acid and pepsin damages the mucosal membrane of the stomach and duodenum and results in life-threatening ulcers [1,2]. Approximately 15,000 fatalities are reported annually as a consequence of ulcers [3]. It has become one of the most widespread problems affecting 40% of developed countries and 80% of developing countries due to the indiscriminate use of non-steroidal anti-inflammatory disease and Helicobacter pylori infections [4]. Reactive oxygen species play a significant role in the etiology of peptic ulcers, as the free radical released from the neutrophils and monocytes can cause oxidative damage to the cells of gastric mucosa via lipid peroxidation and oxidation of proteins [5]. Using medications with antioxidant properties can be effective in the treatment of ulcers [6]. Antiulcer medications work by suppressing the secretion of gastric acid and stimulating the immune system by enhancing the secretion of mucin [7]. Antacids, $H_2$ receptor blockers, muscarinic antagonists, and proton pump inhibitors are used in the treatment of ulcers. However, the successful eradication of $H. pylori$ is essential for the treatment of peptic ulcers and avoiding its recurrence. Triple therapy containing two
antibiotics clarithromycin and amoxicillin or metronidazole along with proton pump inhibitors is currently being used as a standard treatment. However, over the past 10–15 years, due to the rising incidence of antibiotic resistance, notably with clarithromycin, the effectiveness of this triple therapy has considerably decreased. Consequently, there is a rising need of developing potential antiulcer agents for effective treatment of ulcers [8].

Omeprazole, a sulfanyl benzimidazole [9] is the first clinically approved member of unique antisecretory drugs, the proton pump inhibitors that control the secretion of gastric acid via irreversible inhibition of enzyme $\mathrm{H}^+$/K$^+$-ATPase located in the parietal cells of stomach [10,11]. It is found to be a potent inhibitor of gastric acid secretion for the treatment of gastroesophageal reflux disease, gastritis, Zollinger-Ellison syndrome, gastric and duodenal ulcers, H. pylori infection, and other associated hypersecretory disorders [12,13].

Omeprazole is susceptible to heat, light, and humidity and undergoes rapid degradation in acidic solutions [14]. Hence, its exposure to the acidic contents of stomach results in the inactivation of almost fifty percent of the dose leading to its poor bioavailability [15]. The most effective approach to prevent its degradation via stomach acid is to incorporate omeprazole into enteric-coated polymeric nanoparticles and extend its half-life [1]. Due to their small size, NPs can pass through the mucus layer and adhere to the underlying epithelium or the mucus network directly. Drug when administered in the form of mucoadhesive nanoparticles can reside in the stomach for a longer period of time and these adhesive interactions may increase drug’s bioavailability via number of mechanism [16]. Various omeprazole-loaded nanoparticles have been reported in literature including omeprazole-loaded cellulose acid phthalate nanoparticles [1], omeprazole-loaded gliadin nanoparticles [16], omeprazole containing eudragit chitosan nanoparticles [17], and omeprazole containing Bletilla striata nanoparticles (OME-BSP NPs) [18]. The OMP-NPs effectively prevented gastric mucosal lesions and have enhanced antiulcer activity as compared to omeprazole. The enteric-coated nanoparticles postpone the release of the medication because it is insoluble in acidic environments. [19]. Enhanced gastric mucosal defense through increased production of mucus and bicarbonate, decreased gastric acid secretion volume, or simply neutralizing the gastric acidity are some of the mechanisms that mediate the protection of the gastric mucosa against acid production [14].

It has been demonstrated that metallic nanoparticle conjugation with antibiotics offers promising outcomes in the treatment of infectious diseases. The effectiveness of antibiotics could be increased by combining them with NPs [20,21]. Among metallic NPs, silver nanoparticles are well known for their broad spectrum activities [22]. The environmentally friendly manufacturing of silver nanoparticles is emerging as a novel and effective approach to the treatment of gastrointestinal ulcers [6]. Various sources were used for the synthesis of silver nanoparticles for the antiulcer activity. The AgNPs synthesized from Glycyrrhiza glabra root extract were found to have antiulcer activity [23]. Similarly, Solanum xanthocarpum extract-loaded silver nanoparticles were proven to have antibacterial and urease inhibitory properties against H. pylori [24].

The AgNPs synthesized from the seeds of Anethum graveolens were tested against proton pump (H$^+$/K$^+$-ATPase) inhibition and they were found to have inhibitory potential against the enzyme establishing proton pump inhibition by AgNPs [25].

Omeprazole and silver nanoparticles are well known for their antiulcer activities. Literature has revealed that a combination of drugs with nanoparticles may enhance their therapeutic potential as compared to drugs and NPs alone. Current research aims at synthesizing silver nanoparticles of omeprazole by chemical reduction method. To the best of our knowledge, this is the first study reporting the synthesis of omeprazole-loaded silver nanoparticles and their urease inhibition, antioxidant, and antibacterial activities against Staphylococcus aureus and Escherichia coli.

2 Materials and methods

2.1 Materials

The chemicals and solvents including AgNO$_3$, sodium hydroxide, HCl, sodium borohydride (NaBH$_4$), and methanol used for the synthesis were of analytical grade and purchased from Sigma Aldrich; vendor Musaji, Abbottabad, Pakistan. Nutrient agar was purchased from Oxoid Ltd, Basingstoke Hampshire, UK. The DPPH powder and the urease enzyme were purchased from Alfa Aesar and Sigma Aldrich, vendor Musaji, Abbottabad, Pakistan, respectively. UV–Vis spectra were recorded on Spectromax M2 (COMSATS University Islamabad Abbottabad Campus). For pH adjustment, a pH meter (Combo pH/EC/TDS Testers HANNA Instrument) was used.

2.2 Synthesis of nanoparticles

Omeprazole-loaded silver nanoparticles were synthesized via chemical reduction method. Around 16.9 mg of AgNO$_3$
was dissolved in 100 mL of distilled water to prepare 1 mM solution of silver nitrate and the solution was kept in dark to prevent light exposure. Similarly, 34.54 mg of omeprazole was dissolved in 100 mL of methanol to prepare its 1 mM solution. After mixing the drug and salt solution no significant color change was observed, so 2–3 drops of NaBH₄ (40 mM) were added to the solution which produced rapid variation in the color of solution indicating the formation of silver nanoparticles which was further confirmed by UV–Vis spectrophotometer.

2.3 Optimization of nanoparticles

The reaction was optimized by mixing different concentrations of silver nitrate and omeprazole to achieve optimum drug-to-metal ratio for the synthesis of nanoparticles. The ratio at which the maximum formation of nanoparticles occurs can be achieved by optimization. In this study, the concentration of drug was fixed whereas the volume of silver nitrate was varied. The ratio that gave the highest absorption peak was selected for the synthesis of nanoparticles.

2.4 Stability of NPs

After synthesis, the stability of NPs was tested against different pH (2–13), temperature range (25–100°C), and brine solution (0.5–2 M). The NPs were kept at room temperature and after 24 h, UV–Vis spectra were recorded; any change in the intensity of absorption provides information about the stability of nanoparticles.

2.4.1 pH stability test

The synthesized nanoparticles were exposed to different pH ranges (2–14) to examine their stability in extremely acidic, basic, and neutral conditions. The pH meter (Combo pH/EC/TDS Testers HANNA Instrument) was used to measure the different pH (2–14) of nanoparticle solution. The acidic and basic conditions were developed by using 0.5 M solution of HCl and NaOH in 10 mL of silver nanoparticle solutions. The solutions were kept for 24 h and later, the stability was confirmed through a decrease in absorbance by the UV–Vis analysis.

2.4.2 Heat stability test

The heat stability of omeprazole-loaded AgNPs was checked by heating the reaction solutions at different temperatures, i.e., 25°C, 50°C, 75°C, and 100°C for 30 min [26]. Around 15 mL of freshly prepared nanoparticle solution was taken in four separate beakers and heated at different temperatures for 30 min to check the heat stability of nanoparticles and UV–Vis spectra were recorded. The change in the absorption intensity provides data about the stability of synthesized AgNPs at different temperatures.

2.4.3 Brine stability test

The stability of synthesized omeprazole-loaded silver nanoparticles was determined against different concentrations of brine solutions. The 4 mL of freshly prepared Omp-AgNPs were taken in four separate vials. Then, 2 mL of 0.5, 1, 1.5, and 2 M solutions of NaCl were added to the solution of NPs. The resulting mixture was thoroughly mixed and kept at ambient temperature. UV–Vis spectra were recorded after 24 h. Change in the absorption give information about the nanoparticles’ stability.

2.5 Characterization of NPs

2.5.1 FT-IR spectroscopy

FT-IR analysis was used to detect the functional moieties present in drugs and their interaction with the metal surface in drug-loaded silver nanoparticles. IR spectra of samples were obtained by Cary630, Agilent Technologies, USA.

2.5.2 X-ray diffraction (XRD) analysis

Crystallographic study of AgNPs was performed by the X-ray diffractometer (JDX-3532, JEOL, Japan) operated at the voltage of 20–40 kV having 2θ range 5–80°.

2.5.3 EDX spectroscopy

The compositional analysis of nanoparticles was carried out by EDX (JSM-5910, JEOl, Japan) having 30 kV energy.
2.5.4 Transmission electron microscopy (TEM)

The size and shape of synthesized omeprazole-loaded silver NPs were evaluated using a TEM (JEOL, Model JEM-1400) operated at a voltage of 110 kV. Samples were prepared for the TEM examination by coating the solution of silver nanoparticles on copper grids coated with carbon.

2.6 Biological potential of NPs

2.6.1 Urease inhibition protocol

In vitro urease inhibition assay of omeprazole-loaded nanoparticles was performed in a 96-well plate by the Berthelot method with few modifications. 25 µL phosphate buffer (pH 7), 10 µL enzyme solution of urease, and 10 µL of test compounds were added to the wells and incubated at 37°C for approximately 10 min. Then, 40 µL urea solution was added to these wells and further incubated for 10 min. Afterwards, the constituents were pre-read using ELISA microplate reader at 625 nm. Then, 45 µL phenol reagent was added to each well followed by the addition of 70 µL alkali reagent. The incubation was continued for 10 min and absorbance was measured. The % inhibition was calculated by using the following formula [27].

\[
\% \text{ Inhibition} = 100 - \frac{\text{Absorbance of test compounds}}{\text{Absorbance of control}} \times 100.
\]

Five dilutions of test samples were prepared and their % inhibitions were determined. The data obtained were used to calculate IC50 values using graphpad prism [29].

2.6.2 Antioxidant activity

The radical scavenging potential of nanoparticles was evaluated by the DPPH method. The 100 mM DPPH solution was prepared in HPLC-grade methanol. 50 µL of DPPH was added to the 50 µL of test compound. The mixture was incubated at room temperature for approximately half an hour and the absorbance was measured at 517 nm [28]. The t-BHA was used as a standard throughout the experiment. The % scavenging activity was measured by using the following formula:

\[
\% \text{ RSA} = 100 - \frac{\text{Absorbance of test compounds}}{\text{Absorbance of control}} \times 100.
\]

Five dilutions of the test samples along with standard were prepared and their % RSA was measured and data were used to find IC50 values using graphpad prism [29].

2.6.3 Antibacterial screening

The antibacterial potential of drug-loaded nanoparticles was screened against two clinically isolated bacterial strains namely S. aureus (ATCC 6538) and E. coli (ATCC 10536) by agar well diffusion method. The 100 µL of bacterial suspension having a concentration of 10^6 CFU·mL⁻¹ was spread on the agar petri plate. By using cork borer four wells of equal size of approximately 6 mm and distance were made in the Petri plate and 20 µL test compounds of the desired concentration were added into each well along with positive control (Ciprofloxacin) and negative control (DMSO). The plates were incubated for 24 h at 37°C. After incubation, the zone of inhibition was measured [29].

2.6.4 Statistical analysis

One-way analysis of variance (ANOVA) with post hoc Bonferroni test (Haris et al. 2023) was employed to determine significant differences between the ureases and antioxidant activities of different test substances at the significance level (\(\alpha = 0.05\)). Independent samples t-test was used to compare the anti-bacterial activity of two samples. The statistical analyses were performed using SPSS 20 (IBM, USA) computer software [30].

2.7 Molecular docking studies

A molecular operating environment (MOE) [31] was used to investigate the binding interaction of synthesized compounds with the active site of urease and xanthine oxidase. X-ray crystal structure of urease (PDB ID: 4GOA [32]) retrieved from the Protein Data Bank was used as a starting structure for docking. Co-crystalized ligands and heteroatoms were removed and docking was carried out using MOE software. The structures of the synthesized compounds were drawn by using Chem Office 3D (2015) and their energy was optimized using Gaussian 09 employing the B3LYP density functional theory method with a 6-311G basis set [33]. Initial optimization of the protein structure was done using MOE software followed by molecular docking studies. Ten of the lowest energy poses were
generated for compounds. A Discovery visualizer was used to determine the 2D and 3D models of docked compounds.

3 Results and discussion

3.1 Synthesis of nanoparticles

A solution of AgNO₃ (1 mM) and omeprazole was prepared in distilled water and methanol separately. Equal quantities of both the solutions were mixed together and kept on stirring at room temperature. No significant color change was observed after mixing as apparent with the naked eye. After 30 min, 2–3 drops of NaBH₄ were added to the reaction mixture. A change in the color from transparent to dark brown was observed immediately after the addition of NaBH₄ indicating the reduction of silver. The stirring was continued for up to 4 h to allow the complete reduction of silver ions for the completion of reaction. The appearance of peak at 421 nm confirmed the synthesis of omeprazole-loaded AgNPs. For the recovery of nanoparticles, the reaction mixture was centrifuged at 8,000 rpm for approximately 30 min at room temperature and washed with distilled water twice to remove the excess ions and unreacted drug. The UV–Vis spectrum (spectrophotometer BMS [UV-1602] Canada) was recorded to confirm the formation of nanoparticles (Figure 1).

3.2 Reaction optimization

The reaction mixture of Omp-AgNPs was optimized using different drug-to-metal ratios and stored for 24 h to assess their stability under the given conditions. The ratio 1:3 (Omp:AgNO₃) corresponds to the highest absorption peak in UV–Vis spectra as shown in Figure 2. Further increase in the concentration of salt led to a decline in the intensity of absorption which confirmed the decomposition and instability of nanoparticles indicating that a certain amount of salt was necessary for the optimum synthesis of NPs. The optimal ratio for the large-scale production of nanoparticles showing maximum absorption in UV–Vis spectra was ratio 1:3.

3.3 pH stability of AgNPs

pH has a significant impact in controlling the size of nanoparticles by altering their surface charge and particle

![Figure 1: UV–Vis spectra of Omeprazole loaded AgNPs.](image1)

![Figure 2: Optimization of Omp-AgNPs.](image2)

![Figure 3: pH stability of AgNPs.](image3)
interaction [34]. The stability of synthesized Omp-AgNPs was examined at different pH values ranging from 2 to 13 by using 0.5 M HCl and NaOH solutions as shown in Figure 3. Omp-AgNPs were found to be slightly acidic in nature having a pH in the range of 6–7. The nanoparticles were stable at a slightly acidic, neutral and slightly basic medium. The red shift in the wavelength was observed at pH 4–5 due to an increase in particle size [35]. The pH 6–7 corresponds to the highest absorption peak in the UV–Vis spectrum indicating the maximum formation and stability of nanoparticles having small size. However, AgNPs were unstable at extremely acidic and basic conditions. The chloride ions were responsible for the destabilization of nanoparticles in highly acidic conditions having pH 2–3 [36], whereas instability of AgNPs in the basic medium can be associated with the destabilization caused by sodium ions, resulting in the agglomeration of nanoparticles due to increase in particle size.

3.4 Heat stability test of NPs

The effect of heat on synthesized nanoparticles was examined at elevated temperatures to ascertain their thermal stability and optimal temperature for nanoparticle synthesis. The AgNPs were heated at different temperatures, i.e., 25°C, 50°C, 75°C, and 100°C for 30 min and their UV–Vis spectra were recorded. The spectra of heated NPs indicate a decrease in absorption intensity with an increase in temperature confirming the destabilization of nanoparticles at high temperatures as represented in Figure 4. This instability of AgNPs is associated with the dephasing of electrons [37].

3.5 Brine stability test

The addition of an electrolyte causes the agglomeration of nanoparticles, which makes them unstable [38]. The NaCl solutions of varying concentrations (0.5, 1, 1.5, and 2 M) were mixed with Omp-AgNPs to assess the effect of electrolyte solution on synthesized nanoparticles. The absorbance of these mixtures was determined by using UV–Vis spectrometer as represented in Figure 5. The findings indicate that nanoparticles were unstable at all the concentrations of brine solution. The instability of Omp-AgNPs in the presence of NaCl is due to the aggregation effect promoted by chloride ions [37].

3.6 FT-IR spectroscopy

The FT-IR spectra of omeprazole and Omp-AgNPs were compared to identify the functional groups involved in the interaction with silver metal. The peak observed at 3,057 cm⁻¹ corresponds to aromatic C–H, the absorption band for stretching vibration of C=N was observed at 1,626 cm⁻¹, the band at 1,406 cm⁻¹ is due to the CH bending, the peak at 1,205 cm⁻¹ corresponds to the stretching of alkyl aryl ether, and the strong absorption peak at 1,012 cm⁻¹ is assigned to the S=O stretching [39]. A decrease in the intensity and shift in absorption position of bands corresponding to C=N, OCH₃, and S=O in the spectra of
nanoparticles (Omp-AgNPs) indicates the involvement of these groups in bonding with silver. The FT-IR spectra of omeprazole and Omp-AgNPs are represented in Figure 6. The mechanism of omeprazole’s interaction with AgNPs is presented in Figure 7. S=O and C==N groups of omeprazole are involved in the structural stabilization of AgNPs (Table 1).

### 3.7 XRD analysis

The phase, crystal structure, and crystallite size of synthesized nanoparticles were examined by XRD analysis. The XRD spectrum of Omp-AgNPs showed diffraction peaks at 38.05, 44.04, 64.37, and 77.36° [40]. These peaks correspond to the (111), (200), (220), and (311) planes of cubic crystal lattice (correlated to ICSD file # 064994). The average particle size of nanocrystal calculated using Debye Scherrer equation was found to be 17 nm (Figure 8).

### 3.8 EDX spectroscopy

The elemental composition of chemically synthesized drug loaded AgNPs was examined by EDX analysis. EDX profile of Omp-AgNPs displayed a very strong signal in silver region which confirms the formation of omeprazole-loaded AgNPs. The optical absorption peak for the nanocrystals of metallic silver (72.97 wt%) was observed at about 3 keV due to...
to SPR as shown in Figure 9. The additional peaks at 0.25, 0.5, and 2.3 are the characteristic signals for carbon, oxygen, and sulfur, respectively. The presence of these peaks in the spectrum of nanoparticles confirmed the presence of omeprazole moiety bound on the surface of AgNPs.

3.9 TEM

The shape and particle size of omeprazole-loaded silver nanoparticles were determined by TEM analysis as shown in Figure 10. TEM image was recorded at different magnifications of 50 and 100 nm. The Omp-AgNPs were polydispersed agglomerates, small in size, and predominantly spherical in shape. The particle size of AgNPs was calculated using ImageJ software. The size of nanoparticles was in the range of 12–24 nm with an average particle size of 17 nm (Figure 11). Results obtained from the TEM are in agreement with XRD.

3.10 Urease inhibition assay

The Omp-AgNPs were evaluated for in vitro urease inhibition potential to examine their activity against enzyme urease by following standard protocol. The formulation of omeprazole in the form of nanoparticles significantly enhanced its inhibitory potential against enzyme urease.

Figure 9: EDX profile of Omp-AgNPs.

Figure 10: TEM image of synthesized Omp-AgNPs at different magnifications of 50 and 100 nm.
as compared to drug alone (Table 2). The percent inhibition of nanoparticles was 80.23% while that of omeprazole is 69.45%, and IC₅₀ values for Omp-AgNPs and omeprazole are 2.17 ± 0.10 and 4.02 ± 0.15 respectively, which shows nanoparticles are highly active against urease. Thiourea was used as a standard inhibitor of urease during the experiment. It showed 93.3% inhibition of enzyme with an IC₅₀ value of 18.1 ± 0.22.

### 3.11 Antioxidant activity

The radical scavenging potential of omeprazole and its nanoparticles was performed by the DPPH method. The development of antioxidants for the treatment of oxidative stress-related disorders has been promoted by extensive research on the protective role of antioxidants against these disorders [41]. Antioxidants react with DPPH and convert it into diphenylpicrylhydrazine (DPPH-H) due to its hydrogen and electron-accepting capability. The radical scavenging potentials of the antioxidant can be determined by the degree of discoloration [29]. The results showed higher scavenging activity for nanoparticles as compared to omeprazole as shown in Table 3. % RSA of omeprazole was 72.21% whereas AgNPs were 84.45%. The IC₅₀ value of omeprazole is 18.7 ± 0.17 while that of Omp-AgNPs is 5.28 ± 0.14 which is less than omeprazole. This shows that nanoparticles are more effective as compared to omeprazole. Tertiary butylated hydroxy anisole (t-BHA) used as a reference showed 89.56% RSA with an IC₅₀ value of 58.76 ± 0.45.

### 3.12 Antibacterial activity

The antibacterial potential of omeprazole and its nanoparticles (Omp-AgNPs) was evaluated against two bacterial pathogens (e.g., *S. aureus* and *E. coli*) as shown in Table 4. The results revealed that omeprazole is ineffective against both the strains at conc. of 1 mg·mL⁻¹ with no zone of inhibition as shown in Figures 12 and 13. The omeprazole-loaded AgNPs showed immense antibacterial activity as compared to drug. AgNPs were more effective against *E. coli* with 13.6 mm ± 1.02 zone of inhibition, whereas zone of inhibition against *S. aureus* was 12 mm ± 0.41. The results indicate that AgNPs can be a substitute for antibacterial agents as compared to drugs.
3.13 Hotspot mapping of active pocket

The crystal structure of urease reveals various key residues that are involved in the binding pocket and allow the inhibitor to retain within the active site. These includes Ni–metal atom, sheet S23 (residues 403–409 color-coded yellow) a small loop L30 (410–412 color coded blue), helix
H14 (435–441 color coded brown), loop L37 (444–454 color coded red), helix H20 (580–593 color coded green), loop L39 (594–598 color coded cyan), helix H21 (599–610 color coded pink), and a loop L41 (632–638 color coded orange) (Figure 14).

The complex of omeprazole interacts with the active site along with the binding energy of $-7.76 \text{ kcal}\cdot\text{mol}^{-1}$. It binds into the active site of the protein by the interaction of Ni–metal to form a complex with the oxygen atom of the omeprazole complex. Hydrogen bond interactions were observed between the complex and His492, CME592, ASP633, Ala636, Glu525, His594, and His593 amino acid residues. Asp494 interacts through pi–sulfur interaction with the complex. Some pi–alkyl and pi–pi interactions were observed between the complex for the retention of the complex molecule in the active pocket of the urease (Figure 15).

4 Conclusion

The chemical approach is one of the simple, fast, low-cost, and effective approaches for the synthesis of nanoparticles. Omeprazole-loaded AgNPs were synthesized by using a chemical method. Characterization of NPs was done by advanced analytical techniques including UV–Vis, FT-IR, EDX, XRD, and TEM analysis. The FT-IR studies confirmed that S═O, C═N, and OCH$_3$ groups of omeprazole are responsible for the stabilization of silver nanoparticles. XRD studies revealed that nanoparticles were crystalline in nature with cubic crystal structure. Elemental composition and weight percent of AgNPs were studied by EDX analysis. Silver was present as a major constituent in omeprazole-loaded silver nanoparticles. The TEM analysis revealed that Omp-AgNPs were spherical in shape having the particle size in the range of 16–20 nm. The antibacterial potential of nanoparticles was evaluated against two bacterial strains namely $S. \text{ aureus}$ and $E. \text{ coli}$ by agar well diffusion method and NPs showed significant activity against both the strains as compared to omeprazole. The DPPH assay was used to evaluate the antioxidant potential of nanoparticles, % RSA of Omp-AgNPs is 84.45%, which is 1.16 times higher than omeprazole. Urease inhibition of nanoparticles was determined by following standard protocol. The Omp-AgNPs showed 80.23% inhibition against urease which is 1.15 times higher as compared to omeprazole. The silver nanoparticles have shown considerable potency when compared to the original drug. Further optimization of the synthesized nanoparticles may lead toward even better results which may lead toward the initiation of preclinical trials on the synthesized nanoparticles. Furthermore, conducting the toxicity studies of synthesized products adds to the future perspective of this project. It can safely be said that the urease inhibition potential of Omp-AgNPs signifies them as potential lead compounds for the development of relevant therapies to address damages caused by $H. \text{ pylori}$ in clinically sick patients.

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