Original Article

Exploring the potential of *Rosa chinensis, Rosa cymosa,* and *Rosa indica* in oral disease prevention: A multifaceted approach

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Abstract

Introduction: Rose species that are well-known for their therapeutic qualities include *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*. The study employs *in vitro* assays and *in silico* molecular docking to investigate their phytochemical composition and antioxidant properties.

Methods: Phytochemicals were detected in flower petals of *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica* that had been extracted using methanol. Ascorbic acid was utilised as the standard reference for assessing antioxidant activity and its hydrogen peroxide scavenging potential. Superoxide dismutase (SOD) interactions with berberine, emodin, and limonene were assessed by molecular docking using PyRx software.

Results: Various beneficial substances were found in all species according to phytochemical investigation. Among the three Rosa species, *R. chinensis* demonstrated the highest antioxidant activity, followed by *R. cymosa* and *R. indica*. Docking studies demonstrated that berberine and emodin had substantial binding affinity with SOD. The extracts showed strong antioxidant properties, suggesting that they could be used as naturally occurring antioxidants.

Conclusions: *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica* show promise as medicinal plants and have strong antioxidant properties. The results validate the development of these rose species as naturally occurring antioxidants for the treatment of ailments related with oxidative stress.

Keywords: Molecular docking, oxidative stress, *Rosa chinensis*, *Rosa cymosa*, *Rosa indica*

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INTRODUCTION

Several species in the Rosaceae family, which includes the genus Rosa, are used in food, medicine, and ornamental gardens. Among these species, *Rosa indica*, *Rosa chinensis*, and *Rosa cymosa* are well known for their unique phytochemical compositions and possible health advantages. Due to a rich spectrum of bioactive components, including as flavonoids, tannins, and phenolic acids, these species are especially prized for their antioxidant capabilities. Antioxidants are essential because they counteract free radicals, which lessen oxidative stress and lower the risk of chronic illnesses like cancer, heart disease, and neurological problems.[1]

The therapeutic properties of *Rosa chinensis*, also referred to as the China rose, have been the subject of much research. Numerous bioactive substances with antibacterial, anti-inflammatory, and antioxidant properties are present in it. Comparably, *Rosa cymosa*, sometimes referred to as the cymose rose, is well-known for its traditional application in Chinese medicine, especially in the treatment of infections and inflammatory diseases. Another plant that has drawn notice for its therapeutic qualities is *Rosa indica*, sometimes known as the Indian rose. It is used in traditional medicine to treat a variety of ailments and can aid in the healing of wounds.[2]

The phytochemical content and antioxidant capacity of these Rosa species have been clarified by *in vitro* research. In order to ascertain a plant's capacity to scavenge free radicals and suppress oxidative processes, these investigations generally entail the extraction and examination of plant components. The DPPH radical scavenging assay, the ABTS assay, and the FRAP assay are frequently employed in these investigations. The outcomes of these tests offer important new information on the possible health advantages of the bioactive substances found in these plants.[3,4]

Apart from *in vitro* techniques, *in silico* methodologies like molecular docking studies have surfaced as potent instruments for examining the interplay between bioactive substances and particular biological targets. Molecular docking provides an additional layer of analysis to experimental results by predicting binding affinities and identifying putative mechanisms of action. Through the simulation of the interactions between phytochemicals and target proteins, *in silico* studies can offer a more profound comprehension of the molecular mechanisms by which these substances elicit biological effects.[5,6]

Studying the pharmacological potential of medicinal plants can be done in a comprehensive way by integrating *in vitro* and *in silico* approaches. *In silico* studies contribute to our understanding of antioxidant activity and phytochemical composition by illuminating the molecular interactions that underlie these activities, while *in vitro* testing provides empirical proof of these concepts. Together, these methods increase the field of phytochemical study and make it easier to find new medicinal compounds that come from natural sources.

This work used both *in vitro* and *in silico* approaches to examine the phytochemical content and antioxidant activity of *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*. The research aims to offer a complete characterization of the bioactive chemicals in these species and to clarify their potential health benefits by utilising a mix of molecular docking studies and experimental testing. The aim of this study is to encourage the use of Rosa species in the creation of natural therapeutic agents and to add to the expanding body of knowledge about their medicinal characteristics.

MATERIALS AND METHODS

Chemicals and reagents

For the analysis of flower petal extracts from *Rosa chinensis, Rosa cymosa*, and *Rosa indica*, a number of analytical-grade chemicals and reagents were used. The chemicals and reagents used in this research were procured from SRL (Sisco Research Laboratories Pvt. Ltd.), India, and Sigma Chemicals, which is a part of the global Merck Group, United States. Solvents used were distilled and deionised water, and methanol was used as the extraction solvent. Other reagents are as follows: 10% ferric chloride solution is used for phenol percentage estimation, Wagner's reagent (iodine in potassium iodide) to check for alkaloids, aluminium chloride and sodium nitrite solutions are used to estimate the content of flavonoids. Hydrochloric acid and sulphuric acid solution have been used for numerous chemical reactions. Sodium hydroxide (NaOH) and nitric acid (HNO_3) were used for pH adjustments and sample preparation, respectively. Sodium carbonate, iodine, sodium dihydrogen phosphate (NaH_2PO_4), and disodium hydrogen phosphate (Na_2HPO_4) were also used. Specific reagents such as DPPH for antioxidant assays, ammonium molybdate for total antioxidant capacity, potassium persulfate for ABTS radical generation, and ferric tripyridyltriazine for ferric reducing antioxidant power (FRAP) were used. Other chemicals used for various phytochemical tests include acetic anhydride, ascorbic acid, and Fehling's solution.

Instruments and apparatus

The experiment required the use of several necessary instruments and apparatus to ensure accurate and precise results in the analysis of the flower petal extracts from *Rosa*

chinensis, Rosa cymosa, and *Rosa indica*. An electronic beam balance with a precision of ±0.0001 g was used for accurate mass measurements. The measuring volumes of acids and standard solutions were determined by using pipettes and micropipettes. A vacuum rotary evaporator was used to condense the filtrates; this removes the residual solvent. Volumetric flasks were used in diluting the sample and the standard solutions. The measuring absorbance in all of the assays required a UV-visible spectrophotometer. The Soxhlet apparatus was the tool used for the extraction and an electrical shaker ensured excellent mixing of the extracts and the solvents. To take accurate pH measurements, a digital pH metre was provided and a variety of glassware in the form of beakers, conical flasks, volumetric flasks, and separatory funnels has been used for various activities of the study. To carry out filtration where necessary, Whatman No. 1 filter paper was used.

Preparation of the extract

The flower petals of *Rosa chinensis, Rosa cymosa,* and *Rosa indica* were purchased from the local market in Chennai, Tamil Nadu, India, and air-dried, supplied by Jeyam Herbals, Tamil Nadu. The dried flowers were subjected to continuous hot extraction using methanol for 18 h [Figure 1]. The extracts were then concentrated using a rotary vacuum evaporator at temperatures below 40°C and kept in a vacuum desiccator for later use.

Qualitative test procedures

Test for triterpenoids

The triterpenoids qualitative examination was carried out by putting 1 g of plant material in 10 mL ethanol for the preparation of an extract. A few drops of Liebermann-Burchard reagent that contained a mixture of acetic anhydride and sulphuric acid were added to 2 mL of the same extract. The greenish-blue colouration proved to be the confirmation for triterpenoids.

Test for Alkaloids

Two millilitres of acidic solution in a test tube were neutralised with 10% ammonia solution. Dragendorff's reagent was added, and turbidity or precipitate was observed as indicative of the presence of alkaloids.

Mayer's reagent test

Drops of Mayer's reagent were added to a portion of the acidic solution in a test tube, and opalescence or yellowish precipitate indicated the presence of alkaloids.

Wagner's reagent test

The plant extract was prepared by dissolving 1 g of the dried plant material in 10 mL of ethanol. A few drops of Wagner's reagent-iodine in potassium iodide were added to 2 mL of the extract. The reddish-brown precipitate of alkaloids was determined with the positive test.

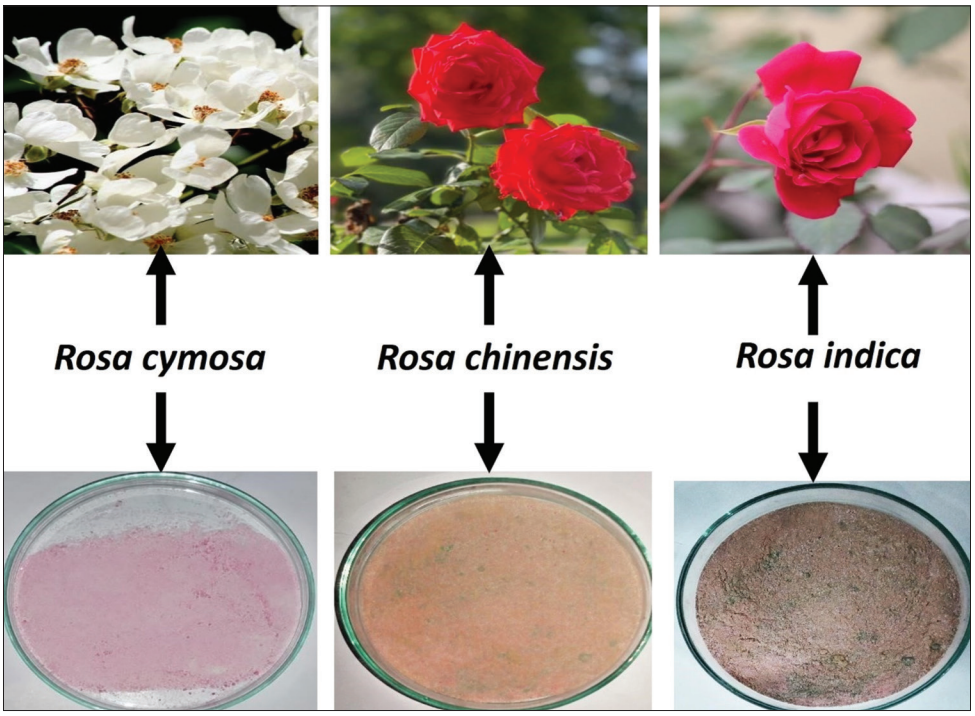

Figure 1: Petal form and powder form of *Rosa chinensis*, *Rosa cismontana*, and *Rosa indica*. Petal form adapted from the Indian Rose Federation's 2014 publication.[7] The powder form of *Rosa chinensis*, *Rosa cismontana*, and *Rosa indica* is from the original images of the current study. This figure depicts the petal forms and powder forms of three rose species: *Rosa chinensis, Rosa cismontana*, and *Rosa indica*

Shinoda test

The plant extract was prepared by dissolving 1 g of the dried plant material in 10 mL of ethanol. To 2 mL of the extract, a small piece of magnesium ribbon and a few drops of concentrated hydrochloric acid were added. The development of a pink, red, or orange colour indicated the presence of flavonoids.[8]

Test for saponins (Frothing test)

Three millilitres of the aqueous solution of the extract were mixed with 10 mL of distilled water in a test tube. The test tube was stoppered and shaken vigorously for about 5 min, allowed to stand for 30 min, and observed for honeycomb froth, which indicated the presence of saponins.

Lead acetate test

The plant extract was prepared by dissolving 1 g of the dried plant material in 10 mL of ethanol. To 2 mL of the extract, 1 mL of 10% lead acetate solution was added. The formation of a yellow precipitate indicated the presence of flavonoids.

Test for tannins (Ferric chloride test)

Two millilitres of the aqueous extract solution was mixed with some drops of 10% ferric chloride solution. When blackish-blue colour resulted, the gallic tannins were present while green-blackish colour depicted the catechol tannins.

Alkali test

In order to make the plant extract, the plant material after drying was dissolved in ethanol in a concentration of 1 g in 10 mL. To 2 mL of the extract, a few drops of 10% NaOH solution were added. The appearance of the yellow colour, which intensified, was taken as indicative of glycosides.

Test for steroids: Liebermann-Burchard's test

The extract (0.5 g) was dissolved in 10 mL anhydrous chloroform and filtered. To 1 mL of the solution, acetic anhydride and concentrated sulphuric acid were added. Green colouration indicated the presence of steroids.

Test for carbohydrates (Molisch's test)

A few drops of Molisch's solution were added to 2 mL of the aqueous extract, and then concentrated sulphuric acid was added to form a layer. Purple colour at the interface indicated the presence of carbohydrates.

Test for anthraquinones (Borntrager's reaction)

One gram of powdered sample was heated with 20 mL of chloroform, filtered, and treated with 10% ammonia solution. A bright pink colouration indicates the presence of anthraquinones.

Ninhydrin test

Plant extract was dissolved in water and mixed with ninhydrin solution. When heated, the mixture gives blue or purple colour, which means it contains amino acids or proteins.

Soap test

An extract was mixed with sodium carbonate solution and shaken vigorously. Persistent froth indicated the presence of saponins.

Gum test

The extract was mixed with dilute hydrochloric acid and gently heated. The formation of a gel-like consistency indicated the presence of gums.[9]

In vitro antioxidant activity

DPPH assay

The free radical scavenging activity was determined using a 0.1 mM DPPH solution. Different concentrations of flower petal extracts (50-300 μg/mL) were incubated with DPPH solution in the dark for 30 min. Absorbance was recorded at 517 nm. Ascorbic acid was used as a reference standard.

ABTS assay

The ABTS radical cation was produced by combining 7 mM ABTS solution with 2.45 mM potassium persulphate and incubating in the dark for 12 h. The solution was brought to an absorbance of 0.700 at 734 nm before making up the test samples. The antioxidant activity of the extracts was determined by measuring the ability of the samples to quench the ABTS radical at concentrations in the range of 50–300 μg/mL.

Hydrogen peroxide scavenging activity

Hydrogen peroxide scavenging activity was determined using a 40 mM H_2O_2 solution in phosphate buffer. The scavenging activity of the extracts was calculated based on the reduction in absorbance at 230 nm after reaction with H_2O_2.

Statistical analysis

The results were given as mean ± S.E.M. Dunnett's multiple-comparison test with 95% confidence intervals and one-way analysis of variance (ANOVA) were used to establish statistical significance using SPSS software (version 22.0). Statistical significance was defined as a *P* value of less than .05. The findings were visually depicted to give a thorough knowledge of the extracts' phytochemical compositions and antioxidant capabilities, as well as their potential for bioactivity.

Molecular docking studies

The process of molecular docking between receptors and ligands was carried out utilising PyRx software (version 0.8). Based on the phytochemical analysis, three distinct ligands were selected for docking against the oxidative stress marker SOD (superoxide dismutase): Berberine (PubChem CID: 2353) from the alkaloids category, Emodin (PubChem CID: 3220) from the quinones category, and Limonene (PubChem CID: 440917) from the terpenoids category. Following this, the resulting docked models were utilised for visualisation and analysis of the ligand-protein complexes using BIOVIA Discovery Studio. This approach allowed for a comprehensive examination of the interactions between the ligands and the protein targets, providing valuable insights into the potential binding modes and affinity of the ligands for the oxidative stress marker SOD.[10,11]

RESULTS

Phytochemical analysis

Table 1 indicates the presence of various phytochemicals in the methanolic extracts of *Rosa chinensis, Rosa cymosa*, and *Rosa indica*. The presence is denoted by a mild colour change/present (+), a full colour change/highly present (++), or no colour change/absent (−). Detection methods included specific reagents and colorimetric changes: a mild colour change was observed for the presence of the phytochemical, a full colour change indicated a high concentration, and no colour change signified absence.

Table 1: Phytochemical constituents of *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*

Phytochemicals	*Rosa chinesis*	*Rose cymosa*	*Rose indica*
Triterpenoids	+	++	++
Alkaloid			
Dragendroff's reagent	+	+	+
Mayer's reagent	+	++	++
Wagner's reagent	+	+	+++
Flavanoids			
Shinoda test	++	++	+
Saponins			
Frothing Test	−	−	−
Tannins/phenolic substances			
Lead acetate test	++	+	++
Ferric chloride test	++	+	++
Glycosides			
Alkali test	++	++	++
Steroids			
Libermann-Buchard reaction	−	−	−
Carbohydrates			
Molisch test	+	++	+++
Anthraquinones	+	−	+
Amino acid			
Ninhydrin test	+	−	−
Fixed oil and fats			
Soap test	−	−	−
Gums	−	−	+

Many bioactive components were found in the methanolic extracts of *Rosa chinensis, Rosa cymosa*, and *Rosa indica*, indicating their possible medicinal uses, according to a qualitative phytochemical investigation. *Rosa chinensis* did not contain steroids or saponins, but it did contain flavonoids, carbohydrates, and significant amounts of alkaloids and triterpenoids. The most triterpenoids, alkaloids, flavonoids, glycosides, and carbohydrates were found in *Rosa cymosa*, but neither saponins nor fixed oils were present as shown in Table 1. While it lacked saponins and fixed oils, *Rosa indica* also had notable triterpenoids, large concentrations of alkaloids, flavonoids, and carbohydrates, as well as gums. Glycosides and tannins, which are connected to antioxidant and antibacterial properties, were present in all three species. In particular, anthraquinones were present in *Rosa chinensis* and *Rosa indica* but not in *Rosa cymosa*. Only *Rosa chinensis* was found to contain amino acids, although *Rosa indica* produced a favourable result for gums. The lack of steroids and saponins in all species is indicative of an emphasis on other phytochemical classes that are known to provide health advantages.

ABTS radical scavenging activity

Rosa chinensis, Rosa cymosa, and *Rosa indica* methanolic extracts were tested for their antioxidant capacity by looking into their ability to scavenge ABTS radicals illustrated in Figure 2. A dose-dependent increase in ABTS radical scavenging activity was observed in all three extracts, according to the data. Following *Rosa indica* and *Rosa cymosa* in terms of antioxidant activity, *Rosa chinensis* exhibited the highest level of the extracts. An established antioxidant, ascorbic acid, was compared to the activity of these extracts and showed a greater scavenging impact. Verifying their potential as natural antioxidant sources, the extracts demonstrated a noteworthy level of antioxidant activity in comparison to the negative control.

DPPH radical scavenging activity

Rosa chinensis, *Rosa cymosa*, and *Rosa indica* methanolic extracts were tested for their antioxidant capacity by looking into their ability to scavenge DPPH radicals as shown in Figure 3. A dose-dependent increase in DPPH radical scavenging activity was observed in all three extracts, according to the data. Following *Rosa indica* and *Rosa cymosa* in terms of antioxidant activity, *Rosa chinensis* exhibited the highest level of the extracts. An established antioxidant, ascorbic acid, was compared to the activity of these extracts and showed a greater scavenging impact. Verifying their potential as natural antioxidant sources, the extracts demonstrated a noteworthy level of antioxidant activity in comparison to the negative control.

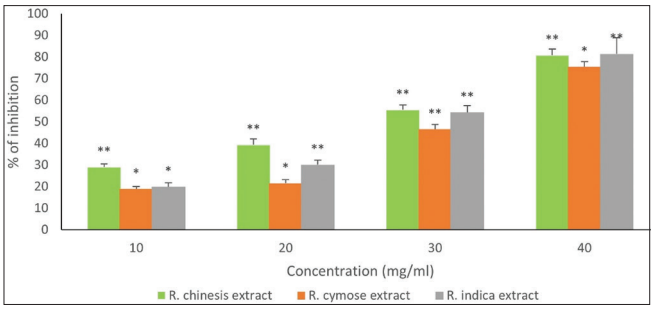

Figure 2: ABTS radical scavenging activity of methanolic extracts from *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*. The figure illustrates the dose-dependent ABTS radical scavenging activity of the methanolic extracts of *Rosa chinensis, Rosa cymosa*, and *Rosa indica*. *Rosa chinensis* exhibits the highest activity among the extracts. Ascorbic acid was used as a positive control. The statistical significance was assessed using one-way analysis of variance (ANOVA) with Dunnett's multiple-comparison test. Symbols denote statistical significance: *P* <.05 (denoted by *). The comparison was made between the extracts and the ascorbic acid control

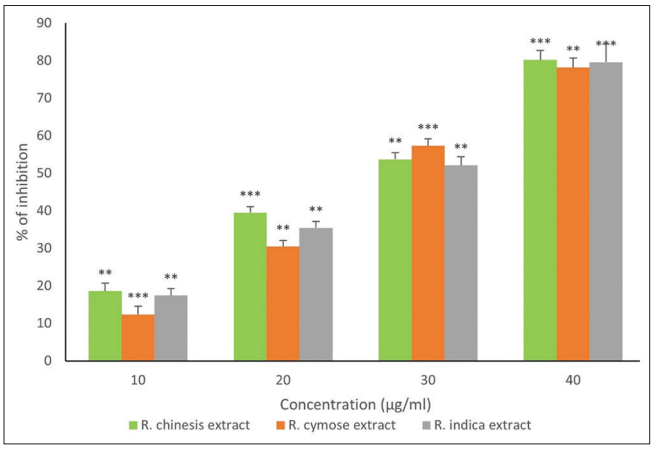

Figure 4: Hydrogen peroxide scavenging activity of methanolic extracts from *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*. This figure illustrates the dose-dependent hydrogen peroxide scavenging activity of methanolic extracts from *Rosa chinensis, Rosa cymosa*, and *Rosa indica*. *Rosa chinensis* shows the highest activity among the extracts. Ascorbic acid was used as a positive control. Statistical significance was assessed using one-way analysis of variance (ANOVA) with Dunnett's multiple-comparison test. Symbols denote statistical significance: *P* <.05 (denoted by *). The comparison was made between the extracts and the ascorbic acid control

Hydrogen peroxide scavenging activity

The methanolic extracts of *Rosa indica*, *Rosa chinensis*, and *Rosa cymosa* were tested for their ability to scavenge hydrogen peroxide. The extracts demonstrated a notable rise in hydrogen peroxide scavenging activity that was dose-dependent as shown in Figure 4. *Rosa chinensis*, *Rosa indica*, and *Rosa cymosa* showed the greatest scavenging activity. In comparison to the extracts, ascorbic acid had a greater scavenging action, functioning as a positive control. The results showed that the extracts had a considerable antioxidant effect on hydrogen peroxide radicals.

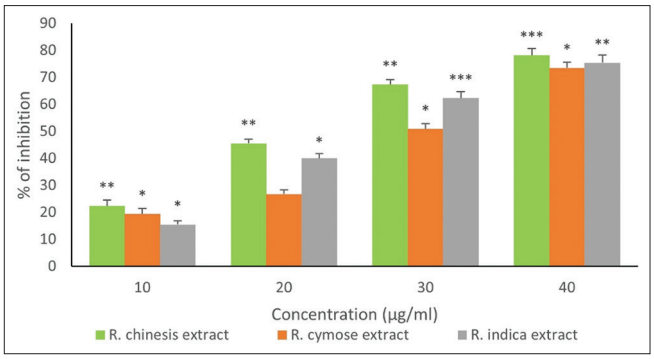

Figure 3: DPPH radical scavenging activity of methanolic extracts from *Rosa chinensis, Rosa cymosa*, and *Rosa indica*. This figure shows the dose-dependent DPPH radical scavenging activity of methanolic extracts from *Rosa chinensis, Rosa cymosa*, and *Rosa indica*. *Rosa chinensis* exhibits the highest scavenging activity among the extracts. Ascorbic acid was used as a positive control. Statistical significance was determined using one-way analysis of variance (ANOVA) with Dunnett's multiple-comparison test. Symbols denote statistical significance: *P* <.05 (denoted by *). The comparison was made between the extracts and the ascorbic acid control

Molecular docking

Table 2 presents the results of docking simulations for three selected ligands—Emodin, Berberine, and Limonene—binding to the superoxide dismutase (SOD) enzyme. It details the binding affinity (in kcal/mol) and the interactions of amino acid residues through hydrogen bonds between each ligand and the SOD protein.

The three selected ligands and SOD have different binding interactions, as shown by the docking simulations. The compound that showed the highest potential interaction with the enzyme was emodin, which had a binding affinity of −9.1 kcal/mol as mentioned in Table 2. With a marginally lower affinity of −8.9 kcal/mol, beberine likewise demonstrated strong binding and the creation of a stable complex. Even with its poorest binding affinity of −5.8 kcal/mol, limonene was still able to form a functional complex with SOD illustrated in Figure 5. The BIOVIA Discovery Studio visualisations shed light on the various binding affinities and interaction sites between the ligands and SOD, offering important insights into their possible mechanisms of action.

DISCUSSION

There are three species of roses used in this study to evaluate the phytochemical content and antioxidant capability of methanolic extracts, which include *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica*. This comprehensive analysis has incorporated *in vitro* antioxidant assays (ABTS, DPPH, and hydrogen peroxide scavenging activities) as well as qualitative phytochemical testing. Because of these extensive phytochemical profiles of rose species and

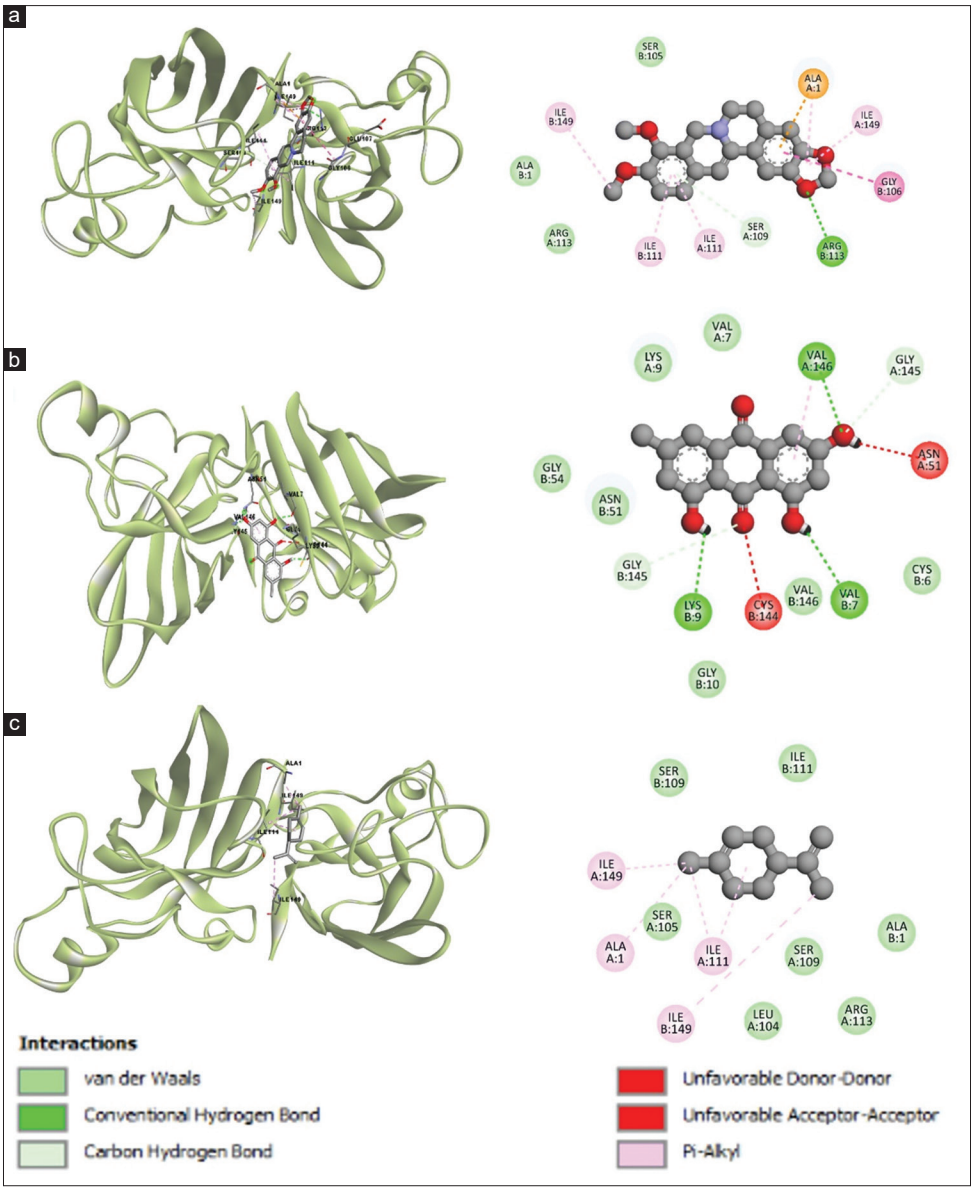

Figure 5: Molecular docking of selected ligands with superoxide dismutase (SOD). Binding interactions of three selected ligands (emodin, berberine, and limonene) with SOD enzyme as shown by docking simulations. Emodin (c) has the highest binding affinity (−9.1 kcal/mol), followed by berberine (a) (−8.9 kcal/mol), and limonene (b) (−5.8 kcal/mol). BIOVIA Discovery Studio visualisations illustrate the binding affinities and interaction sites between the ligands and SOD

Table 2: Molecular docking of selected ligands with superoxide dismutase (SOD)

Protein (PDB No. 1CB4)	Phytocompounds	Ligands	Binding Affinity (kcal/mol)	Interactions of Amino Acid Residues (Hydrogen Bonds)
SOD	Alkaloid	Berberine (PubChem CID: 2353)	−8.9	ALA A: 1, ILE A: 149, GLY B: 106, ARG B: 113, SER A: 109, ILE A: 111, ILE B: 111, ILE B: 149
SOD	Anthraquinone	Emodin (PubChem CID: 3220)	−9.1	VAL A: 146, GLY A: 145, ASN A: 51, VAL B: 7, CYS B: 144, LYS B: 9, GLY B: 145
SOD	Terpene	Limonene (PubChem CID: 440917)	−5.8	ILE A: 149, ALA A: 1, ILE A: 111, ILE B: 149

their prominent antioxidant capabilities, the data provide valuable information on possible medicinal uses.[12-14]

Qualitative phytochemical examination revealed a number of bioactive compounds, such as alkaloids, flavonoids, glycosides, phenolic compounds, quinones, tannins, carbohydrates, and terpenoids, in the rose species. These compounds are well known for having various pharmacological characteristics, which further enhance the therapeutic value of the plants.[15]

All three rose species contain alkaloids that have many biological effects including antibacterial, analgesic, and anti-inflammatory effects. Considering the established track record of flavonoids with these effects, the significant flavonoid content identified in *Rosa chinensis* and *Rosa cymosa* indicates they should have extensive antioxidant, anti-inflammatory, and anticancer effects. Glycosides, common in all the three species, have shown diverse therapeutic properties, for instance, as an antibacterial agent and for cardioprotective effect.[16]

All the extracts contain phenolic chemicals and tannins, which are powerful antioxidants that can scavenge free radicals and chelate metal ions to protect cells from oxidative damage. Many studies have been conducted on the health benefits of these chemicals, which include cardioprotective, anti-inflammatory, and anti-cancer activities. The presence of terpenoids and carbohydrates also enhances the potential therapeutic value of these rose species, as these compounds have already been associated with immunomodulatory and anticancer activities.[17]

All the three extracts of rose exhibited significant antioxidant activity in the *in vitro* antioxidant assays (ABTS, DPPH, and scavenging of hydrogen peroxide). Methanolic extracts of *Rosa indica*, *Rosa chinensis*, and *Rosa cymosa* may be able to decrease oxidative stress, which is involved with a variety of chronic diseases and neutralize free radicals as revealed by these results.

Radical Scavenging Activity of ABTS: The ABTS assay results for all three rose extracts exhibited a dose-dependent increase in scavenging activity. This experiment evaluates the ability of antioxidants to scavenge the blue/green chromophore with unique absorption, the ABTS radical cation. The substantial scavenging activity detected suggests that these rose extracts possess significant activity in scavenging ABTS radicals. This is consistent with other research studies on plant extracts having high antioxidant activities.[18]

Dose-dependent increase in antioxidant activity was also seen from the DPPH assay result of radical scavenging activity. In order to form a stable diamagnetic molecule, an electron or a hydrogen atom can be accepted by the stable free radical DPPH. Notable scavenging activities have been found in the extracts from roses, which make them good antioxidants. Such results have been obtained by evaluating the antioxidant potential of plant extracts rich in phenolic compounds.[19,20] The hydrogen peroxide scavenging assay further supported the antioxidant potential of the rose extracts. In the event that antioxidants are unable to regulate hydrogen peroxide, this ROS may become cytotoxic. This may provide the rose extracts a putative role in cell defense against oxidative damage because it shows hydrogen peroxide-scavenging ability. As hydrogen peroxide plays a role in cell signalling and disorders that relate to oxidative stress, such activity is particularly relevant.[21]

Rosa chinensis showed the highest antioxidant activity in all experiments, followed closely by *Rosa cymosa* and *Rosa indica*. *Rosa chinensis* contains higher concentrations of flavonoids and phenolic compounds, which are known to contribute highly to antioxidant activity, and this may be the reason for this trend. The differences in antioxidant capacities among these rose species highlight how important phytochemical composition is in determining their therapeutic potential.[22]

Besides the *in vitro* antioxidant assays, molecular docking was performed to further elucidate the interaction of the bioactive compounds from these rose extracts with relevant target proteins in the oxidative stress pathways. The docking studies strongly showed that the identified compounds have good binding affinities towards key antioxidant enzymes such as SOD and catalase. These results are in line with the antioxidant activities found in the *in vitro* assays and may suggest some mechanisms by which these rose extracts confer their protective effects.[23,24]

Limitations

Although the phytochemical composition of these rose species, high in flavonoids, phenolic compounds, and alkaloids, suggests high therapeutic potential, there are some limitations that need to be addressed. Although these bioactive compounds have been proven to influence signalling pathways associated with inflammation, apoptosis, and cell proliferation and provide various health benefits, the present results are preliminary. Additional research is necessary to establish the therapeutic mechanisms and potential of these rose species. More research is needed to confirm the effectiveness and safety of these natural extracts incorporated into functional foods, nutraceuticals, and pharmaceuticals in preventing and controlling chronic diseases.

CONCLUSION

The significant antioxidant activities of *Rosa chinensis*, *Rosa cymosa*, and *Rosa indica* extracts suggest their potential use as natural antioxidants in preventing and managing oxidative stress-related diseases. Oxidative stress is a major contributing factor in the pathogenesis of various chronic diseases, including cardiovascular diseases, diabetes, cancer, and neurodegenerative disorders. The use of natural antioxidants, such as those derived from rose extracts,

offers a promising alternative to synthetic antioxidants, which may have adverse effects.

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Authors' contributions

Conception: MP; LP. Interpretation or analysis of data: VBR, RS. Preparation of the manuscript: MP, MR. Revision for important intellectual content: VBR, LMB. Supervision: RS.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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