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Comprehensive Analysis of Metabolomics and Potential Health Benefits of *Rosa sericea* Lindl

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Abstract

The genus Rosa L., particularly *Rosa sericea* Lindl., is widely distributed in temperate and subtropical regions, and it holds considerable ecological, horticultural, pharmaceutical, and food industry value. Although previous studies have extensively explored the genetic diversity, morphological characteristics, and chemical composition of *Rosa sericea*, systematic research on its metabolomics is still limited. This study focuses on the metabolomic profiling of *Rosa sericea*, aiming to identify and classify its metabolites, and to predict their potential health-related functions using annotations from the Human Metabolome Database (HMDB) and KEGG pathway analysis. We performed metabolite classification and identified key categories, including flavonoids, carboxylic acids, organoxoygen compounds, fatty acyls, and prenol lipids. KEGG pathway analysis suggested several potential functions of the metabolites, including antioxidant, anti-inflammatory, immune-regulating, and metabolic roles. While the study provides insights into the potential health benefits of *Rosa sericea*, these predictions need to be validated through further experimental studies.

Keywords: *Rosa sericea*, Metabolomics, Metabolite classification, KEGG pathway analysis, Health benefits

Introduction

The genus Rosa L., belonging to the family Rosaceae and subfamily *Rosoideae* [1], includes approximately 200 species worldwide [2], which are predominantly distributed across temperate and subtropical regions of the Northern Hemisphere [3]. In China, there are 95 species [4]. These plants not only possess significant ecological value but also play crucial roles in horticulture [5], pharmaceuticals [6], and the food industry [7].

Rosa sericea Lindl., a perennial shrub in the *Rosaceae* family and Rosa genus, is primarily distributed in China's Yunnan [8], Guizhou, Sichuan, and Tibet provinces, as well as in countries like India, Myanmar, and Bhutan. It typically grows at altitudes ranging from 2000 to 3800 meters, thriving in mountaintop areas, valley slopes, or sun-exposed dry lands [9]. This species is known for its strong resistance [10]. The fruit of *Rosa sericea* is ovoid or spherical in shape, and when mature, its color ranges from bright red, purplish-red, yellow, to orange-yellow [11]. The fruit is rich in nutrients [12] and contains various bioactive compounds [13], exhibiting medicinal properties such as promoting digestion, strengthening the spleen, and alleviating diarrhea [9]. It is primarily used to treat conditions like indigestion, abdominal distension, borborygmi, and diarrhea [14], indicating its considerable potential for resource development and utilization.

In recent years, with the advancement of omics technologies, research on *Rosa sericea* has expanded beyond traditional taxonomy to include fields like population genetics and metabolomics. However, its resource development and utilization are still limited

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by the lack of systematic research. This study aims to integrate research on the species' genetic diversity, and secondary metabolites, along with newly acquired metabolomic data, to provide a comprehensive analysis of its biological characteristics. This approach is expected to offer a theoretical foundation for future resource development.

Morphological Characteristics and Taxonomic Study

Rosa sericea Lindl., a shrub belonging to the four-petaled group of the Rosa genus in the *Rosaceae* family [4], has been a focal point in botanical research due to its complex morphological features and taxonomic classification. The *Rosa sericea* complex includes *Rosa sericea* Lindl., Rosa omeiensis Rolfe, and Rosa mairei H. Lév. [4]. These species share considerable morphological similarity, leading to long-standing debates regarding their taxonomic status [4]. According to the Flora of China, Rosa omeiensis is distributed in the central and western parts of China, while *Rosa sericea* and Rosa mairei are primarily found in the western regions of China. Among them, three varieties of *Rosa sericea-Rosa sericea* f. glandulosa Yü et Ku, *Rosa sericea* f. pteracantha Franch., and *Rosa sericea* f. glabrescens Franch are recorded only in Tibet [9].

Rosa sericea typically grows to a height of 1-2 meters, with 7-11 leaflets. The leaf margins have serration on the upper half, and the leaf surface is glabrous and wrinkled, while the underside is covered with fine, long, silky hairs [3]. This characteristic is similar to that of Rosa mairei, but in Rosa mairei, both sides of the leaf are covered with silky hairs. The petals and sepals of *Rosa sericea* are in a 4-fold arrangement [4], and the flowers are solitary, appearing in the leaf axils. The flower lacks bracts, and the pedicel is glabrous. The sepals are ovate-lanceolate, with tips gradually tapering to a sharp point, and the edges are entire with no serration. The outer surface of the sepals is either sparsely covered with soft hairs or nearly glabrous, while the inner surface is densely covered with long soft hairs. The petals are white, and the fruit is ovoid to spherical, with a diameter of about 0.8-1.5 cm. The flowering period occurs in May and June, and the fruiting period in July and August [4]. The leaflets of *Rosa sericea* f. glandulosa and Rosa omeiensis are both glandular on the underside, whereas the leaves of *Rosa sericea* f. glabrescens are glabrous on the underside, resembling the original form of Rosa omeiensis [14]. These transitional morphological traits have led to ongoing debates regarding the taxonomic status of *Rosa sericea* and Rosa omeiensis, with some scholars considering Rosa omeiensis as a variety of *Rosa sericea* [4].

Genetic Diversity Study

The study of genetic diversity in *Rosa sericea* Lindl. is of great significance for its conservation and utilization. *Zhou Ningning, et al.* [11] conducted a genetic diversity analysis on 80 samples from 8 populations of *Rosa sericea* using SSR markers. Genomic DNA was extracted from the samples using an improved CTAB method, and 11 pairs of SSR primers were used for PCR amplification. The amplification products were then detected through denaturing polyacrylamide gel electrophoresis and silver staining. The results indicated that *Rosa sericea* exhibits high genetic diversity at the species level, suggesting that the species has accumulated considerable genetic variation through long-term natural selection and evolution. Additionally, the degree of genetic differentiation among different populations was relatively high, and gene flow was significantly restricted. This phenomenon may be closely related to the geographic isolation and ecological differences of the populations. Cluster analysis further revealed a strong correlation between the genetic relationships of the populations and their geographic distribution, suggesting that geographic factors play an important role in the genetic differentiation of *Rosa sericea*.

Chemical Composition Study

The fruit of *Rosa sericea* possesses a rich array of chemical constituents, offering significant nutritional and medicinal value. Studies have shown that the fruit not only contains various nutrients, such as amino acids, mineral elements, and vitamins [12], but also is abundant in a range of bioactive compounds, including triterpenoids, flavonoids, glycosides, and sterols (Table 1). For example, compounds isolated from *Rosa sericea* fruit include euscaphic acid 3,4-monoacetonide, euscaphic acid, 4-O-β-D-glucopyranosyl gallate, quercetin, oleanolic acid, and campesterol [9].

Table1: Phytochemical Compounds and Their Biological Activities from *Rosa Species*.

Compound	Source	Function	Reference
Pentacyclic triterpenic acids	Fruit of *Rosa sericea*	Antiviral, hypoglycemic, anti-inflammatory, anticancer	[15]
Oleanolic Acid	Fruit of *Rosa sericea*	Antiviral, hypoglycemic, anti-inflammatory, anticancer	[16]
Quercetin	Fruit and leaves of *Rosa sericea*	Antiviral, hypoglycemic, anti-inflammatory, anticancer	[18]
Kaempferol	Leaves of *Rosa sericea*	Moderate cytotoxicity against MCF-7 breast cancer cells	[17]
Hyperoside	Fruit of *Rosa sericea*	Anti-acute liver injury, antidepressant, antidiabetic	[28]

These chemical components endow *Rosa sericea* fruit with a variety of pharmacological activities. Among them, pentacyclic triterpenic acids, quercetin, and oleanolic acid exhibit antiviral, hypoglycemic, anti-inflammatory, and anticancer effects [15-18], demonstrating important clinical significance for the treatment of viral and bacterial infections, diabetes, tumors, hyperlipidemia, and immune system disorders [3]. Quercetin-3-O-β-D-xylopyranosyl-(1→2)-α-D-ribopyranoside, isolated from the leaves, shows moderate cytotoxic activity against the MCF-7 breast cancer cell line, indicating potential anticancer properties [17]. In terms of nutritional composition, the fruit of the *Rosa sericea* complex is rich in amino acids, mineral elements, and vitamins. The fruit contains 16 types of amino acids, including the 7 essential amino acids required by the human body, which constitute more than 36% of the total amino acid content. Aspartic acid is the most abundant among them [12]. Regarding mineral elements, the calcium (Ca) content in *Rosa sericea* fruit reaches 5520 mg/100 g, significantly higher than that of other common wild fruits, and the fruit also contains relatively high levels of potassium (K), phosphorus (P), and magnesium (Mg) [12]. These abundant nutrients make *Rosa sericea* fruit not only of significant medicinal value but also a high-quality natural resource for the development of food and health products.

Comprehensive Metabolomic Profiling and Functional Prediction of Metabolites in Rosa sericea Lindl.: Insights into Potential Health Benefits

In this study, we employed a metabolomics approach to comprehensively screen and classify metabolites within the sample. Using annotations from the Human Metabolome Database (HMDB) and KEGG pathway analysis, we revealed the distribution of metabolites and explored their potential functions. It is important to emphasize that while potential health-related effects are suggested based on metabolite classification and pathway analysis, these need to be further confirmed through experimental validation.

Metabolite Classification Based on HMDB Database

Based on HMDB database annotations, metabolites were classified into several chemical classes, which were visualized in a pie chart (Table 2 and Figure 1). The analysis revealed a diverse set of metabolites, distributed across the following key categories: Flavonoids (13.22% of total metabolites, 120 compounds): This group represents a significant portion of plant-derived metabolites, commonly found in secondary plant metabolism. Carboxylic acids and derivatives (13.00% of total metabolites, 118 compounds): These metabolites are involved in fundamental metabolic processes, such as energy production and detoxification. Organoxoygen compounds (15.86% of total metabolites, 144 compounds): This category includes metabolites with oxygen-containing functional groups, which are essential in various cellular functions. Fatty acyls (7.71%) and prenol lipids (7.16%): These metabolites are important in lipid metabolism and membrane structure, contributing to various biochemical processes. Minor classes such as keto acids and derivatives (0.99%), quinolines and derivatives (1.32%), and benzopyrans (2.09%) contributed smaller proportions, each representing specialized metabolic processes. A notable portion of metabolites (17.62%) were classified as "Others," indicating the presence of unidentified or novel compounds, which warrant further investigation. These classifications offer an overview of the biochemical diversity within the sample. However, it is essential to note that while the metabolites are categorized into these groups, the precise health effects of these metabolites require experimental validation.

Table 2: HMDB Classification of Metabolites in *Rosa sericea*: Distribution Across Key Chemical Categories.

Category	Representative Metabolites	Number of Metabolites
Organooxygen compounds	Glucosamine, Clitocine, Quinolacetic Acid, Citrusin F, Furfural, Pteroside B, Gentamicin C, D-Apiose, Risbitin, Jasmolone, Etimicin, Cis-Melilotoside, D-Fructose, Cryptochlorogenic Acid, Glucosinalbin, Glucose Lactate Lactate, Phenacylamine, Osmundalin, Sesamose, Trehalose 6-Phosphate, Fructose-6-Phosphate, D-Sorbitol, Galactaric Acid, Sucrose, Raffinose, Acaciabiuronic Acid, Isomaltol, Arabinose, Cornoside, Benzoyl Glucuronide, Domesticoside, Melilotoside, Zingerone Glucoside, Verproside, Quinic Acid, Cymorcin Monoglucoside, L-Threonic Acid, Orientaloside, Triglochinin, Ptaquiloside, 6-Phosphogluconic Acid, Verbasoside, Linocinnamarin, Trichocarposide, Lersivirine, Curculigoside, Phlorisovalerophenone, Verdamicin, Coniferin, Tiaprofenic Acid, Garcimangosone D, Gluconolactone, Lichenin, Tyramine Glucuronide, Inositol, Trehalose, Fructose Lactate, Sorbose, et al.	144
Flavonoids	Panasenoside, Procyanidin B5, Hibiscitrin, Leucopelargonidin, Limocitrol, Myricetin, Spiraeoside, Acacetin, Gnaphaliin, Gardenin B, Demethylnobiletin, Nevadensin, Casticin, Diosmetin, Luteoforol, Curcumin Monoglucoside, Butin, Leucocyanidin, Procyanidin C1, Chrysosplenetin, Myricitrin, Dihydrotamarixetin, Dihydrokaempferol, Isokaempferide, Isosakuranetin, Flavopiridol, Trilobatin, Afzelechin, Eujambolin, Avicularin, Ranupenin 3-Rutinoside, Miquelianin, Quercetin, Quercetin 7-Glucoside, Liquiritin, Taxifolin, Spinosin A, Hispiduloside, Atalantoflavone, Apigenin 5-Glucoside, Epigallocatechin, Isoquercitrin, et al.	120

Carboxylic acids and derivatives	Homoserine, L-Proline, Betalamic Acid, Cycloleucine, L-Methionine, Ranelic Acid, L-Nio, Cilengitide, Dermorphin, Relamorelin, Tiglylglycine, Alanylproline, Tricholomic Acid, L-Pipecolic Acid, Hawkinsin, Diglycolic Acid, Citric Acid, Oxiglutatione, Ile-Glu, Tyr-Ser, Glycine, Phosphoguanidinoacetate, Acetylcysteine, Glu-Val, Gln-Ile, Ala-Leu, Leu-Glu, Leu-Leu, L-Glutathione, Methotrexate, Ile-Phe, Leu-Phe, Acetylleucine, L-Phosphoarginine, Ab-Fubinaca, Afalanine, Ethyl Aconitate, Taurine Aspartate, Valganciclovir, Cefamandole, Deltorphin, Pyridinoline, Phenylacetylglutamine, Pantetheine, Glutaminylhistidine, Laninamivir, Leu-Val, Tiopronin, L-Phenylalanine, Leu-Ser, Fructose Citrate, L-Aspartic Acid, Dl-Arginine, et al.	118
Fatty Acyls	Hexadecatrienoic Acid, Asitrilobin C, Ricinoleic Acid, Vaccenic Acid, Cucurbic Acid, Ethylmalonic Acid, Turanose, Lactobionic Acid, Turanose, Melibiitol, Prenyl Glucoside, Osmaronin, Heliangin, Eriojaposide A, Mupirocin, Morellic Acid, Cerebronic Acid, Hericenone E, Enisoprost, Traumatin, Undecylenic Acid, Traumatic Acid, Undecanedioic Acid, Suberic Acid, Castaneiolide, Diadenosine Triphosphate, Pantoyllactone Glucoside, et al.	70
Prenol lipids	Esculentic Acid, Caryophyllene Epoxide, Soyasapogenol F, Cystone A, Curcumene, Manglupenone, Soyasapogenol C, Soyasapogenol B, Pachymic Acid, Phoenicoxanthin, Aristolene, Acoragermacrone, Protobassic Acid, Isoalantolactone, Ganolucidic Acid E, Ligustroside, Loganoside, Asperagenin, Triterpenoid, Triterpenoids, Echinocystic Acid, Glycyrrhetinic Acid, Fucoxanthin, Vaccinoside, Nigellic Acid, Taraxinic Acid, Plumieride, et al.	65
Benzene and substituted derivatives	Bergenin, Amarogentin, 2-Methylbenzoic Acid, Sibrafiban, 4-Methylbenzoic Acid, Phenylethylamine, Benzoic Acid, Henagliflozin, Neoacrimarine G, Phenylacetic Acid, Niflumic Acid, Paclobutrazol, Methyl Vanillate, Eudesmic Acid, Terephthalic Acid, Methyl Gallate, et al.	27
Cinnamic acids and derivatives	3-Hydroxycinnamic Acid, Hydroxymedioresinol, Cis-Caffeoyl Tartaric Acid, Caftaric Acid, Avenanthramide C, Nitecapone, Coumarinic Acid, Labiatenic Acid, 5-Caffeoylshikimic Acid, Sinapic Acid, Caffeoylmalic Acid, et al.	26
Steroids and steroid derivatives	Physalolactone C, Canesceol, Halometasone, Galactinol, Punigluconin, Mespirenone, Uralenolide, Hydroxysteroid, Boldenone, Doxercalciferol, Chaps, Dehydroeburicoic Acid, Desglucocoroloside, Dihydroouabain, Falecalcitriol, Antcin K, Chlormadinone	25
Tannins	Sanguiin H4, Castanin, Pedunculagin, Strictinin, Heterophylliin A, Corilagin, Tercatain, Sanguiin H7, Heterophylliin E, Sanguiin H1, Ellagic Acid Arabinoside, Vescalagin, Tellimagrandin Ii, Casuarinin, Pterocaryanin B, Sanguiin H11, Granatin A, et al.	20
Coumarins and derivatives	Urolithin A, (+)-Marmesin, Skimmin, Marmesin Rutinoside, Pimpinellidine, Isofraxidin, Scopoletin, Esculetin, Esculin, Coumarin, Fraxin, Marmesin, et al.	20
Benzopyrans	Mellein, Isogentisin, Swerchirin, Coriandrone E, Isoeugenitol, Isomangiferin, Pratenol B, Gentisin, Gartanin, Homodolicholide, et al.	19
Isoflavonoids	Dalbergioidin, Tectorigenin, Irilone, Genistein, Kanzonol I, Glycitin, Coumesterol, Pseudobaptigenin, et al.	13
Quinolines and derivatives	Casimiroin, Brequinar, Rutacridone Epoxide, Rufloxacin, Acrimarine J, Kynurenic Acid, Gravacridonechlorine, et al.	12
Indoles and derivatives	Indole-5,6-Quinone, 3-Methylindole, L-Tryptophan, Indoline, et al.	12
Phenols	Vanillylmandelic Acid, Homovanillic Acid, Coniferyl Acetate, Normetanephrine, et al.	12
Keto acids and derivatives	Oxoadipic Acid, Sedanonic Acid, 2-Maleylacetate, et al.	9
Glycerophospholipids	Glycerophosphoinositol, et al.	9
Lactones	Sapidolide A, Solerol, et al.	8
Phenylpropanoic acids	Fukiic Acid, Carbidopa, Dihydroferulic Acid, et al.	8

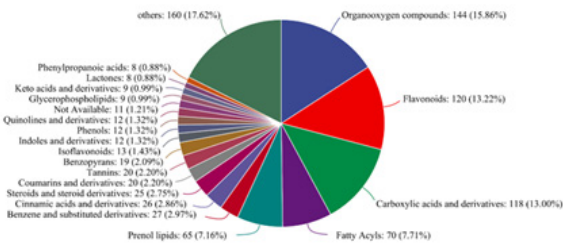

Figure 1: Pie Chart Visualization of HMDB Classification for *Rosa sericea* Metabolites.

KEGG Pathway Analysis and Potential Health Function

To further understand the possible biological functions of the metabolites, we performed KEGG pathway analysis (Table 3 and Figure 2). This analysis identified several metabolic pathways that may have implications for antioxidant, anti-inflammatory, immune-regulating, and metabolic processes:

Table 3: KEGG Pathway Analysis of Metabolites in *Rosa sericea*: Distribution and Functional Insights.

KEGG Pathway Description	Metabolites	Number of Metabolites
ABC transporters	L-Proline, Adenosine, D-Fructose, Cytidine, L-Histidine, L-Glutamine, D-Sorbitol, Xylobiose, Sucrose, Raffinose, Inosine, L-Glutathione, Hemin, Deoxyguanosine, Deoxyadenosine, L-Phenylalanine, Inositol, Trehalose, L-Aspartic Acid	19
Aminoacyl-tRNA biosynthesis	L-Proline, L-Methionine, L-Tryptophan, L-Histidine, L-Asparagine, L-Glutamine, L-Phenylalanine, L-Tyrosine, Dl-O-Phosphoserine, L-Aspartic Acid	10
Lysine biosynthesis	Homoserine, Oxoadipic Acid, Dl-2-Aminoadipic Acid, 2-Oxoglutaric Acid, L-Aspartic Acid	5
Isoquinoline alkaloid biosynthesis	3,4-Dihydroxybenzaldehyde, Palmatine, 4-Hydroxycinnamic Acid, L-Dopa, L-Tyrosine	5
Histidine metabolism	Urocanic Acid, L-Histidine, L-Histidinol-Phosphate, 2-Oxoglutaric Acid, L-Aspartic Acid	5
Glucosinolate biosynthesis	L-Methionine, L-Tryptophan, 3-(6'-Methylthio) Hexylmalate, L-Phenylalanine, L-Tyrosine	5
Alanine, aspartate and glutamate metabolism	L-Asparagine, L-Glutamine, Citric Acid, 2-Oxoglutaric Acid, L-Aspartic Acid	5
Ubiquinone and other terpenoid-quinone biosynthesis	4-Hydroxycinnamic Acid, Isochorismate, Alpha-Tocotrienol, 4-Hydroxy-3-Polyprenylbenzoate, 2-Succinylbenzoate, L-Tyrosine	6
Phenylalanine, tyrosine and tryptophan biosynthesis	L-Tryptophan, Quinic Acid, 3-Dehydroshikimate, L-Phenylalanine, 5-Dehydroquinic Acid, L-Tyrosine	6
Isoflavonoid biosynthesis	Genistein, 2-Hydroxyisoflavanone Naringenin, 2'-Hydroxygenistein, Glycitin, Coumesterol, Pseudobaptigenin	6
Cysteine and methionine metabolism	Homoserine, L-Methionine, O-Acetylserine, L-Glutathione, Dl-O-Phosphoserine, L-Aspartic Acid	6
D-Amino acid metabolism	L-Proline, L-Methionine, L-Histidine, L-Glutamine, L-Phenylalanine, 2-Oxoglutaric Acid, L-Aspartic Acid	7
Tryptophan metabolism	Oxoadipic Acid, Quinoline-4,8-Diol, 3-Methylindole, L-Tryptophan, Tryptophol, 5-(2'-Carboxyethyl)-4,6-Dihydroxypicolinate, 8-Methoxykynurenate, Kynurenic Acid	8
Phenylalanine metabolism	Enol-Phenylpyruvate, 3-Hydroxycinnamic Acid, Phenylethylamine, Phenylacetic Acid, N-Acetyl-L-Phenylalanine, Phenylacetylglutamine, L-Phenylalanine, L-Tyrosine	8
Biosynthesis of nucleotide sugars	Glucosamine, D-Fructose, Keto-3-Deoxy-D-Manno-Octulosonic Acid, Fructose-6-Phosphate, Alpha-D-Mannose 1-Phosphate, 3-Deoxy-D-Manno-Octulosonate 8-Phosphate, D-Sedoheptulose 7-Phosphate, Inositol	8
Ascorbate and aldarate metabolism	Deoxycholic Acid 3-Glucuronide, Galactaric Acid, Glucuronolactone, L-Threonic Acid, Semidehydroascorbic Acid, Tyramine Glucuronide, 2-Oxoglutaric Acid, Inositol	8
Galactose metabolism	D-Gal Alpha 1->6D-Gal Alpha 1->6D-Glucose, D-Fructose, Fructose-6-Phosphate, D-Sorbitol, Galactinol, Sucrose, Raffinose, Melibiitol, Inositol	9
Tyrosine metabolism	Indole-5,6-Quinone, Vanillylmandelic Acid, Homovanillic Acid, 4-Hydroxycinnamic Acid, L-Dopa, Labiatenic Acid, 3,4-Dihydroxyphenylglycol, 3,4-Dihydroxymandelic Acid, Normetanephrine, L-Tyrosine	10
Carbon metabolism	O-Acetylserine, Fructose-6-Phosphate, Citric Acid, 6-Phosphogluconic Acid, 6-Phosphonoglucono-D-Lactone, D-Sedoheptulose 7-Phosphate, Gluconolactone, 2-Oxoglutaric Acid, Dl-O-Phosphoserine, L-Aspartic Acid	10
Nucleotide metabolism	Adenosine, Hypoxanthine, Cytidine, Cytosine, L-Glutamine, Xanthine, Adenine, Inosine, Xanthylic Acid, Deoxyguanosine, Deoxyadenosine	11
2-Oxocarboxylic acid metabolism	L-Methionine, Oxoadipic Acid, L-Tryptophan, 3-(6'-Methylthio) Hexylmalate, Dl-2-Aminoadipic Acid, Citric Acid, (S)-2-Aceto-2-Hydroxybutanoic Acid, L-Phenylalanine, L-Tyrosine, 2-Oxoglutaric Acid, L-Aspartic Acid	11

Purine metabolism	Adenosine, Hypoxanthine, L-Glutamine, Xanthine, Adenine, Inosine, Xanthylic Acid, Deoxyguanosine, Diadenosine Triphosphate, Deoxyadenosine, 3',5'-Cyclic Gmp, 5-Aminoimidazole Ribonucleotide	12
Phenylpropanoid biosynthesis	Sinapyl Alcohol, 4-Hydroxycinnamic Acid, 5-Hydroxyferulic Acid, P-Coumaraldehyde, Coniferyl Acetate, 5-Caffeoylshikimic Acid, Eleutheroside B, Sinapic Acid, Coniferin, Caffeyl Alcohol, L-Phenylalanine, L-Tyrosine	12
Flavone and flavonol biosynthesis	Panasenoside, Myricetin, Acacetin, Quercetin 3-Beta-D-Glucoside, Isowertin 2''-Rhamnoside, Chrysoeriol, Apigenin 7-O-Glucoside, 3-O-Methylquercetin, Vitexin 6''-O-Malonyl 2''-O-Xyloside, Luteolin 7-Glucuronide, Kaempferol-3-O-Rutinoside, Quercetin, Isoquercitrin	13
Flavonoid biosynthesis	Leucopelargonidin, Myricetin, Luteoforol, Butin, Leucocyanidin, 5-Caffeoylshikimic Acid, Dihydrokaempferol, (-)-Epiafzelechin, Isosakuranetin, Butein, 5,7-Dihydroxyflavanone, Afzelechin, Chalconaringenin, Phloretin, Vitexin 6''-O-Malonyl 2''-O-Xyloside, Quercetin, Taxifolin, Epigallocatechin	18
Biosynthesis of cofactors	L-Methionine, Oxoadipic Acid, L-Tryptophan, Deoxycholic Acid 3-Glucuronide, L-Glutamine, Fructose-6-Phosphate, Alpha-D-Mannose 1-Phosphate, Citric Acid, Oxiglutatione, L-Glutathione, Isochorismate, 4-Hydroxy-3-Polyprenylbenzoate, 2-Succinylbenzoate, 5-Amino-6-Ribitylamino Uracil, 3-Dehydroshikimate, Tyramine Glucuronide, L-Tyrosine, 2-Oxoglutaric Acid, 5-Aminoimidazole Ribonucleotide, L-Aspartic Acid	20
Biosynthesis of various plant secondary metabolites	L-Methionine, L-Tryptophan, Cis-Melilotoside, Melilotoside, 2,4-Dihydroxy-2H-1,4-Benzoxazin-3(4H)-One, Coumarinic Acid, (+)-Marmesin, Secoisolariciresinol, Echinocystic Acid, Hordatine A, Dihydrocoumarin, Scopoletin, Fraxetin, Esculetin, Coumarin, Marmesin, 3-Dehydroshikimate, L-Phenylalanine, L-Tyrosine, L-Aspartic Acid, (-)-Pinoresinol	21
Biosynthesis of amino acids	Homoserine, L-Proline, L-Methionine, Oxoadipic Acid, L-Tryptophan, Dl-2-Aminoadipic Acid, L-Histidine, O-Acetylserine, L-Asparagine, L-Glutamine, Fructose-6-Phosphate, Citric Acid, (S)-2-Aceto-2-Hydroxybutanoic Acid, L-Histidinol-Phosphate, D-Sedoheptulose 7-Phosphate, 3-Dehydroshikimate, L-Phenylalanine, 5-Dehydroquinic Acid, L-Tyrosine, 2-Oxoglutaric Acid, Dl-O-Phosphoserine, L-Aspartic Acid	22
Biosynthesis of secondary metabolites	Homoserine, L-Proline, Betalamic Acid, L-Methionine, Oxoadipic Acid, Cis-Zeatin O-Glucoside, Panasenoside, L-Tryptophan, Leucopelargonidin, Sinapyl Alcohol, Myricetin, Palmatine, 12-Opda, Aflatoxin G2, Lovastatin Acid, Phoenicoxanthin, 13(S)-Hpotre, Cis-Melilotoside, Quercetin 3-Beta-D-Glucoside, Curcumin Monoglucoside, D-Fructose, Gibberellin A3, 4-Hydroxycinnamic Acid, 5-Hydroxyferulic Acid, Leucocyanidin, L-Dopa, Benzoic Acid, L-Pipecolic Acid, Dl-2-Aminoadipic Acid, Trehalose 6-Phosphate, L-Histidine, O-Acetylserine, L-Asparagine, Fructose-6-Phosphate, Alpha-D-Mannose 1-Phosphate, Sucrose, Citric Acid, Xanthine, Adenine, (S)-2-Aceto-2-Hydroxybutanoic Acid, L-Histidinol-Phosphate, Xanthylic Acid, P-Coumaraldehyde, Melilotoside, 2,4-Dihydroxy-2H-1,4-Benzoxazin-3(4H)-One, Coumarinic Acid, (+)-Marmesin, Isochorismate, Genistein, 5-Caffeoylshikimic Acid, Scopolamine, 6-Phosphogluconic Acid, Secoisolariciresinol, Dihydrokaempferol, 3-O-Methylquercetin, (-)-Epiafzelechin, Echinocystic Acid, Alpha-Tocotrienol, Pyropheophorbide A, 6-Phosphonoglucono-D-Lactone, Gibberellin A15, Pa(16:0/18:2), Pheophorbide A, Hordatine A, 3-Oxo-2-(2-Entenyl) Cyclopentaneoctanoic Acid, Traumatin, Isosakuranetin, Traumatic Acid, 4-Hydroxy-3-Polyprenylbenzoate, Afzelechin, Chalconaringenin, Phloretin, Kaempferol-3-O-Rutinoside, D-Sedoheptulose 7-Phosphate, Quercetin, 2-Hydroxyisoflavanone Naringenin, Sinapic Acid, Scopoletin, 2-Succinylbenzoate, Cyclo-Dopa 5-O-Glucoside, Fraxetin, Secologanate, 5-Amino-6-Ribitylamino Uracil, Cinnamyl Alcohol, Pantetheine, Coniferin, Esculetin, Taxifolin, Coumarin, Marmesin, Gluconolactone, Theasaponin F1, 3-Dehydroshikimate, Caffeyl Alcohol, Coumesterol, Pseudobaptigenin, Epigallocatechin, L-Phenylalanine, 5-Dehydroquinic Acid, Dimethylallyl Diphosphate, L-Tyrosine, 2-Oxoglutaric Acid, Inositol, Trehalose, 5-Aminoimidazole Ribonucleotide, Dl-O-Phosphoserine, L-Aspartic Acid, Isoquercitrin, (-)-Pinoresinol	109

Metabolic pathways	Homoserine, L-Proline, Betalamic Acid, D-Gal Alpha 1->6D-Gal Alpha 1->6D-Glucose, Glucosamine, L-Methionine, Adenosine, Oxoadipic Acid, Indole-5,6-Quinone, L-Tryptophan, Vanillylmandelic Acid, Leucopelargonidin, 4-Hydroxybenzaldehyde, 2-Methylbenzoic Acid, Enol-Phenylpyruvate, Sinapyl Alcohol, Furfural, 4-Methylbenzoic Acid, 12-Opda, Aflatoxin G2, Deoxycholic Acid 3-Glucuronide, 3-Hydroxycinnamic Acid, Lovastatin Acid, 13(S)-Hpotre, Quercetin 3-Beta-D-Glucoside, 7-Methylinosine, D-Fructose, Homovanillic Acid, 4-Hydroxycinnamic Acid, 5-Hydroxyferulic Acid, Leucocyanidin, Phenylethylamine, L-Dopa, 2-Keto-6-Acetamidocaproate, Hypoxanthine, 6-Carboxy-5,6,7,8-Tetrahydropterin, Benzoic Acid, L-Pipecolic Acid, Cytidine, Cytosine, Keto-3-Deoxy-D-Manno-Octulosonic Acid, Dl-2-Aminoadipic Acid, Urocanic Acid, Trehalose 6-Phosphate, L-Histidine, O-Acetylserine, L-Asparagine, L-Glutamine, Fructose-6-Phosphate, D-Sorbitol, Alpha-D-Mannose 1-Phosphate, Galactaric Acid, Glucuronolactone, Galactinol, Sucrose, Raffinose, Citric Acid, Oxiglutatione, Xanthine, 2-Maleylacetate, Adenine, Inosine, (S)-2-Aceto-2-Hydroxybutanoic Acid, Phosphoguanidinoacetate, L-Histidinol-Phosphate, Xanthylic Acid, P-Coumaraldehyde, Quinic Acid, 2,4-Dihydroxy-2H-1,4-Benzoxazin-3(4H)-One, L-Glutathione, L-Threonic Acid, Isochorismate, Phenylacetic Acid, Labiatenic Acid, Genistein, 5-Caffeoylshikimic Acid, Scopolamine, 6-Phosphogluconic Acid, N-Acetyl-L-Phenylalanine, Secoisolariciresinol, Dihydrokaempferol, Semidehydroascorbic Acid, 27-Deoxy-5B-Cyprinol, Dolichyl B-D-Glucosyl Phosphate, Echinocystic Acid, Alpha-Tocotrienol, 6-Phosphonoglucono-D-Lactone, Gibberellin A15, Pa(16:0/18:2), 3,4-Dihydroxyphenylglycol, 12-Keto-Tetrahydro-Leukotriene B4, Hordatine A, Deoxyguanosine, 3-Oxo-2-(2-Entenyl)Cyclopentaneoctanoic Acid, 4-Hydroxy-3-Polyprenylbenzoate, 3-Deoxy-D-Manno-Octulosonate 8-Phosphate, Chalconaringenin, Phloretin, 3,4-Dihydroxymandelic Acid, D-Sedoheptulose 7-Phosphate, Quercetin, 2-Hydroxyisoflavanone Naringenin, (R)-2-Benzylsuccinate, Sinapic Acid, Normetanephrine, 2-Succinylbenzoate, Cyclo-Dopa 5-O-Glucoside, Phloretic Acid, 5-Amino-6-Ribitylamino Uracil, Cyclohexanecarboxylic Acid, Pantetheine, Terephthalic Acid, Taxifolin, Kynurenic Acid, Diadenosine Triphosphate, Gluconolactone, Deoxyadenosine, Theasaponin F1, 3-Dehydroshikimate, Tyramine Glucuronide, L-Phenylalanine, 5-Dehydroquinic Acid, 3',5'-Cyclic Gmp, L-4-Hydroxyglutamate Semialdehyde, Dimethylallyl Diphosphate, L-Tyrosine, 2-Oxoglutaric Acid, Inositol, D-Xylono-1,5-Lactone, Trehalose, 5-Aminoimidazole Ribonucleotide, Dl-O-Phosphoserine, L-Aspartic Acid, Isoquercitrin	134

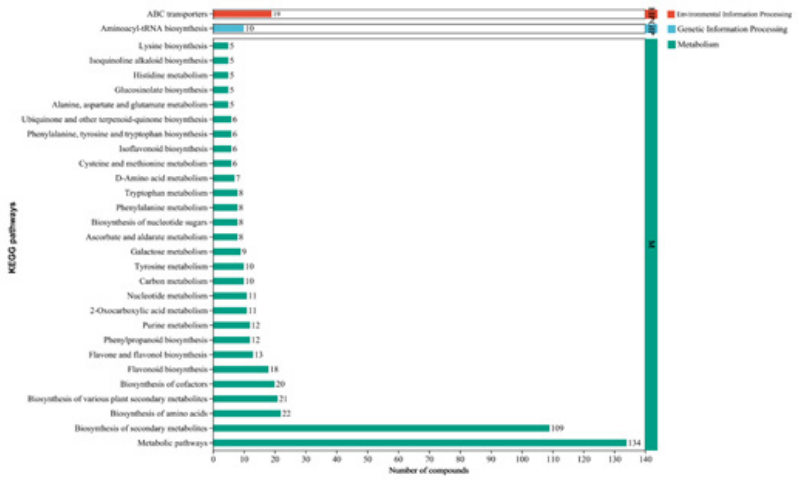

Figure 2: KEGG Pathway Analysis of Metabolites in *Rosa sericea*: Distribution Across Key Pathways.

Antioxidant and Anti-inflammatory Pathways: Flavonoid biosynthesis and isoquinoline alkaloid biosynthesis pathways suggest the potential for antioxidant and anti-inflammatory properties, which may help mitigate oxidative stress and inflammation [19,20]. The phenylpropanoid biosynthesis pathway, involving compounds like caffeic acid, also suggests antioxidant properties, potentially reducing oxidative damage.

Metabolic Regulation and Energy Production: The glycolysis/gluconeogenesis pathways indicate the role of some metabolites in glucose metabolism and energy production, which could have implications for metabolic disorders like diabetes and obesity [21,22].

Immune Support and Skin Health: Lysine biosynthesis and

histidine metabolism pathways point to roles in collagen formation and immune function [23,24], suggesting possible benefits for skin health and tissue repair.

Antimicrobial and Anti-inflammatory Effects: The terpenoid backbone biosynthesis pathway suggests the potential for antimicrobial and anti-inflammatory effects [25,26], likely contributing to the overall health benefits of the sample.

Vision and Skin Health: The carotenoid biosynthesis pathway indicates that metabolites like beta-carotene may contribute to eye health, immune response, and skin protection [27,28]. While these KEGG pathway predictions provide insights into the potential functions of the metabolites, it is critical to emphasize that these are theoretical predictions. The actual health-related effects must be confirmed through subsequent experimental research.

Conclusion

This study presents a detailed metabolomic analysis of *Rosa sericea*, highlighting the diversity of its metabolites and their potential health-related functions. Through the use of the Human Metabolome Database (HMDB) and KEGG pathway analysis, key metabolites were identified, which could play roles in antioxidant, anti-inflammatory, immune-regulating, and metabolic processes. These findings provide valuable insights into the potential therapeutic applications of *Rosa sericea*, but further experimental validation is needed to confirm the actual health benefits. The results lay a theoretical foundation for future research and development of *Rosa sericea* as a potential natural resource for pharmaceuticals and health products.

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