Distribution and ethnomedicinal importance of genus *Rosa* L. (Rosaceae) in India

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Review

Abstract

Background: The knowledge of geographical distribution and ethnobotanical uses is critical for the effective conservation and utilization of native plant genetic resources. No attempt has been made to amalgamate and analyze all of the available information on the ethnobotany, and distribution of *Rosa* in India. Therefore, this work aimed to provide a comprehensive review on the geographical distribution, and ethnobotany of the genus *Rosa*, as well as to give insights into possible future research opportunities.

Methods: Information on geographical distributions was compiled using regional floras, books, eFloras, regional herbaria, research articles related to distribution, and ethnobotanical studies of *Rosa* in India and online databases were also searched for the distribution records at global level.

Results: The data revealed a total of 38 species of roses in India with 26 wild, 10 cultivated and 2 wild as well as cultivated species. The highest number of *Rosa* species were found in Jammu and Kashmir (20 taxa), followed by Himachal Pradesh (17 taxa), Uttar Pradesh (11 taxa), Ladakh and Assam (9 taxa each), Uttarakhand, and West Bengal (8 taxa each), Tamil Nadu (5), Karnataka, Meghalaya, Sikkim (4 taxa each), Delhi, Manipur, and Odisha (3 taxa each), Arunachal Pradesh, Bihar, Kerala, and Punjab (2 taxa each), Andhra Pradesh, Haryana, Madhya Pradesh, Maharashtra and Rajasthan (1 taxon each). *Rosa webbiana*, *R. moschata*, *R. macrophylla* and *R. sericea* were the most widely distributed in the Western Himalayan region. Besides, ten species were used to treat several health ailments including cough, eye infection, skin ailments, epilepsy, respiratory trouble, jaundice, inflammation, and leucorrhea, hepatitis, sexual dysfunction, fever, flu, diarrhea, stomachache, cancer. These wide spectrum ethnobotanical applications of the genus reflect their long association with prevailing ethnic communities across regions.

Conclusion: The species of *Rosa* have economic as well as medicinal value. Therefore, future research is required on phytochemical, pharmacological and toxicological aspects of the less investigated species of *Rosa* to explore their economic and medicinal potential from India.

Keywords: Rosa species, Ethnobotany, Ecogeographical distribution, India

Background

India is one of the world's 17 mega diversity nation, encompassing a wide variety of biodiversity (Dar *et al.* 2022). The country's ecological diversity is immense, stretching from sea level to the world's highest mountain ranges; from arid and hot conditions in the northwest to cold desert environments in the trans-Himalayan zone; and tropical wet evergreen forests in Western Ghats and Northeast India (BSI 2022). This wide array of ecoregions, geo-climatic factors associated with elevational gradient makes India a rich repository of plant genetic resources (Chaudhary *et al.* 2022). One such important genetic resource of the country is rose. India is a hotspot of roses (Duthie 1971; Bamber 1976) with various species adapted from 500 m to 4700 m above mean sea level in many natural habitats in the Himalayan Indian region (Hooker 1879; Pal 1991; Singh *et al.* 2020) and the species number ranges between 10-25 (Kaul *et al.* 1999; Dhananjaya *et al.* 2009; Tejaswini & Prakash 2005). The subsequent change of names and use of synonyms have increased the complexity in taxonomy and classification of the roses (De Cock 2008). The genus *Rosa* of family rosaceae consists of nearly 200 species and is broadly distributed in North America, Middle East, and Asia (Phillips & Rix 1988, Ku & Robertson 2003; Wissemann & Ritz 2005). The species are characteristically shrubs with alternate and pinnately compound leaves (except in *Rosa persica* Michx. ex Juss. and *Rosa berberifolia* Pall.). The flowers are hermaphrodite (*Rosa setigera* Michx. is, however, cryptically dioecious) (Kevan *et al.* 1990; Kemp 1994), pentamerous (except *Rosa sericea*), and polyandrous, and their color ranges from white, pink, yellow to red. Multiple superior ovaries are present in roses that develop into achenes (simple dry fruits). Fruits are developed in a fleshy pericarp called rosehip (Winther *et al.* 2016).

Roses have been widely acclaimed aesthetically and economically for their exquisite blooms and spectacular growth and popularized worldwide for their nutritious, therapeutic, ornamental, and cosmetic usefulness (Hummer & Janick 2009; Guimares *et al.* 2010; Firdous *et al.* 2021; Singh *et al.* 2021; Wang *et al.* 2022). Many foodstuffs and drinks are prepared from the rose hips and include jams, jellies, teas, and alcoholic beverages (Grochowski 1990). In India, rose petals are used in the preparation of recipes like sherbet (rose drink), gulkand (rose jam) (Hegde *et al.* 2022). *Rosa* species are used in European and Asian Traditional Medicine to treat various health-related issues of liver, kidney, lungs, heart, pain, stomach (Ercisli 2005; Genc & Ozhatay 2006; Ayati *et al.* 2018). In the past decade, promising pharmacological activities have been reportedfor various extracts of *Rosa* species, including antioxidant, immunomodulation, anti-inflammatory, anticancer, antidiabetic, cardioprotective, antimicrobial, and neuroprotective activities (Patel 2017). These activities are due to the presence of putative bioactive constituents like ascorbic acid, flavonoids, phenolic acids, anthocyanins, fatty acids, carotenoids, and essential oils (Ercisli 2007; Barros *et al.* 2011; Ouerghemmi *et al.* 2016; Fascella *et al.* 2019).

Regardless of the ethnobotanical value and medicinal significance of the *Rosa* species, little effort has been made to integrate all of the relevant available data concerning the ethnomedicinal uses as far the species of *Rosa* in India. Moreover, the distribution of *Rosa* species in India remains unclear. Therefore, the objective of the present study was to provide an insight on the distribution and ethnomedicinal uses of this genus in India which will help in collection and utilization of this alternative therapeutic and food source, as well as point out directions for future research.

Materials and Methods

A comprehensive literature survey was conducted pertinent to the distribution, and ethnobotany, of *Rosa* species in India. For compiling this review, sources such as Google Scholar, Scopus Floras, edited books, CAB international, PubMed, Science direct were employed. The keywords used for collecting the references include *Rosa* and distribution, *Rosa* and ethnobotany, *Rosa* and ethnomedicinal value, rose hips and medicine, roses and uses. The following methodology was adopted to compile the final list of *Rosa* species and their distribution in India (Fig. 1). First, an extensive literature survey was done using different regional floras (Singh & Kachroo 1976; Sharma & Kachroo 1981; Kachroo *et al.* 1977; Oommachan 1977; Raizada & Saxena 1978; Dhar & Kachroo 1983; Chowdhary & Wadhwa 1984; Sharma & Jamwal 1988; Singh & Kachroo 1994; Kanjilal & Bahadur 2004), books (Polunin & Stainton 1984; Pal 1991; Khare 2008; Vidyarthi 2010; Dvorsky *et al.* 2018), eFloras (eFI 2021), regional herbaria (HBJU, KASH, CAL, LWG, RRLH, CUKH, acronyms in accordance with Thiers 2022), and research articles related to distribution and ethnobotanical studies in national and international journals. Online databases viz., Tropicos (2021) POWO (2021), GBIF (2020), PFAF (2022) and IBP (2021) were also searched for the distribution records and biogeographic information about the *Rosa* species. Only full-length research articles related to ethnobotanical studies, published in peer reviewed journals and written in English and dated December 2022 were considered. At first, literature screening of the extracted articles involved examining the titles and abstracts relevant for relevant article for inclusion. Then full-length articles were evaluated against the inclusion exclusion criteria. The outline of

the methodology adopted for literature screening is presented in Fig. 1. For botanical names and synonyms we relied on TPL (2023).

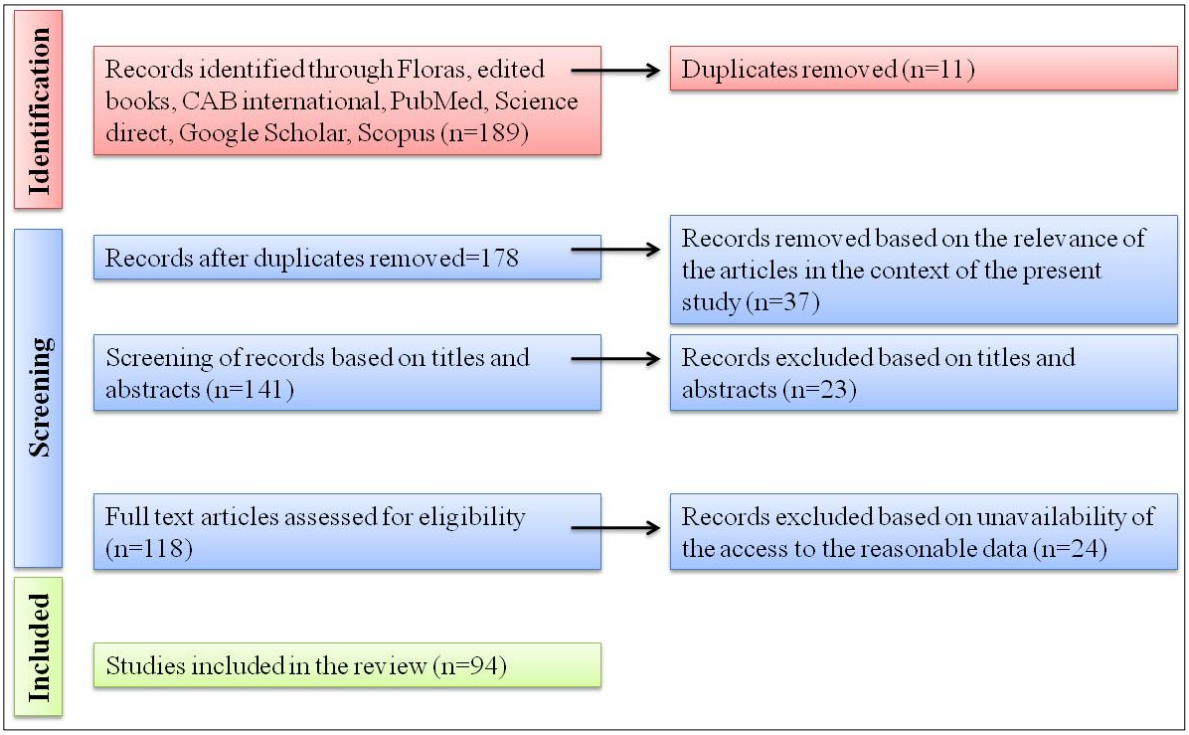

Figure 1. Methodology adopted for literature screening.

Results and Discussions

Distribution

As per the data compiled, the genus *Rosa* is represented by 38 species in India and constitutes 26 wild, 10 cultivated and 2 wild as well as cultivated species (Fig. 2, Table 1). One variety of *Rosa foetida,* i.e., *R. foetida* var. *persiana,* also occurs in the wild and as well as in cultivation in Ladakh. In contrast, a wild form of *Rosa chinensis,* i.e., *R. chinensis* f. *viridiflora* exists in India. The species of *Rosa* present in India include most of the medicinally important species of the genus *Rosa*. These species have a diverse distribution across different geographic regions of India, including tropical, subtropical, and temperate zones however, majority of the *Rosa* species in India are found in the temperate regions (Fig 2). The wide range of habitats occupied by roses in India include extreme environments like sandy beaches, acid soils, limestone rocks, deserts, marshes, and the cold deserts of Ladakh (Table 1). Several climate factors like humidity temperature rainfall etc. significantly affect the plant growth and development and eventually determine the distribution pattern of plant species (Bertrand *et al.* 2011; Lenoir *et al.* 2008). Elevation, seasonality and amount of precipitation in the warmest and driest months greatly affect the geographical distribution of *R. canina* (Karakaya 2016, Karataş 2019). The distribution of rose species in India is significantly linked to the extreme variations in the climate (Viraraghavan 2017).

The data revealed the highest *Rosa* diversity in Jammu and Kashmir (20 taxa), followed by Himachal Pradesh (17), Uttar Pradesh (11 taxa), Ladakh and Assam (9 taxa each), Uttarakhand, and West Bengal (8 taxa each), Tamil Nadu (5), Karnataka, Meghalaya, Sikkim (4 taxa each), Delhi, Manipur, and Odisha (3 taxa each), Arunachal Pradesh, Bihar, Kerala, and Punjab (2 taxa each), Andhra Pradesh, Haryana, Madhya Pradesh, Maharashtra and Rajasthan (1 taxon each). Some of the wild species of *Rosa* such as *Rosa webbiana*, *R. moschata*, *R. macrophylla* were principally distributed in the Western Himalayan region, but the distribution of some species such as *R. canina, R. bracteata*, *R. cathayensis*, *R. omeiensis*, *R. sempervirens*, *R. foetida* var. *persiana*, *R. chinensis* f. *viridiflora* was found restricted to few states (Fig.). For some species, for instance, *R. bracteata*, *R. cymosa*, *R. hemisphaerica*, *R. gallica*, *R. laevigata*, *R. odorata*, *R. omeiensis*, and *R. sempervirens,* few records existed, and some were old and only herbarium samples are available, for example, *R. hirsuta*. *R. moschata*, *R. multiflora*, *R. cathayensis* Rehder et E. H. Wilson, *R. macrophylla,* and *R. webbiana* are endemic to the Western Himalayan region (Nayar *et al.* 2009; Singh *et al.* 2017), and *R. leschenaultiana* is endemic to Coorg, Karnataka (eFI 2021), (Fig. 3). The ongoing developmental activities such as agricultural expansion programs, infrastructural development, and construction of dams in several states

of India may result in the destruction and fragmentation of the *Rosa* species habitat. *R. canina*, for example, a heavily exploited species in European countries for its medicinal properties has a limited range in India and is restricted to the Kashmir Himalaya. Except *Rosa bourboniana, Rosa hirsute, R. leschenaultiana,* all other species are either native or naturalized in countries outside India.

Figure 2. *Rosa* species in India. (1) *R. alba,* (2) *R. Banksiae,* (3) *R. beggeriana,* (4) *R. bourboniana,* (5) *R. bracteata,* (6) *R. canina,* (7) *R. cathayensis,* (8) *R. centifolia,* (9) *R. chinensis,* (10) *R. chinensis* f. *viridiflora,* (11) *R. clinophylla,* (12) *R. corymbifera,* (13) *R. cymosa,* (14) *R. damascena,* (15) *R. ecae,* (16) *R. foetida,* (17) *R. foetida var. persiana,* (18) *R. fortuniana,* (19) *R. gallica,* (20) *R. gigantea,* (21) *R. glutinosa,* (22) *R. hemisphaerica,* (23) *R. hirsuta,* (24) *R. indica,* (25) *R. laevigata,* (26) *R. leschenaultiana,* (27) *R. longicuspis,* (28) *R. machailensis,* (29) *R. macrophylla,* (30) *R. moschata,* (31) *R. multiflora,* (32) *R. nanothamnus,* (33) *R. odorata,* (34) *R. omeiensis,* (35) *R. pendulina,* (36) *R. rubiginosa,* (37) *R. sempervirens,* (38) *R. sericea,* (39) *R. soulieana,* (40) *R. webbiana.*

The diversity of roses has gained considerable attention worldwide. Almost half of the rose species are found in Asia (Fouge're-Danezan *et al.* 2015), with China having 95 wild *Rosa* species, 65 of which are endemic (Ku & Robertson 2003). In Pakistan 13 species of *Rosa* exists Tropicos (2022) while from Iran, 16 species and 7 hybrids of roses have been recorded (Zielinski 1982; Khatamsaz 1992; Sharghi *et al.* 2014; Arjmandi *et al.* 2016). A total of 129 rose species have been reported from North America (Rydberg 1920) while the number of identified wild roses in Europe is estimated to be 46 species (Kurtto *et al.* 2004). Likewise, 42 species were listed in the checklist of native

Italian flora (Bartolucci *et al.* 2018). Twenty-five rose species have been reported in Turkey (Kutbay & Kılınc 1996), whereas Croatia harbors 37 species (Tomljenovic & Pejic 2018).

Table 1. Distribution of *Rosa* species found in India. **(**W-Wild, C-Cultivated, HP-Himachal Pradesh, AS-Assam, KL-Kerala, OD-Odisha, UP-Uttar Pradesh, WB-West Bengal, JK-Jammu and Kashmir, DL-Delhi, TN-Tamil Nadu, PB-Punjab, AD-Andhra Pradesh, BR-Bihar, MN-Manipur, MH-Maharashtra, ML-Meghalaya, RJ-Rajasthan, MP-Madhya Pradesh, CG-Chhattisgarh, KA-Karnataka, LA-Ladakh, SK-Sikkim, HR-Haryana, AP-Arunachal Pradesh, UK-Uttarakhand)

Name of taxon	**Status**	**Habitat**	**Flowering & Fruiting Time**	**Distribution**		
				India	**References**	**Global***
Rosa alba L.	C	Gardens	June-Aug	HP, AS, KA, OD, PB, UP, WB	Chowdhary & Wadhwa (1984); Vattakaven *et al.* (2016); Kaur *et al.* (2017)	Bangladesh, Kazakhstan, New York, Tadzhikistan, Uzbekistan
Rosa banksiae R.Br.	C	Thickets, scrub, valleys, stream sides, roadsides	Apr-Oct	HP, JK, DL, KL, TN, UP	Kanjilal *et al.* (1936); Raizada & Saxsena (1978); Tejaswini & Prakash (2005); Khuroo *et al.* (2011); Singh (2013); Viraraghavan (2017)	China, Korea, Spain, Uzbekistan
Rosa beggeriana Schrenk ex Fisch. & C.A. Mey.	W	Slopes, valleys, river side's, roadsides	May-Oct	JK, UP	Polunin & Stainton (1984); Tejaswini & Prakash (2005)	Iran to Central Asia and Pakistan
Rosa borboniana N.H.F.Desp.	C	Gardens	Flowers thrice a year (April-May, July-August, and mid-October)	HP, UP, PB, WB	Tejaswini & Prakash (2005); Kumar *et al.* (2014)	India
Rosa bracteata J.C.Wendl.	W	Mixed forests, scrub, sandy hills, stream sides, seashores, roadsides	May-Nov	JK	Tejaswini & Prakash (2005)	China South-Central, China Southeast, Nansei-shoto, Taiwan
Rosa R. canina L.	W	Roadside, pastures, forests	May-Oct	JK	Tejaswini & Prakash (2005); Singh *et al.* (2020)	Macaronesia, NW Africa, Europe to Central Asia and Pakistan
Rosa cathayensis (Rehder& E.H. Wilson) L.H. Bailey	W	Roadside, forests, slopes	May-Sept	HP	Singh *et al.* (2017)	Mexico
Rosa centifolia L.	C	Gardens	May-Oct	JK, UP, AD, AS, BR, TN	Bhattacharjee (1991); Tejaswini & Prakash (2005); Khare (2008); Singh *et al.* (2010); Das & Teron (2014); Bhuyan (2015)	Bulgaria, Italy, Spain, France
Rosa chinensis Jacq.	C	Gardens	Apr-Oct	JK, HP, AS, TN, UP, WB, MH,	Tejaswini & Prakash (2005); Purkayastha *et al.* (2007); Khare (2008); Khuroo *et al.* (2011); Singh (2013); Rana *et al.* (2019)	China, Vietnam, Nepal, Pakistan

Rosa chinensis f. *viridiflora* (Lavall,e) C.K. Schneid.	W	Forests	Apr-Nov	SK	eFI (2021)	China, Europe, and America
Rosa clinophylla Redout, & Thory syn *R. involucrata* Roxb. ex Lindl.	W	Forest floors, riverbank areas	March-June (Flowering)	AS, BR, KA, MN, ML, OD, RAJ, UP, WB	Prain (1903); Haridasan & Rao (1985); Ghora & Panigrahi (1986); Chowdhury & Das (2011); Viraraghavan (2017); POWO (2019)	Assam, East Himalaya, Laos, Myanmar, Nepal, Thailand, West Himalaya, Bangladesh
Rosa corymbifera Borkh.	W	Woods, hedges, scrubs, near the forest area	June-Oct	HP, JK	Chowdhary & Wadhwa (1984); Sharma & Jamwal 1988	Europe to Western & Central Asia, NW Africa
Rosa cymosa Tratt.	C	Gardens	May-Sept	HP	Yadav *et al.* (2014)	Bolivia, China, Vietnam, Laos
Rosa damascena Herrm.	C	Gardens	Mar-Aug	AD, AS, CG, HP, JK, MP, PB, UP, WB, RJ	Chowdhary & Wadhwa (1984); Khare (2008); Sonowal & Barua (2011); Fayaz *et al.* (2019)	Western Asia, China, USA
Rosa ecae Aitch.	W	Dry slopy areas, along with river belts and the roadside	May-August	JK, UK, LA	Polunin & Stainton (1984); Chowdhary & Wadhwa (1984); Viraraghavan (2017)	Afghanistan, Kirgizstan, Pakistan, Tadzhikistan, Turkmenistan
Rosa foetida Herrm. [Syn *Rosa eglanteria var. lutea* (Mill.) Thory; *R. lutea* Mill.]	W	Dry area	July-Oct	JK, LA, HP	Chowdhary & Wadhwa (1984)	Afghanistan, Iran, Iraq, Kirgizstan, Lebanon-Syria, Pakistan, Tadzhikistan, Turkey, Uzbekistan
Rosa foetida var. *persiana* (Lem.) Rehder	W	Dry area	June, fruiting absent	LA	Polunin & Stainton (1984); Chowdhary & Wadhwa (1984); Singh *et al.* (2020)	Afghanistan, Iran, Iraq, Turkey, Azerbaijan, Kyrgyzstan, Tajikistan
Rosa × *fortuniana* Lindl. & Paxton	C	Gardens	Late spring or early summer	NA	eFI (2021)	China
Rosa gallica L.	C	Gardens	May-Oct	NA	Khare (2008)	Australia, Bulgaria, France, Germany, Turkey, Hungary, Iraq, Switzerland, Russia, Yugoslavia
Rosa gigantea Collett ex Cr,p.	W	Ravines and grassy hills, thickets, and wood margins	Nov-Feb	MN, UP	Viraraghavan (2017)	E. Asia - S.W. China, Myanmar, northern Thailand, northern Vietnam.
Rosa glutinosa Sibth. & Sm.	C	Gardens		DL	IARI (2016)	Turkey, Iraq
Rosa hemisphaerica Herrm. Syn *R. sulphurea* Dryand.	W	Dry areas along hilly slopes	May-Sept	JK, UK, LA	Stewart *et al.* (1972)	Iran, Transcaucasus, Turkey, Turkmenistan
Rosa hirsuta Ghora & Panigrahi	W		Aug-Sept	UP, UK	Ghora & Panigrahi (1986)	India
Rosa indica L.	C	Gardens	May-Aug	JK, HP, ML, UP, AP	Oommachan (1977); Chowdhary & Wadhwa (1984); eFI (2021)	China, Taiwan

Rosa laevigata Michx.	W	Rocky place at low altitude, thickets, scrub, open montane areas, open fields	Apr-Nov	DL, ML, WB	Haridasan & Rao (1985)	China, Hainan, Taiwan, Vietnam
Rosa leschenaultiana (Redout, & Thory) Wight & Arn.	W	Shola forests and grasslands	Throughout the year	KA, TN, KL	Hooker (1890); Paulsamy *et al.* (2003); Ramachandran & Selvalakshmi (2011); Viraraghavan (2017)	India
Rosa longicuspis Bertol.	W	Hedges, on open hillsides and in the scrub, mossy wood	May-Oct	AS, ML	Hooker (1885); Viraraghavan (2017)	China South-Central
Rosa machailensis K.Singh	W	Forest area, rocky surface	April-May	JK	Singh *et al.* (2022)	-
Rosa macrophylla Lindl.	W	Forest area, roadside, slopy areas	May-Oct	HP, LA, UK, OD, SK, JK	Bamber (1916); Singh & Kachroo (1994); Kanjilal & Bahadur (2004); Sharma & Devi (2013); Singh *et al.* (2020)	Afghanistan, China, East and West Himalaya, Nepal, Pakistan
Rosa moschata Herrm. Syn. *R. brunonii* Lindl.	W	Forest area, roadside, near rivers, streams	April-Sept	HP, LA, UK, HR, JK	Kachroo *et al.* (1977); Kanjilal and Bahadur (2004); Sharma *et al.* (2011); Balodi *et al.* (2018); Singh *et al.* (2020)	Afghanistan, Iran, Tunisia, Mexico, New Zealand
Rosa multiflora Thunb.	W	Thickets, scrub, slopes and riversides, roadside (eflora 2013)	May-Oct	AS, HP, JK, KA, MP, UP, WB	Duthie (1971); Oommachan (1977); Kanjilal & Bahadur (2004); Khare (2008)	China, Japan, Korea, Nepal, Pakistan
Rosa nanothamnus Boulenger	W	Hilly dry slopes, roadsides	May-Nov	HP, JK	Sharma & Jamwal (1988)	China
Rosa × odorata (hort. ex Andrews) Sweet [*Rosa indica* var. *odorata* Andrews]	W	Mixed forests, on hill sides, grassy slopes, pastures, roadsides	May-Oct	MN, SK	Hooker (1885)	China, Myanmar, Thailand, Vietnam
Rosa omeiensis Rolfe	W	Forests, thickets, scrub, pastures, hilly slopes	May-Sept	AP	Tsering *et al.* (2017)	China, East Himalaya, Inner Mongolia, Qinghai, Tibet
Rosa pendulina L.	C	Gardens	May-Sept	JK	Jeelani *et al.* (2011)	Albania, Austria, Bulgaria, France,

						Germany, Hungary, Italy, Poland, Romania, Spain, Switzerland
Rosa rubiginosa L. Syn. *Rosa eglanteria* L.	W	Open coppices and old hedgerow slopes, usually found on calcareous soils	May-Oct	HP, JK, LA, UK	Kachroo *et al.* (1977); Chowdhary & Wadhwa (1984); Hooker (1885)	Europe, Madeira, Himalayas
Rosa sempervirens L.	W	Roadside, hedgerow, roadsides	May-Sep	TN	Hooker (1885)	Albania, France, Greece, Italy, Morocco, Portugal, Spain, Tunisia, Turkey
Rosa sericea Wall. ex Lindl.	W	Forests, shrubberies and alpine slopes, mountain tops and slopes of valleys, in dry, sunny places	May-Oct	AS, HP, LA, SK, UK, WB	Bamber (1916); Raizada & Saxena (1978); Chowdhary & Wadhwa (1984); Hooker (1885); Kanjilal & Bahadur (2004); Kala (2006); Khare (2008); Sharma & Devi (2013)	China, East Himalaya, Myanmar, Nepal, Tibet, West Himalaya
Ros soulieana Cr,p.	W	Grasslands	May-Sep	AS	Sagar & Sivakumar (2009)	Tibet to South China
Rosa webbiana Wall. ex Royle	W	Dry and rocky slopes along roadsides at higher altitudes	May-Oct	HP, JK, LA, UK	Chowdhary & Wadhwa (1984); Adhikari *et al.* (2007); Angmo *et al.* (2012); Singh *et al.* (2020)	China, Afghanistan, Nepal, Pakistan, West Himalaya, Kazakhstan, Kirgizstan, Tadzhikistan, Tibet, Turkmenistan, Uzbekistan

***Sources:** http://www.plantsoftheworldonline.org; https://www.tropicos.org; http://www.efloras.org; https://pfaf.org; https://www.gbif.org; https://wcsp.science; kew.org

Figure 3. Photographs of some of the *Rosa* species. (A) *R. canina*; (B) *R. machailensis* (C) *R. moschata* (4) *R. macrophylla* (5) *R. foetida* var. *persiana* (6) *R. webbiana*.

Ethnomedicinal uses

The analysis showed that *Rosa* species have a long history of treating a broad spectrum of ailments in different traditional systems of medicine worldwide, including India. In India, of the 38 species of *Rosa*, 10 species are used in traditional health care system to treat several ailments (Table 2). These include colds, cough, eye infection, skin ailments, epilepsy, respiratory trouble, hepatitis, sexual dysfunction, fever, flu, diarrhea, stomachache, cancer, jaundice, inflammation, leucorrhea, menses, and heart disorders (Table 2). Several plant parts are used for the treatment purpose and include roots, leaves, bark, branchlets, flowers, fruits, sprouts, and seeds. Flowers and fruits are the most widely used parts for the treatments purpose (Table 2). *R. webbiana* and *R. moschata* are the most commonly used species of genus *Rosa* to treat health ailments in India.

Table 2. Ethnomedicinal uses of *Rosa* species in India.

Botanical name	Vernacular name: Study area, State	Part used	Ethnomedicinal uses	Reference
Rosa alba L.	Gulab: Kangra, Himachal Pradesh	Flowers	Decoction in eye inflammation	Kumar & Sharma (2014)
Rosa centifolia L.	Golab: Bargarh, Orissa	Petals	Burn, skin ailments, eye diseases	Sahu *et al.* (2010)
	Gulab: Firozabad, Uttar Pradesh	Flowers	Eye infection, syphilis	Singh *et al.* (2010)

	Golap: Kamrup, Assam	Seeds	Anemia	Das and Teron (2014)
	Rose: East Godavari, Andhra Pradesh	NA	Mild laxative, carminative	Divya *et al.* (2015)
	Tezigulap: Dibrugarh, Assam	Flowers	Eye infection	Bhuyan (2015)
Rosa chinensis Jacq.	Pota shu: Andaman & Nicobar Islands	Leaves, flowers	Epistaxis (nose bleeding)	Chander *et al.* (2015)
R. damascena Herrm.	Gulab: Gwalior, Madhya Pradesh	Flowers	Gonorrhea	Anis *et al.* (2000)
	Gulab: Dhule and Jalgaon, Maharashtra	NA	Purgative, ulcer, conjunctivitis and headache	Jain *et al.* (2010)
	Jangli Gulab: Baramulla, Jammu and Kashmir	Flowers	Cold, cough and skin diseases	Yousuf *et al.* (2012)
	Rose: Dantewada, Chhattisgarh	Roots, flowers, leaves	Intestinal ulcers, diarrhea, wounds	Sahu *et al.* (2014)
	Rose: East Godavari District, Andhra Pradesh	NA	Astringent, aperient, carminative, refrigerant, cardiac tonic	Divya *et al.* (2015)
	Bulgariun Gulab: Shivalik Hills Zone of Himachal Pradesh	Flowers	Antipyretic, diuretic, fever, tonic, malarial fever, cathartic	Kumar & Chander (2018)
	Gulab: Anantnag, Jammu and Kashmir	Flowers	Cold, cough and other respiratory ailments	Fayaz *et al.* (2019)
Rosa indica L.	Diengtiew-jain heh: Meghalaya, Northeast	Seeds	Dysentery and as anthelminthic	Jaiswal (2010)
	NA: Bahraich, Uttar Pradesh	Flowers	Headache, constipation, dyspepsia	Sangeeta & Mall (2013)
	Gulab: Udhampur, Jammu and Kashmir	Flowers	Dyspepsia, flatulence and aperient	Bhatia *et al.* (2014)
	Rosappu: Nainamalai, Namakkal, Tamil Nadu	Petals and fruits	Wounds, injuries, astringent, removes bile	Ganesan & Xu (2017)
	Gulab: Haridwar, Uttarakhand	Leaves, bark, fruits	Scorpion bite, hair loss, dysentery, diarrhea, leucorrhea, anti-cancerous, ulcer, wounds and increase fertility	Kumar & Dangwal (2018)
Rosa macrophylla Lindl.	Dand-kunja: Uttaranchal	Fruits	Skin ailments	Adhikari *et al.* (2007)
	Wan Gulab: Kishtwar, Jammu and Kashmir	Roots	Eye troubles and burns	Kumar *et al.* (2009)
	Gulabri: Chamba, Himachal Pradesh, India	Flowers	Cold and cough	Rani *et al.* (2013)
	Jangligulab: Poonch, Jammu and Kashmir	Flowers	Internal fever	Ajaz & Ahmed (2017)
	Jungligulab: Chamba, Himachal Pradseh, India	Flowers	Stomachache	Rana *et al.* (2019)
Rosa moschata Herrm. Syn. *Rosa brunonii* Lindl.	Kunj pani: Uttarakhand Himalayan Region	Fruits	Leucorrhea, bleeding, pregnancy termination	Kumari *et al.* (2009)
	Jangligulab: Mandi, Himachal Pradesh	Whole plant	Burning of skin, eye diseases, cancer	Sharma *et al.* (2011)

	Kojai: Bharmour, Himachal Pradesh	Fruits	Vermicidal	Dutt *et al.* (2011)
	Kuja: Kullu, Himachal Pradesh	Leaves, flowers and aerial part	Wounds, ophthalmia, diarrhea	Sharma & Samant (2014)
	Karir: Udhampur, Jammu and Kashmir	Leaves, flowers	Galactagouge (Goats), eye inflammation, acne	Bhatia *et al.* (2014)
	Krimgulaab, Krich: Srinagar, Jammu and Kashmir	Petals, flowers	Ophthalmological disorders, cure acne, blemishes, inflammation, diarrhea	Kumar *et al.* (2015)
	Kuja/ Shami: Mandi, Himachal Pradesh	Leaves, fruits, wood	Diarrhea, ophthalmia, wounds	Sharma *et al.* (2015)
	Karrer: Ramnagar, Jammu and Kashmir	Whole plant	Constipation, body inflammation, heart and eye diseases, anti-septic	Kumar *et al.* (2017)
	Kubjak Gulab: Shivalik Hills Zone, Himachal Pradesh	Flowers	Laxative, expectorant, diaphoretic, antipyretic, diuretic, cathartic, expectorant, cathartic, tonic, respiratory trouble	Kumar & Chander (2018)
	Kujin: Uttarkashi, Uttarakhand	Fruits	Gastrointestinal disorders, indigestion	Balodi *et al.* (2018)
	Kubjak Gulab: Shivallik hills	Flowers	Respiratory trouble, laxative, expectorant, diaphoretic, antipyretic, diuretic, cathartic, tonic	Kumar &Chander (2018)
Rosa multiflora Thunb.	NA: Srinagar, Jammu and Kashmir	Flowers	Epilepsy and insomnia	Kumar *et al.* (2015)
Rosa sericea Wall. ex Lindl.	Dhurkunja, Shedham: Uttaranchal	Roots	Uterine disease	Adhikari *et al.* (2007)
	Dhur- Kunja: Kedarnath Wildlife Sanctuary, Uttarakhand	Fruits	Headaches, liver complaints	Singh & Rawat (2011)
	Klyampot: Pangolakha Wildlife Sanctuary, East Sikkim	Fruits	Headache liver complaints, constipation	Lepcha & Das (2011)
Rosa webbiana Wall. ex Royle	Mentouck, Siah, Marpo: Zanskar and Kashmir, Jammu and Kashmir, Ladakh	Petals	Nasal bleeding, nose swelling, hepatitis, liver disorders, jaundice	Kaul (1977)
	Chua: Lahul and Spiti, Himachal Pradesh	Flowers	Constipation, throat irritation	Srivastava *et al.* (1992)
	Siah-marpo: Uttaranchal,	Flowers	Stomachache, jaundice, hepatitis, nasal bleeding, liver problems	Adhikari *et al.* (2007)
	Siah-marpo: Ladakh	Flowers, fruits	Fever	Ballabh & Chaurasia (2007)
	T-siya, Seva (Spiti), Shanab, Susli (Lahul): Lahaul-Spiti, Himachal Pradesh	Fruits	Sexual dysfunction, liver disorder	Singh & Lal (2008)
	Sai marpo: Kargil, India	Flowers, Fruits	Bleeding, jaundice and liver problems	Angmo *et al.* (2012)

	T-siya, Seva: Spiti valley, Himachal Pradesh	Flowers, fruits	Jaundice, vigor, vitality	Singh *et al.* (2012)
	Sia-mendo: Kibber Wildlife Sanctuary, Himachal Pradesh	Fruits	Lung problems and headache	Devi *et al.* (2013)
	Saveemendok, Pin Valley National Park in Lahaul and Spiti district, Himachal Pradesh	Flowers	Headache, nerve pain, earache	Targe *et al.* (2022)
	Chawag: Kullu, Himachal Pradesh	Leaves, flowers and aerial part	Hepatitis, jaundice, stomachache	Sharma & Samant (2014)
	Arwal, Aewalgulaab: Shankaracharya Hill, Srinagar, Jammu and Kashmir, India	Flowers, roots	Chest infections, nasal bleeding and nasal swelling, hepatitis, jaundice, and other liver disorders, aperient, brain tonic and memory enhancer	Kumar *et al.* (2015)
	Ghanugulaab: Hills of northwestern Himalaya, Jammu and Kashmir, India	Flowers	Nose swelling, Nasal bleeding, jaundice, liver diseases and hepatitis	Dutt *et al.* (2015)

Rose species are widely used in different traditional medical systems around the world. For example, *Rosa alba*, locally known as 'Rosa-branca' in Brazil, is used to treat wound healing, local pain, flu hypertension, and issues related to heart and urine (Bieski *et al.* 2015; Ribeiro *et al.* 2017). In the traditional Chinese system of medicine, fruits of *R. beggeriana* fruits are used to treat hypertension, kidney stones, and as a diuretic (Amiri & Joharchi 2013), while the fruits and leaves are used to treat treating cold, bronchitis, cough, flu, stomachic, and pharyngitis in Izmir Province of Turkey (Ugulu *et al.* 2009). In Spanish folk medicine, fruits and shoots of *Rosa beggeriana* are employed to treat cold as an appetizer, digestive, diuretic, and anemic (Rivera *et al.* 2005). The leaf, fruits, and flowers of *R. canina* are used in the traditional medicine of Italy as an eyewash in curing eye infections, kidney diseases, cardiac diseases, peptic ulcer, rheumatism, bronchitis, asthma, cough, eczema, cancer, hemorrhoids, expectorants, and antidiarrhea (Genc & Ozhatay 2006; Vitalini *et al.* 2013 Tuttolomondo *et al.* 2014). In the Iranian pharmacopeias, roots, leaves, flowers, and fruits of *R. canina* are used to treat digestive problems, anemia, hypertension, insect bites, depression, kidney stone, fatty liver, regulate blood sugar and pressure, as a diuretic, dermatic issues (Ghorbani 2005; Jalali *et al.* 2009; Mosaddegh *et al.* 2012; Moghanloo *et al.* 2019).

The Turkish folk medicine utilizes the roots, fruits, leaves flowers of *R. canina* to treat kidney diseases, dementia, cardiac diseases, rheumatism, diabetes, peptic ulcer, bronchitis, asthma, cold, cough, flu, eczema, cancer, hemorrhoids, inflammation, HIV, cardiovascular problems, high fever, tonsillitis, as a sedative, appetizer, and digestive (Genc & Ozhatay 2006; Cakilcioglu *et al.* 2010; Baser *et al.* 2012; Nadiroglu *et al.* 2019). The tea made from the *Rosa centifolia* flower was taken orally for treating eyes, colics, and spots in Mexico (Canales *et al.* 2005). In China, the roots and leaves of *Rosa chinensis* were reported to be used traditionally in problems like bone fracture, traumatic injury, diarrhea, enteritis, stomachache, appendicitis, and as a laxative (Hong *et al.* 2015; Chaudhary *et al.* 2006). In traditional Iranian Medicines, the flower decoction of *R. damascena* is used to treat chest and abdominal pains, menstrual bleeding, and digestive ailments (Mahboubi 2016). The flowers of *R. foetida* are used to treat diabetes in Iran (Bahmani *et al.* 2014) and abdominal pain and stomach disorders in Pakistan (Noor *et al.* 2014). *R. rubiginosa* fruit is eaten in Argentina and used in dermatic problems and as an antitussive (Lozada 2006). The North American Indian tribes used the root decoction of *R. damascena* as a remedy for cough in children (Libster 2002). In China, *R. multiflora* was traditionally used as an herbal remedy against diseases that include osteoarthritis, inflammation, rheumatoid arthritis, cold, flu (Guo *et al.* 2011). In some regions of Iran and Pakistan, the flowers are used as ovary tonic, emmenagogue, and to treat abdominal pain, and stomach disorders. The fruits of *R. hemisphaerica* are used against hypotension intestinal parasites as a diuretic and purgative in Iran traditional medicine (Ghorbani 2005). In Korea, *R. laevigata* was traditionally employed for diarrhea and frequent urination

(Lee *et al.* 2020).The flowers of *R. moschata* are used to treat constipation heart tonic,and skin diseases in Azad Jammu & Kashmir, Pakistan (Amjad *et al.* 2020).

The major chemical constituents extracted from rose species are phenolic acids, flavonoids, carot enoids, triterpenes, tannins, polysaccharides, organic acids, fatty acids, and vitamins (Wang *et al.* 2022). The *Rosa* species in India have rich phytochemical composition (Singh *et al.* 2021; Singh & Gairola 2023). Species such as *R. corymibera*, *R. webbiana* and *R. canina* and *R. moschata* contain high concentration of phenolics (Ozcan 2002; Ercisli 2007; Fascella *et al.* 2019). Similarly, several phenolic compounds have been reported from the fruits of *R. sempervirems*, *R. rubiginosa* (Kerasioti *et al.* 2019). Recent study reported three types of triterpenoids, oleanolic acid, ursolic acid, and lupinic acid in *R. laevigata* (Li *et al.* 2021). The leaves of *R. sericea* contain rubantrone A, quercetin-3-*O*-*β*-d-xylopyranosyl-(1 → 2)-*α*-d-ribopyranoside; gallicin-*p*-*O*-(6′-*O*-caffeoyl)-*β*-d-glucoside and kaempferol-3-*O*-*β*-d-xylopyranosyl-(1 → 2)-*α*-d-ribopyranoside (Li *et al.* 2013). *R. banksiae* flowers contain flavonoids such as rutin, luteolin-4′-O-glucoside, apigenin-7-O-glucoside, apigenin and quercetin (Zen*g et al.* 2020). Despite of its rich phytochemical composition, the chemical studies on are restricted to species such as *R. canina*, *R. laevigata*, *R. multiflora*, *R. damascena*, and *R. chinensis*. Species like *R. beggeriana, R. borbouniana*, *R. bracteata*, *R. cathayensis*, *R. clinophylla*, *R. ecae*, *R. foetida*, *R. fortuniana*, *R. gigantea*, *R. glutinosa*, *R. hirsuta*, *R. leschenaultiana*, *R. longicuspis*, *R. macrophylla*, *R. nanothamnus*, *R. omeienses*, *R. pendulina*, *R. odorata* have hitherto not been evaluated for their phytochemical composition.

Likewise, most of the pharmacological studies carried out globally were restricted to *R. canina*, *R. damascena*, *R. multiflora*, *R. centifolia*, *R. chinensis*, *R. laevigata*; therefore, much effort is required on the researcher's part to decipher and evaluate the potential of other Indian *Rosa* species as well keeping in view their immense traditional use against various ailments. For example, the aqueous acetone extract of *R. canina* fruits exhibits antiobesce activity in an *in vitro* study (Ninomiya *et al.* 2007). The fruit extract of *R. canina* shows antihyperglycemic (Taghizadeh *et al.* 2016) and antiinflammatory activities (Gruenwald *et al.* 2019). The methanol extract of *R. damascena* reduces HIV-1IIIB and HIV-1MN activity (Akram *et al.* 2020). A variety of components extracted from *Rosa* plants had shown potential antimicrobial activity (Ma *et al.* 2020). *R. moschata* has been shown to exhibit antispasmodic activity in isolated rabbit jejunal preparations (Ali *et al.* 2014). The ethanolic fruit extract of *R. multiflora* possesses analgesic activity (Zhang *et al.* 2008). Total flavonoids of *R. laevigata* shows hepatoprotective action (Dong *et al.* 2018) and antioxidant properties (Su *et al.* 2015). Species such as *R. hemisphaerica*, *R. macrophylla*, *R. nanothamnus*, *R. sempervirens*, and *R. sericea* have hitherto not been evaluated pharmacologically.

Conclusion

A comprehensive review of the genus Rosa in India revealed the presence of 38 species in India, distributed across several geographical regions, suggesting its potential for future research with considerable medicinal and biotechnology application. The data collected during this research will form the basis for future *Rosa* species collections. The study also revealed that *Rosa* species are potential sources of diverse secondary metabolites; however, biochemical investigations on wild roses in India are limited, with the majority of them focusing on cultivated species. The geographic distribution of the *Rosa* species could have a significant influence on the morphological characteristics and the presence/absence of secondary metabolites, as well as the concentrations of each metabolite in their tissues and in various populations. It is important to emphasize that Indian *Rosa* species, especially those found in the Western Himalayan region, have received less attention in terms of phytochemistry and the evaluation of their pharmacological properties therefore future research may focus on the phytochemical and pharmacological properties of less investigated *Rosa* species.

Declarations

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