

## Phyto-Chemical, Pharmacological, Ethno-Botanical and Ecological Importance of *Prunus cerasoides* D. Don. for Human Health and Livelihood Development: A Review

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### ABSTRACT

*Prunus cerasoides* D. Don, a deciduous tree of the Rosaceae family, is widely distributed across the Himalayan regions including the North-central Indian State of Himachal Pradesh, as well as the countries of Nepal, Bhutan, Myanmar, Thailand and the Western part of China. Additionally, it can be found in various parts of India's North-eastern provinces, including Sikkim, Assam, Khasi Hills, Manipur and Mizoram

and is valued for its therapeutic and ethnobotanical importance. This review summarizes the phytochemical constituents identified from various parts of the plant, including flavonoids, terpenoids, phenolics, glycosides, and sterols. Documented pharmacological properties include antioxidant, anti-inflammatory, antimicrobial, anticancer, and anti-plasmodial effects, as well as protective activity against benign prostatic hyperplasia (BPH). The plant is also used in traditional medicine for treating wounds, fractures, skin conditions, and digestive disorders. Indigenous knowledge across different regions of India and neighbouring countries highlights its continued relevance in local healthcare systems. This compilation provides an updated account of the phytopharmacological and ethnomedicinal attributes of *P. cerasoides* as reported in the literature.

**Keywords** *P. cerasoides*, Phytochemical, Pharmacology, Ethnobotanical, Antioxidant, Antibacterial.

### INTRODUCTION

The genus *Prunus*, belonging to the family Rosaceae, comprises a wide range of wild edible fruit trees and shrubs such as plum, cherry and peach. These species have long been recognized for their applications in traditional medicine, food processing, ornamental horticulture and most notably, for their therapeutic potential. Underutilized forest tree species with sig-

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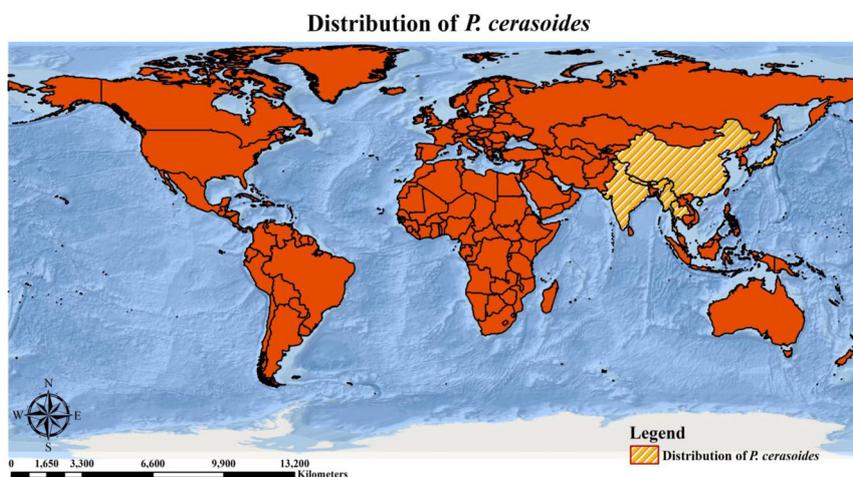
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**Fig. 1.** Map showing the geographical distribution of *P. cerasoides*. Source: The maps were generated by the authors using ArcGIS version 10.8.2 using information from the relevant literatures (Joseph *et al.* 2018).

nificant traditional uses in ethnomedicine have been recognized as valuable candidates in the search for newer and safer pharmaceutical compounds (Singh *et al.* 2024). *P. cerasoides* D. Don, commonly known as the Himalayan wild cherry, Padmaka in Sanskrit and Tlaizawng in Mizo (Rhodes *et al.* 2016) is one such underutilized species with considerable significance in pharmacology and ethnomedicine. According to Anjum and Tripathi (2013), wild edible fruits like *P. cerasoides* are rich in bioactive compounds and high-value nutraceuticals that can contribute to nutritional security. Notably, wild and non-conventional fruits have often shown superior nutritional attributes compared to cultivated counterparts (Novak and Haslberger 2000). *P. cerasoides* is a medium to large deciduous tree bearing pink to crimson flowers and small drupaceous fruits that ripen to red. It flowers in October and fruits between April and May. The species is distributed throughout the Himalayan region including Nepal, Bhutan, and parts of North-eastern and Northern India, as well as in Myanmar, Thailand and Southwestern China (Fig. 1). Due to its perceived sacredness, it is often preserved in religious sites, though its medicinal uses extend well beyond cultural symbolism. The gum exuding from the trunk is used traditionally as a substitute for gum tragacanth (Joseph *et al.* 2018), and the flowers are a vital nectar and pollen source for all four native *Apis* species found in India, *Apis cerana indica*, *Apis florea*, *Apis mellifera*, and *Apis dorsata* highlighting the

species' ecological relevance in apiculture (Awasthi *et al.* 2015). Despite its broad spectrum of traditional and ecological values, *P. cerasoides* remains significantly underutilized. Its naturally occurring populations have seen marked decline, primarily due to low germination rates and continued exploitation for medicinal, ritual, and utilitarian purposes (Tewari and Tewari 2016). It is currently categorized as 'Data Deficient' on the IUCN Red List (Rhodes *et al.* 2016). This review seeks to consolidate available knowledge on the phytochemistry, pharmacological activities, and ethnobotanical uses of *P. cerasoides*, while identifying critical research gaps and emphasizing the need for sustainable conservation strategies.

## MATERIALS AND METHODS

An extensive review of scientific literature was conducted to gather comprehensive information on the botanical description, distribution, cultivation, propagation, traditional utilities, ecological significance, and economic potential of *P. cerasoides*. Data were gathered from online databases, and scientific repositories, comprising Plants of the World Online (<https://powo.science.kew.org/>), Web of Science, PubMed (<https://pubmed.ncbi.nlm.nih.gov/>), Science Direct, as well as the NISCAIR Online Periodicals Repository (NOPR) (<http://nopr.niscair.res.in/>). To ensure accuracy and currency, the plant's scientific name and synonyms were verified using World Flora Online

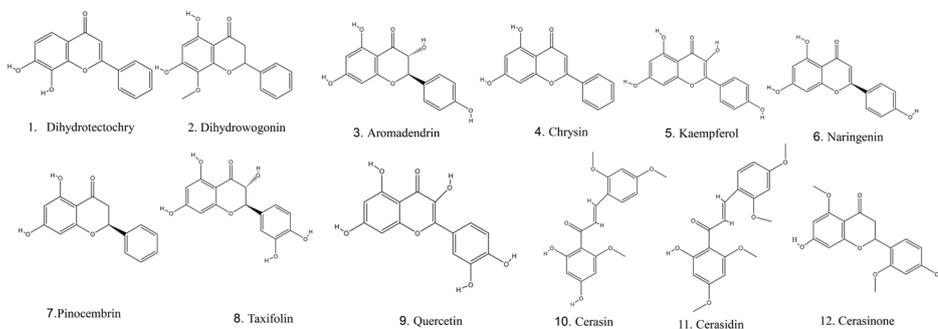
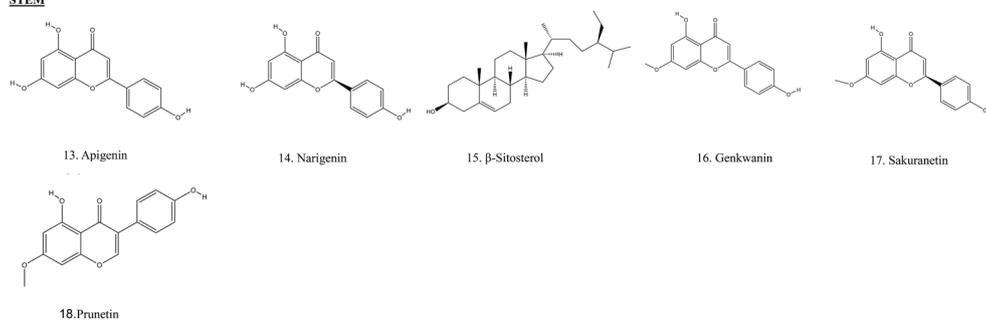
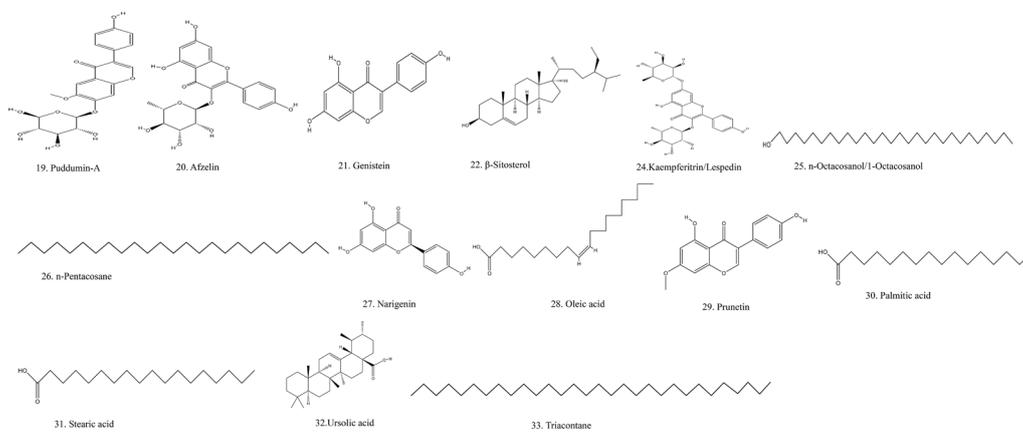
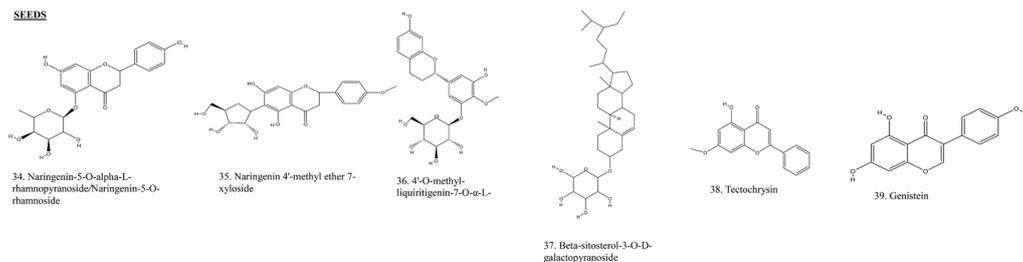
(<https://www.worldfloraonline.org/>). “*Prunus cerasoides*,” “ethnomedicinal use,” “botanical distribution,” “antioxidant,” “phytochemicals,” and “pharmacological activities” were systematically combined to locate relevant sources. Chemical structures and formulas of identified compounds were drawn using Chem Draw version 22.0.0.22 and validated through the Pub Chem database. Additionally, geographical maps illustrating the distribution of *P. cerasoides* were created using ArcGIS version 10.8.2.

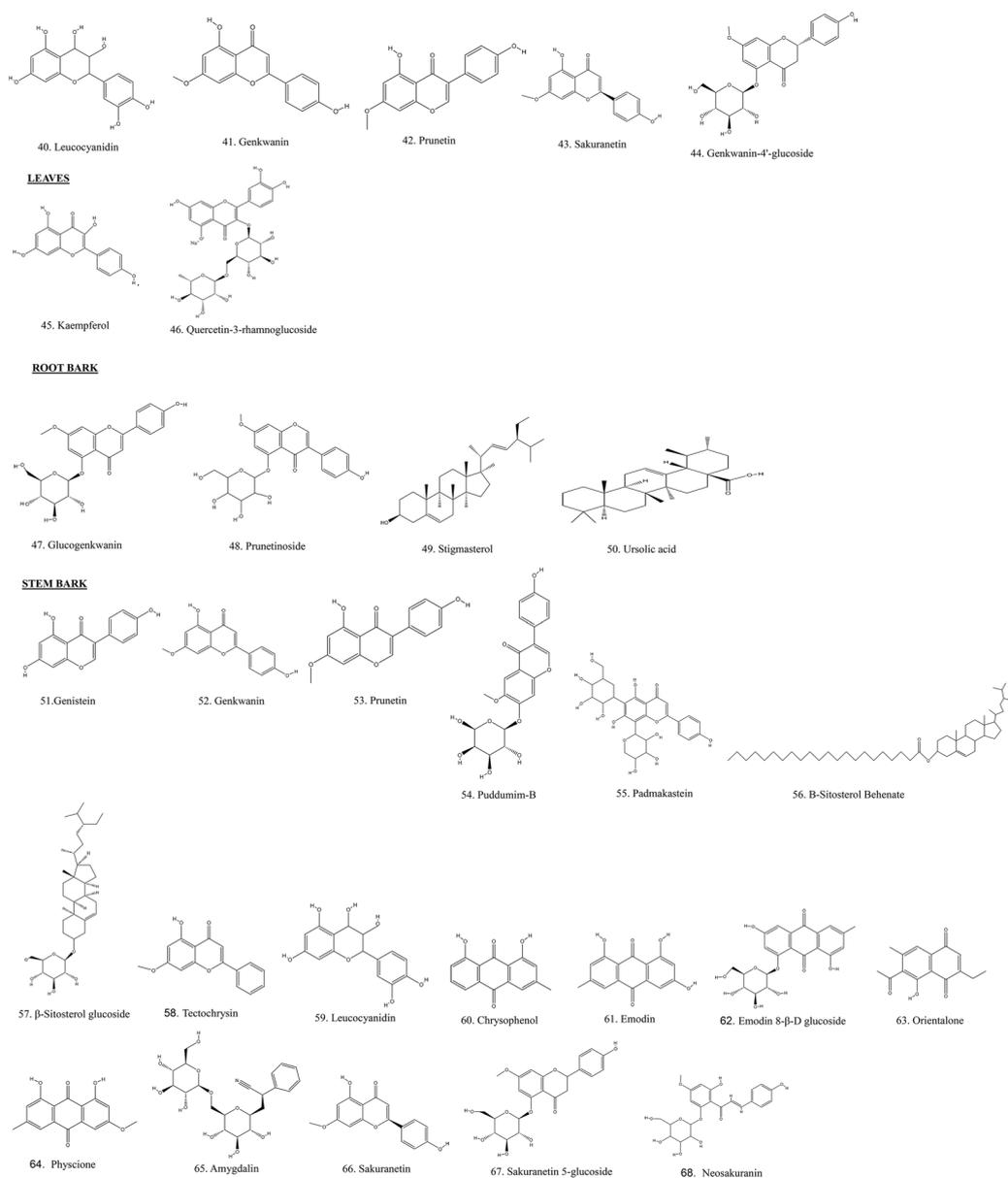
### Phyto-chemical properties/constituents of *P. cerasoides*

*P. cerasoides* has been documented to have several phyto-chemical compounds in different parts of the plant and is esteemed for its therapeutic properties. A variety of bioactive compounds, including flavonoids, alkaloids, steroids, phenolics, tannins, polyphenols, saponins, carbohydrates, terpenoids, glycosides, and amino acids, have been identified in *P. cerasoides*. Additionally, its leaf extract is acknowledged as a rich natural source of antioxidants (Joseph *et al.* 2018). The chemical characteristics and antioxidant properties of the gum exudates from *P. cerasoides* were analyzed by Malsawmtluangi *et al.* (2014). Research findings demonstrated that the gum had characteristics common to polysaccharides. It was discovered that galactose and arabinose made up the majority of the gum. The qualitative analysis of the stem bark revealed the absence of anthranol glycosides and coumarins, while flavonoids, diterpenes, cardiac glycosides, alkaloids, phytosterols, saponins, tannins, and triterpenes were detected using standardized methods. Only 1.9% of the phytoconstituents were triterpenes, whereas the most prevalent ones were diterpenes and flavonoids (26% and 20.5%, respectively) (Arora and Mahajan 2018). The analysis of exudate gum derived from the plant stems revealed a total carbohydrate content of  $73.72 \pm 2.44\%$  and a protein content of approximately  $2.33 \pm 1.25\%$ . The gum demonstrated characteristics similar to those of a typical natural polysaccharide, which is primarily composed of monosaccharides such as arabinose, galactose, glucose, rhamnose and xylose. Pre-formulation experiments demonstrated that the gum possesses potential applicability in the pharmaceutical industry. To facilitate the controlled

release of diclofenac sodium, researchers explored the development of pH-sensitive mucoadhesive beads by combining the naturally sourced gum from *P. cerasoides* with sodium alginate (Seelan *et al.* 2016). The antioxidant properties of *P. cerasoides* gum were evaluated through DPPH and hydroxyl radical scavenging assays, assessment of reducing potential and measurement of total phenolic content, highlighting its antioxidant potential (Malsawmtluangi *et al.* 2014).

The solid fraction of *P. cerasoides* seeds contains polyphenols, flavonoids, vegetal acids, and both procyanidins and anthocyanidins, which may offer therapeutic benefits in the prevention of various diseases (Bak *et al.* 2010). In various extracts obtained from *P. cerasoides* leaves, qualitative phyto-chemical screening confirmed the occurrence of alkaloids, steroids, terpenoids, flavonoids, phenolics, tannins, saponins, glycosides, carbohydrates, proteins, and amino acids (Joseph *et al.* 2016). The methanol extract contained the highest concentration of aforesaid chemical components. The diverse range of secondary metabolites found in *P. cerasoides* leaves indicates notable medicinal potential (Joseph *et al.* 2016). The presence of steroidal compounds is significant in pharmaceutical applications, as these molecules are responsible for several biological processes in the human body. The flavonoid compound Puddu-min-A, derived from *P. cerasoides*, demonstrated an enhanced diuretic effect. *P. cerasoides* seeds are traditionally recognized for their efficacy in treating kidney stones, urinary problems, and polyuria (Tiwari *et al.* 2017) (Table 1) (Fig. 2). The leaf extract of *P. cerasoides* was examined for its effects on prostate and urinary diseases. The research validated the efficacy of testosterone in the growth and maintenance of the rat prostate. Three distinct fractions of methanolic extract were assessed for their efficacy against prostate disorders in rats. The group treated with fraction III, showed a decreased impact of testosterone on prostate enlargement compared to those receiving fractions I and II. The extract obtained from *P. cerasoides* leaves exhibited the ability to reduce testosterone-induced prostate weight in rats (Sarma 2016). The extracts of *P. cerasoides* leaves, including acetone, chloroform, methanol, and ethyl acetate, were evaluated for their

**HEARTWOOD****STEM****SAPWOOD****SEEDS**



**Fig. 2.** Isolated compounds of *P. cerasoides* from various parts of the plant.

total phenolic and flavonoid content, along with their antioxidant properties. All extracts demonstrated differing levels of antioxidant potential depending on concentration, however, the methanol extract contained the highest total phenolic content (0.033 mg GAE/g of extract), total flavonoid content (6.26  $\pm$  0.016 mg QE/g of extract), and free radical scavenging activity (IC<sub>50</sub>, 56.00  $\mu$ g/ml) with a value

of 3.86  $\pm$  0.242. The total phenolic content showed a favorable connection with antioxidant capacity. The foliage of *P. cerasoides* exhibits a substantial concentration of bioactive phenolics and naturally occurring antioxidants (Joseph *et al.* 2016). The fruits of *P. cerasoides*, utilized for wine production, possess the highest levels of flavonoids, antioxidant compounds, total antioxidant activity, and poly-

**Table 1.** Phyto-chemical constituents in various parts of *P. cerasoides*.

Parts	Compounds present	Sources
Heartwood	Dihydrotecto-chrysin, dihydro-wogonin, aromadendrin, chrysin, kaempferol, naringenin, pinocembrin, taxifolin, quercetin, 2',4'-dihydroxy-2,4,6'-trimethoxy-chalcone (Carasin), 2'-hydroxy 2, 4, 4', 6'-tetramethoxy chalcone (Carasidin), 7-hydroxy-5, 2', 4'-trimethoxy flavanone (Carasinone)	Groh <i>et al.</i> (1994)
Stem	Apigenin, narigenin, $\beta$ -sitosterol, genkwanin, sakuranetin, prunetin	Pallavi <i>et al.</i> (2011)
Sapwood	Flavone glycoside puddumin-A (7-O-( $\beta$ -D-glucopyranosyl)-5-O-methyl-naringenin), afzelin, genistein, $\beta$ -sitosterol, $\beta$ -sitosterol- $\beta$ -D-glucoside, kaempferitrin, noctacosanol, npentacosane, naringenin, oleic, prunetin, palmitic, stearic acids, ursolic acid and triacontane.	Jangwan and Bahuguna (1989), Bahuguna and Jangwan (1987)
Branches	Substitute for amygdalin and hydrocyanic acid	Pallavi <i>et al.</i> (2011)
Seeds	Naringenin-5-O- $\alpha$ -L-rhamnopyranoside, naringenin 4'-methylether 7-xyloside, naringenin 4'-methyl ether-7-O- $\beta$ -D-glucoside, 4'-O-methyl-liquiritigenin-7-O- $\alpha$ -L-rhamnopyranoside, $\beta$ -sitosterol-3-O-D-galactopyranoside, tectochrysin, genistein leucocyanadin, genkwanin, prunetin, Sakuranetin, genkwanin-4'-glucoside and flavonoid glycoside 7-O- $\beta$ -D-galactopyranosyl-5-O-methyl naringenin	Chakravarti and Bhar (1942), Shrivastava (1982), Jangwan and Kumar (2015)
Leaves	Kaempferol and Quercetin-3-rhamnoglucoside.	Thapliyal and Bahuguna (1993)
Root bark	Glucogenkwanin, prunetinoside, stigmasterol and ursolic acid	Chakravarti and Bhar (1942)
Stem bark	A flavanone glycoside (naringenin-4'-methylether-7-O- $\beta$ -D-galactoside), genistein, genkwanin, prunetin, Puddumin-B, padmakastein and its derivatives, $\beta$ -sitosterol behenate, $\beta$ -sitosterol glucoside, 4'-glucoside of genkwanin, tectochrysin, leucocynidin, chrysophenol, emodin, 8- $\beta$ -D glucosides, orientalone, physcion, amygdalin, prunasetin (isoflavone), puddumetin, sakuranetin, flavanone, sakuranetin (5, 4'-dihydroxy-7-methoxy flavones) and its 5-glucoside, neosakuranin (2,4'-dihydroxy-4-methoxy-6-glucosid-oxy chalcone), leucocyanidin, taxifolin	Jangwan and Bahuguna (1989), Garg <i>et al.</i> (1986), Thapliyal and Bahuguna (1993), Narasimhachari and Seshadri (1949)
Fruits	2, 4, 4'-dihydroxy-6-methoxy chalcone-4-O-( $\beta$ -D-glycopyranosyl (1 $\rightarrow$ 4)) $\alpha$ -L-rhamnopyranoside	Jangwan and Painuly (2007)

phenols, making them a highly valuable wild fruit that can be effectively utilized instead of remaining economically insignificant (Rana and Singh 2013).

### Therapeutic and pharmacological properties of *P. cerasoides*

*P. cerasoides* is highly valued for its broad spectrum of therapeutic and pharmacological effects. It has been identified as possessing antioxidant, analgesic, anti-abortifacient, antispasmodic, contraceptive, carminative, febrifuge, expectorant, and tonic properties (Sharma 2013), making it a significant component in traditional medicinal systems. In a mouse model of cerebral ischemia, *Prunus cerasoides* extract (PCE) was shown to upregulate neuroglobin (Ngb) levels, suppress oxidative stress and apoptosis, and improve functional outcomes, suggesting its potential as a neuroprotective agent (Kim *et al.* 2021).

### Anti-cancer properties

The anti-cancer potential of *P. cerasoides* was demonstrated through the isolation of flavonoids from its stem bark. These compounds were tested using the MTT assay against HeLa cancerous cell lines, showing significant anticancer activity. The extract was shown to have anti-cancer effects, as evidenced by its IC<sub>50</sub> value of 0.247 mg/ml and its ability to inhibit 24.75% of malignant cells at the lowest dosage of 0.0312 mg/ml (Arora and Mahajan 2019).

### Protective effects against benign prostatic hyperplasia (BPH)

The potential of *Prunus bark*, including that of *P. cerasoides*, to prevent testosterone-induced BPH, also known as benign prostatic hyperplasia, has been studied. The findings demonstrated a notable

inhibitory effect, implying that *P. cerasoides* may be applied as a therapeutic option for BPH (Jena *et al.* 2016). This advantage emphasizes its focused role in managing prostate health.

### Antimicrobial potential

*P. cerasoides* also exhibits antimicrobial properties. Both Gram-positive bacteria (*Staphylococcus aureus*, *Bacillus subtilis*) and Gram-negative bacteria (*Salmonella typhi*, *Escherichia coli*) were tested against *P. cerasoides* ethanol extracts. Aqueous extracts from the stem bark were tested against a range of pathogenic microorganisms, including both Gram-positive bacteria (*Enterococcus faecalis*, *Staphylococcus aureus*, *Staphylococcus epidermidis*) and Gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhimurium*, *Shigella flexneri*). The extract demonstrated significant suppression of all examined bacterial strains, confirming its effectiveness in combating bacterial infections (Sharma 2013).

The extract was also evaluated against yeast strains (*Candida albicans*, *Candida tropicalis*), revealing their potential as a source for new antimicrobials and effective herbal medicines. The findings suggest that *P. cerasoides* could serve as a promising source of new antimicrobial agents, addressing the growing challenge of antimicrobial resistance (Arora and Mahajan 2018).

### Anti-plasmodial activity of *P. cerasoides*

*P. cerasoides* was tested for its anti-plasmodial efficacy against *Plasmodium falciparum*. Water-based extracts derived from the leaves, wood, bark, and fruit exhibited minimal to no action at doses reaching up to 100 µg/ml. The methanol extract displayed moderate to suboptimal activity, with IC<sub>50</sub> values ranged between 21 and 100 µg/ml. The methanolic extract was fractionated, separated in nine fractions with moderate anti-plasmodial activity and three with good activity (IC<sub>50</sub>: 1–20 µg/ml). Five fractions had minimal to no activity. Significantly, mammalian cell lines were not cytotoxically affected by the active portions (Sachdeva *et al.* 2021).

### Gum in drug delivery

The polysaccharide gum from *P. cerasoides* was used to develop controlled-release formulations with diclofenac sodium as the active ingredient, employing ionotropic gelation techniques with divalent cations as cross-linking agents (Seelan *et al.* 2016). Additionally, combinations of *P. cerasoides* gum with chitosan and galactomannan were tested as a wall material to encapsulate thermolabile compounds such as anthocyanins. The resulting formulations demonstrated stability with enhanced shelf life by protecting the active ingredients from photo-oxidation and thermal degradation. The combination of *P. cerasoides* gum with chitosan and galactomannan improved the stability and antioxidant potential of the encapsulated compounds, suggesting its potential in drug delivery applications (Sendri *et al.* 2022).

### Indigenous and Ethnomedicinal uses of *P. cerasoides*

In various regions of India and neighbouring countries, *P. cerasoides* continues to be used in indigenous healing practices. Bark is used for wound healing, fever, and dislocations (Singh and Attri 2014), while seed and seed kernel are used in the treatment of kidney stones, skin problems, and bleeding disorders (Mehra *et al.* 2014). The fruit is recognized for its digestive and astringent properties (Joseph *et al.* 2018), and flowers are known for their diuretic and laxative effects. Honey derived from *P. cerasoides* flowers is traditionally used in eye treatments (Dhiman *et al.* 2010). Leaves are used in managing urinary and prostate-related disorders (The Wealth of India, 2003). In Mizoram, a decoction made from the bark is consumed as a remedy for malaria (Bora *et al.* 2007). In Nagaland, bark and wood are used to treat indigestion, fever, diarrhea, asthma, urinary ailments, and wounds, while heartwood decoctions are applied for healing wounds and sprains (Hazarika and Pongener 2018). In Uttaranchal, bark boiled in water is used for swelling (Uniyal and Shiva 2005). In Nepal, the plant's leaves are used to treat fractures (Joshi *et al.* 2011), and bark and leaves are used for blood purification, internal injuries, and rheumatic pain (Rana *et al.* 2013). In Sikkim, crushed stem bark is applied to injuries for ethnoveterinary care (Bharati

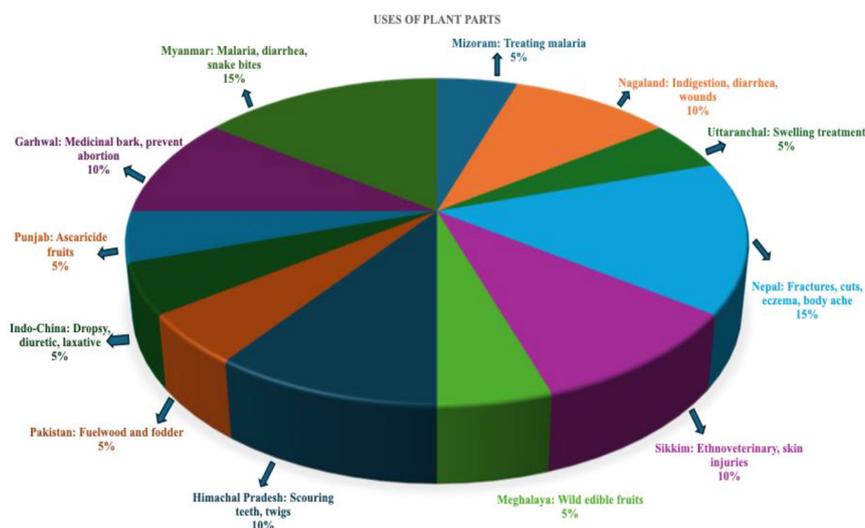


Fig. 3. A pie-chart showing the indigenous uses of *P. cerasoides*.

and Sharma, 2010). Among wild edibles, the fruits of *P. cerasoides* are consumed by the indigenous people of Meghalaya (Sawian *et al.* 2007). In Himachal Pradesh, the stem is traditionally used for scouring teeth (Rawat *et al.* 2010). In Pakistan, the plant serves as fuelwood and fodder (Shah *et al.* 2018). In Southern Chin State, Myanmar, the Müün ethnic group uses the leaves for malaria, bark decoction for edema, snake bites, and diarrhea, and bark for treating ringworm (Ong *et al.* 2018). The seeds are also used by indigenous communities of Garhwal to prevent abortion, typically taken as a decoction on an empty stomach (Ghildiyal *et al.* 2014). In Punjab, the fruits of *P. cerasoides* are recognized for their role as an ascaricide (Tiwari *et al.* 2017). In the Kullu district of Himachal Pradesh, twigs are used for cleaning teeth (Rathore and Shashni 2020) (Fig. 3). Diverse applications in indigenous healthcare reflect their importance which warrants its clinical validation.

#### Prunus as an indicator and framework species

Climate change has caused substantial changes in plant phenology on a global scale. Currently, numerous plant species bloom and leaf out earlier than in the past due to global warming (Parmesan 2006). One of the most significant sources of information on how global warming affects plants is the timing of Japan's

cherry tree festivals. The Kyoto data set, notably, predates all other known datasets on plant blooming timings and indicates that cherry is currently flowering sooner than at any point in the last 1200 years (Aono and Kazui 2008). According to Abu-Asab *et al.* (2001), the Japanese-donated cherry trees in the government of Washington, DC, are blooming one week earlier than usual in response to the rising temperatures, which shows the perfect example of the impacts of climate change. In Thailand, *P. cerasoides* has been recognized as a "framework tree species" for the restoration of evergreen forest in response to forest degradation (Pakkad *et al.* 2004).

#### CONCLUSION

*P. cerasoides* is a species that is both widely distributed and culturally significant, demonstrating impressive potential in multiple areas such as traditional medicine, pharmacology, renewable energy, and ecological restoration. Its diverse phytochemical constituents, such as flavonoids, terpenoids, phenolics and glycosides, contribute to its documented antioxidant, anticancer, antimicrobial, and anti-inflammatory effects. The plant has also shown promising activity against benign prostatic hyperplasia and malaria-causing parasites. Ethnomedicinal and indigenous knowledge systems across various regions have

long recognized its healing potential, especially for treating fractures, wounds, skin conditions and urinary disorders. Despite growing interest in *P. cerasoides*, significant research gaps persist across multiple domains. The anti-plasmodial potential of the species is supported by preliminary findings, yet the specific active compounds and their mechanisms of action remain unidentified. Ecologically, limited studies exist on its genetic diversity, reproductive success, and habitat-specific propagation strategies, all of which are essential for informed conservation. Future research should prioritize the characterization of genetic variability, adaptive traits, and long-term ecological interactions to inform effective *in-situ* and *ex-situ* conservation strategies. An integrated approach combining ecological, genetic, and pharmacological research will be key to preserving this underutilized yet valuable species for both biodiversity and public health benefits.

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