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A COMPREHENSIVE REVIEW ON PRUNUS MAHALEB

Praveen Kumar Dasari*, Kumar Raja J., Jashuva CH., Thanmai M., Gayatri Devi S., Pavani S.

Mother Teresa Pharmacy College, Sathupally, Telangana, India.

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Corresponding Author: Praveen Kumar Dasari

Address: Mother Teresa Pharmacy College, Sathupally, Telangana, India.

Email ID: drdppharma@gmail.com,

ABSTRACT

The mahaleb cherry (*Prunus mahaleb* L.), a fragrant shrub belonging to the Rosaceae family, has long been cultivated for its valuable essential oil and seeds. Known for their significant therapeutic and nutritional properties, the plant is primarily grown in Mediterranean regions but is also found across North Africa, Central Asia, and parts of Southern Europe. The cherry has been traditionally recognized for its wide array of health-promoting effects, which include antioxidant, antimicrobial, anti-inflammatory, gastroprotective, neuroprotective, and diabetic management properties. Due to these beneficial effects, *Prunus mahaleb* holds great promise for applications in both natural medicine and modern pharmacology. This comprehensive review draws on data collected from a variety of reputable online databases, including Google Scholar, Science Direct, Scopus, Research Gate, Elsevier, Med, and Web of Science. In addition to these online resources, data from the library of the pharmacognosy department were also examined to provide a deeper understanding of the plant's photochemical constituents, pharmacognosy, and pharmacological activities. The gathered information was meticulously analyzed and verified to ensure authenticity. The goal of this review is to uncover the full potential of *Prunus mahaleb* for therapeutic use, particularly in the areas of medicinal nutrition, pharmaceutical industries, and future research on its bioactive compounds.

KEYWORDS: *Prunus mahaleb,* essential oil and seeds, therapeutic, nutritional properties.

INTRODUCTION

The plant produces hydrogen cyanide, a toxin primarily found in its leaves and seeds. It is cultivated mainly for its fragrant flowers and valuable wood. This is a deciduous tree or large shrub, growing up to 29 feet tall and 29 feet wide. The leaves are simple, alternate, and toothed. They are green in color, small (2.5-5 cm long), and nearly round, with some being almost as wide as they are long. The stems are grey-brown with prominent lenticels on young growth, and as they mature, they become shallowly fissured. The stems do not have thorns. The flowers are small, fragrant, and pure white, measuring 8-20 mm in diameter with an 8-15 mm pedicel. They appear in inflorescences that typically contain fewer than 10 flowers arranged in a raceme. The fruit is a small drupe resembling a cherry, with a thin flesh and a diameter of 8-10 mm. It starts off green, turns red, and finally ripens to a dark purple or black color, accompanied by a notably bitter taste. The plant flowers in mid-spring, and the fruit reaches full maturity between mid to late summer. Native to the Mediterranean, Iran, and parts of Central Asia, it grows in environments such as moist forests, riverbanks, roadsides, fields, thickets, dump sites, and railroads. The plant reproduces via seeds. Its light green, broadly ovate to round, glossy leaves, extremely fragrant flowers, and small black fruits help distinguish it from other native *Prunus* species. The repeated range of the mahaleb cherry spans Central and Southern Europe, widen to Spain and Gibraltar, and gain at Northwest Africa. It grows from the Balkans to Ukraine, Western and Central Asia. This species can be found at elevations ranging from lowlands to above 1,000 meters in areas such as the South Carpathians, Caucasus, and Tien Shan Mountains. It has been introduced and is considered potentially invasive in South America, North America, Australia, and New Zealand.

Fig. 1: Prunus Mahaleb.

Habitat and Ecology

The mahaleb cherry is a hot-tolerated pioneer species that flourish in warm, sunny, and dry slopes at mid-elevations. It is well-suited to Mediterranean and temperate dry climates, requiring annual precipitation levels between 500-600 mm and showing strong resistance to frost. The plant prefers calcareous soils with a pH around 5.5, particularly in rocky or stony habitats. While it can tolerate some shade in its early growth stages, it becomes highly reliant on full sunlight as it matures. Fruit production is regulated, with the earliest blooming flowers having a competitive advantage in acquiring maternal resources, leading to faster fruit development.

Importance and Usage

The mahaleb cherry is valued for its robust root system and is often used in horticulture as a frost-resistant rootstock for sweet cherries (*Prunus avium*) and sour cherries (*Prunus cerasus*). Its wood is dense, hard, and fragrant, making it ideal for crafting small objects such as tobacco pipes, canes, and cigarette holders. The small, bitter fruits can be used to extract a purple dye, while the seeds are more widely utilized. The seeds produce an aromatic spice, with a flavor similar to almonds, traditionally used in Middle Eastern and North African cuisine to enhance the taste of bread, cakes, cheese, and cookies.

Recent research highlights the potential of *Prunus mahaleb* seeds as a promising new source of edible oil, particularly due to their high levels of polyunsaturated fatty acids, including α-eleostearic acid, a rare conjugated fatty acid in vegetable oils. This oil may offer significant health benefits. Additionally, the bark, wood, and seeds contain coumarins, which exhibit potential anti-inflammatory, sedative, and vasodilatory effects, making them valuable pharmaceutical use. As a pioneer genus with a intense root system, Prunus mahaleb is pivotal for fed off soil erosion and is preferably flatter for land reclamation and afforestation forecast. The plant's tolerance to pruning also makes it ideal for use in hedging. Ecologically, its importance is emphasized by the fact that birds and mammals, such as badgers, consume its fruit, aiding in seed dispersal over long distances.

Fig. 2: *Prunus Mahaleb* Seeds.

Threats and Diseases

The mahaleb cherry is liable to numerous fungal sepsis, plus bracket fungus (*Laetiporus sulphureus*) and witches' broom (*Taphrina cerasi*), that influence its trunk and branches. Other common fungal parasites include rust fungus (*Tranzschelia discolor*), which affects its leaves, *Taphrina minor*, which causes shrinkage and reddish-brown discoloration of the leaves, and *Phloeosporella padi*, which causes leaf spots.

Native to: Albania, Austria, Belgium, Bulgaria, East Aegean Islands, France, Germany, Greece, Hungary, Iran, Iraq, Italy, Kazakhstan, Kyrgyzstan, Crimea, Lebanon-Syria, Morocco, North Caucasus, Pakistan, Portugal, Romania, Sicily, Spain, Switzerland, Tajikistan, Transcaucasia, Turkey, Turkey-in-Europe, Turkmenistan, Ukraine, Uzbekistan, and Yugoslavia.

Control Methods

There is limited information on managing the mahaleb cherry, as it is not widely recognized as an invasive species. Smaller trees can be manually uprooted. For larger trees or shrubs, the cut-stump method is more effective, which involves cutting the main stem near the ground and applying a suitable herbicide to the freshly cut stump to prevent regrowth. For additional assistance, consulting a local extension agent is recommended.

Exploring the Antioxidant and Phenolic Benefits of Prunus mahaleb: A Functional Food Perspective:

Prunus mahaleb L. (also known as Cerasus mahaleb L. Mill.) is recognized as a medicinal plant that naturally grows in Tokat and various other regions of Turkey. The seeds and flesh of its fruit are utilized in the production of products such as mahaleb vine, flour, oil, and more. Wild mahaleb fruits are abundant in bioactive compounds, including phenolic

compounds, anthocyanins, flavonoids, and vitamins C and E (tocopherols). Due to its health benefits, the plant is commonly used in folk medicine, particularly for managing diabetes. Studies have demonstrated that the wild fruits and other parts of the Prunus mahaleb tree exhibit strong free radical scavenging properties and possess antioxidant, anti-inflammatory, and anticancer activities, categorizing it as a functional food with the potential to help prevent various chronic diseases. This study assesses the phenolic content and antioxidant activity of methanolic extracts from the fruit, leaves, and bark of the mahaleb plant collected in Tokat. The total phenolic content in the bark was found to be 170.21 mg of gallic acid equivalents (GAE) per gram, while the total flavonoid content was measured at 260.5 mg of quercetin equivalents (QE) per gram. Furthermore, the anthocyanin content in the fruit was recorded at 38.54 mg of catechin equivalents (CE) per gram., while the total flavonoid content reached 260.5 mg of quercetin equivalents (QE) per gram. Additionally, the anthocyanin content in the fruit was 38.54 mg of catechin equivalents (CE) per gram. Antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay, where the fruit extract showed the highest antioxidant activity, achieving a 90.2% inhibition rate in the DPPH assay. The results indicate that the mahaleb plant, particularly its fruit, contains significant amounts of phenolic, flavonoid, and anthocyanin compounds, making it a valuable source of bioactive ingredients. While the fruit is edible, other parts of the plant that are not commonly consumed can still be utilized for various purposes. Due to its high anthocyanin levels, *Prunus mahaleb* may also serve as a natural food colorant and antioxidant component in the formulation of functional food products.

Plant Materials: Black mahaleb (*Prunus mahaleb* L.) samples were gathered in June from Tokat, Turkey. The fruits and seeds were manually separated, with the fruit portion being freeze-dried using a freeze dryer. The prepared samples were then stored at 4°C in dark conditions until they were ready for further analysis.

Preparation of Extracts: Dried leaves and bark were ground into a fine powder using a mortar and pestle. Thirty grams of each test were withdraw with 300 mL of 95% methanol for 48 hours at room warmth. The extracts were filtered, dried using a rotary evaporator, and then freeze-dried. For the fruits, the same extraction method was used, except 400 mL of 1 M sodium acetate, 240 mL of 1 M HCl, and 360 mL of water were added to fresh fruit samples. The extracts were stored in a fridge before audit. The mixture was homogenized and then

centrifuged at 4°C at 5,000 g for 15 minutes. The supernatant was collected and set aside for further testing.

Measurement of Anthocyanin Content: Pigments were extracted using 5 mL of acidified methanol (1% HCl, w/v). The extracts were shaken for 48 hours at 4°C, and the absorbance of the filtered extracts was measured at 530 nm and 657 nm. The formula A530 - 0.25 A657 was worn to modify for the offering of chlorophyll and its decline products.

Determination of Total Flavonoid Content (TFC):

The total flavonoid content (TFC) was measured following the method developed by Huang et al., with minor modifications. Five milliliters of a 2% aluminum trichloride ($AlCl_3$) solution in methanol were combined with an equal volume of the extract solution (0.4 mg/mL). The absorbance was recorded at 367 nm using a UV-visible spectrophotometer. A standard curve was generated using quercetin, and the TFC was reported as milligrams of quercetin equivalents (QE) per gram of dry extract (mg QE/g DE). All experiments were performed in triplicate to ensure precision and reliability.

Total Phenolic Content: The total phenolic content was measured spectrophotometrically using the Folin-Ciocalteu reagent, following the method of Singleton and Rossi. A standard calibration curve was prepared using gallic acid (20-120 mg/L), and the total phenolic content was expressed as milligrams of gallic acid equivalents (GAE) per gram of fresh weight. Absorbance was measured at 670 nm.

Assessment of Antiradical Activity in Samples: Antiradical activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method. The percentage inhibition of the samples was determined by mixing 0.1 mL of the extract with 3.9 mL of a 0.1 mM DPPH solution in methanol. This mixture was left to incubate at room temperature in darkness for 30 minutes. After incubation, the absorbance was measured at 517 nm using an Agilent 8453 spectrophotometer.

DISCUSSION

Prunus mahaleb is thought to have originated in northern Iraq, where its seeds, fruits, and other parts have been traditionally used in medicine as well as for flavoring and aroma. In Turkish folk medicine, various parts of the plant are utilized as tonics for various health issues. The bitter fruits and seeds have a long-standing reputation for treating gastrointestinal

problems, diabetes, and serving as heart tonics. Additionally, the tree's bark resin has been used for generations to address gastritis. Herbal teas made from the stems, fruit stalks, leaves, and flowers have also been traditionally consumed locally to relieve colds and asthma, especially in winter. Furthermore, oil extracted from the kernels is used in making liqueurs, varnishes, and specialty wines due to its fragrant qualities. In countries such as Sudan, the seed kernels are used to treat childhood diarrhea, while in Arab nations, they are recognized for their sedative and vasodilatory properties.

Many traditional applications have been confirmed through biological studies, both in vitro and in vivo. The goal of this research is to gather and analyze the existing literature on Prunus mahaleb, focusing on its botanical, ethnobotanical, phytochemical, and pharmacological features. Studies have shown that Prunus mahaleb exhibits a wide range of pharmacological effects, including antibacterial, antifungal, antiviral, antioxidant, anti-inflammatory, and neuroprotective activities. Inflammation is particularly linked to various conditions such as atherosclerosis, cardiovascular diseases, stroke, cancer, diabetes, osteoarthritis, asthma, migraine, periodontitis, irritable bowel syndrome, and chronic fatigue syndrome. Currently, nonsteroidal anti-inflammatory drugs (NSAIDs) are widely used to manage chronic inflammatory disorders, but they can have negative side effects. Consequently, there is growing interest in developing effective natural anti-inflammatory agents. Recent research has indicated that many wild fruits, including Prunus mahaleb, demonstrate anti-inflammatory properties through various mechanisms. Nitric oxide (NO) serves as a biomarker for inflammation, particularly when inducible nitric oxide synthase (iNOS) is activated. Suppressing NO levels suggests potential anti-inflammatory effects. A study by A. Oskoueian et al. investigated the in vitro anti-inflammatory properties of methanol extracts from Prunus mahaleb seeds, revealing the extract's ability to inhibit iNOS activity while preserving cell viability.

Cyclooxygenase-2 (COX-2) is crucial in the inflammatory process, and several studies have linked it to the onset and progression of diabetes and diabetic nephropathy. Thus, COX-2 inhibition is seen as an indicator of anti-inflammatory potential. Another study assessed the anti-inflammatory effects of a water extract from Prunus mahaleb fruit, demonstrating its ability to inhibit the upregulation of TNF-α and COX-2 gene expression, both significant contributors to colon inflammation. This finding supports the idea that Prunus mahaleb extract possesses anti-inflammatory effects in the colon. Tumor necrosis factor-alpha (TNF-

α) is a cytokine that plays a role in systemic inflammation, influencing the expression of adhesion molecules in human umbilical vein endothelial cells (HUVECs). The reaction of these adhesion molecules to inflammatory stimuli can affect the progression of atherosclerosis by enhancing interactions between blood cells, such as leukocytes, and endothelial cells.

Adhesion molecules like ICAM-1, VCAM-1, and E-selectin are known to promote inflammation. Flavonoids, abundant in plants, have a negative correlation with cardiovascular disorders and are recognized for their protective effects against atherosclerosis. Anthocyanins, the primary flavonoids found in Prunus mahaleb fruits and vegetables, contribute to the vibrant red, blue, and purple hues in many plant-based products. Concentrated extracts of Prunus mahaleb contain significant levels of anthocyanins, flavanols, and coumarins, which have been shown to lower the expression of ICAM-1, VCAM-1, and E-selectin in human umbilical vein endothelial cells (HUVECs), potentially leading to anti-inflammatory effects.

Most studies investigating the pharmacological activities of Prunus mahaleb extracts, including their antiproliferative, antiplatelet aggregation, and cytotoxic properties, have utilized in vitro assays. In vitro systems are favored for their cost-effectiveness and efficiency in screening for chemotherapeutic activity compared to in vivo systems. While in vitro findings may not always accurately predict in vivo results, they provide valuable preliminary data that can guide future research. Moreover, in vitro studies help narrow down the focus for subsequent investigations, which may involve more extensive and costly in vivo methods. Resistance to antibiotics has become a significant global health concern. Bacteria develop resistance through various mechanisms, including disrupting cell wall synthesis, inhibiting protein and nucleic acid synthesis, or acting as antimetabolites. Over time, resistance has emerged to all types of antimicrobial drugs, leading to a rise in clinical challenges related to bacterial resistance.

Uses: Oil:

The seeds of *Prunus mahaleb* can be used to produce edible oil, which is rich in polyunsaturated fatty acids, including α-eleostearic acid. This particular fatty acid is known for its potential health benefits, such as anti-inflammatory and cardioprotective effects.

Medicine

In traditional Iranian medicine, the seed extract of *Prunus mahaleb* has been used to treat conditions such as kidney stones and respiratory infections. It has demonstrated antioxidant and antibacterial properties.

Wood

The hard, durable wood of *Prunus mahaleb* is often used in cabinet-making and for crafting pipes.

In Turkey, the fruits and seeds of *Prunus mahaleb* have been used for centuries as a tonic for heart-related issues. They are also commonly employed in traditional remedies for diabetes and gastrointestinal problems. The oil derived from the seed kernels contains small amounts of cyanogenic glycosides and coumarin derivatives, which contribute to its medicinal properties.

Mahaleb seeds

Mahaleb, also known as mahlab, is used in small amounts to enhance the flavor of fruit dishes, cakes, and specific cheeses like tresse cheese. For centuries, it has been a key ingredient in the Middle East and surrounding areas, particularly as a flavoring in baked goods. Historical recipes from ancient Sumer reference the use of the fruit or seed, called "ḫalub."

While mahlab has some savory uses, such as in lamb tagine, it is primarily recognized as a baking spice. It is incorporated into various pastries and breads throughout regions from Greece to Iraq. A notable example is its use in tsoureki, a Greek sweet bread traditionally made for Easter, which is also popular in Christmas baking. Often ground, the spice is favored in turnovers, Middle Eastern cheeses, and desserts, where its subtle cherry-almond flavor enhances the overall profile. There are numerous recipes featuring mahaleb, including items like fatayers and sambousaks, as well as spice blends for dishes like shawarma. The *Prunus mahaleb* plant is typically harvested from the wild for local use, serving as a source of both food and medicine. It is especially prized for the almond-like flavor that its seeds provide and, in some cases, is even commercially harvested for this purpose.

CONCLUSION

The review above emphasizes that *Prunus mahaleb* L. is a significant medicinal plant due to

its wide range of biological activities. These effects can be attributed to the plant's rich composition of phytochemical constituents, including coumarins (such as coumarin, dihydrocoumarin, and herniarin), polyphenolic compounds (phenolic acids, flavonoids, and anthocyanins), glycosides, tannins, and proanthocyanidins. These compounds contribute to *Prunus mahaleb*'s demonstrated anti-inflammatory, analgesic, antibacterial, and antioxidant properties, making it valuable in conventional, pharmaceutical, and therapeutic contexts. The purpose of this review is to pinpoint the specific active components responsible for the bioactivities of *Prunus mahaleb* L., which could inspire future developments in medicinal products, food innovations, and industrial applications. With further research, the plant's diverse bioactive properties could stimulate advancements in various fields, ranging from pharmaceutical formulations to functional foods.

REFERENCES

1. David publications. Journal of agriculture science of technology, 2021; 11: 46-51.
2. P. Jordano, Ecology, 1995; 76: 2627.
3. C. Garcia, P. Jordano, J. A. Godoy, Molecular Ecology, 2007; 16: 1947.
4. M. Amodeo, S. Zalba, Plant Ecology, 2013; 214: 1299.
5. D. Bass, N. Crossman, S. Lawrie, M. Lethbridge, Euphytica, 2006; 148: 97.
6. C. M. Herrera, P. Jordano, Ecological Monographs, 1981; 51: 203.
7. M. Abedian, M. Talebi, B.-E. SayedTabatabei, C. Ghobadi, Journal of Agricultural Science, 2012; 4: 191.
8. P. Jordano, J. A. Godoy, Molecular Ecology, 2000; 9: 1293.
9. H. M. Sbihi, I. A. Nehdi, S. I. Al-Resayes, Journal of Food Science, 2014; 79: 795.
10. S. Özgül Yücel, Journal of the American Oil Chemists' Society, 2005; 82: 893.
11. M. El-Dakhakhny, Journal of Pharmaceutical Sciences, 1970; 59: 551.
12. P. Jordano, E. W. Schupp, Ecological Monographs, 2000; 70: 591.
13. M. Fuentes, et al., Plant Ecology, 2001; 157: 69.
14. A. Scalbert, I. T. Johnson, M. Saltmarsh, Am. J. Clin. Nutr., 2005; 81: 215.
15. K. D. Croft, Arch. Biochem. Biophys., 2016; 595: 120.
16. A. T. Dinkova-Kostova, A. Y. Abramov, Free Radical Biol. Med., 2015; 88: 179.
17. K. M. Holmström, L. Baird, Y. Zhang, I. Hargreaves, A. Chalasani, J. M. Land, L. Stanyer, M. Yamamoto, A. T. Dinkova-Kostova, A. Y. Abramov, Biol. Open, 2013; 2: 761.

18. M. H. Ludtmann, P. R. Angelova, Y. Zhang, A. Y. Abramov, A. T. Dinkova-Kostova, Biochem. J., 2014; 457: 415.
19. L. Li, J. Fu, J. Sun, D. Liu, Wang, Y. Hou, J. Xu, Curr. Opin. Toxicol., 2019; 13: 35.
20. N. Auberval, S. Dal, E. Maillard, W. Bietiger, C. Peronet, M. Pinget, V. Schini-Kerth, S. Sigrist, Eur. J. Nutr., 2017; 56: 1467.
21. C. S. Kim, Y. Kwon, S. Y. Choe, S. M. Hong, H. Yoo, T. Goto, T. Kawada, H. S. Choi, Y. Joe, H. T. Chung, R. Yu, Nutr. Metab., 2015; 12: 33.
22. R. C. Scarpulla, Physiol. Rev., 2008; 88: 611.
23. F. Blando, C. Albano, Y. Liu, I. Nicoletti, D. Corradini, N. Tommasi, C. Gerardi, G. Mita, D. D. Kitts, J. Sci. Food Agric., 2015; 96: 2641.
24. C. Gerardi, N. Tommasi, C. Albano, F. Blando, L. Rescio, E. Pinthus, G. Mita, Eur. Food Res. Technol., 2015; 241: 683.
25. C. Gerardi, S. Frassinetti, L. Caltavuturo, A. Leone, G. Mita, J. Funct. Foods, 2016; 27: 537.
26. S. N. Murthy, H. S. Cooper, H. Shim, R. S. Shah, S. A. Ibrahim, D. J. Sedergran, Dig. Dis. Sci., 1993; 38: 1722.
27. A. Ferramosca, V. Savy, V. Zara, Biosci., Biotechnol. Biochem., 2008; 72: 62.
28. U. Erben, C. Loddenkemper, K. Doerfel, S. Spieckermann, D. Haller, M. M. Heimesaat, M. Zeitz, B. Siegmund, A. A. Kühl, Int. J. Clin. Exp. Pathol., 2014; 7: 4557.
29. J. Charan, N. D. Kantharia, J. Pharmacol. Pharmacother., 2013; 4: 303.
30. H. Zhu, Y. R. Li, Exp. Biol. Med., 2012; 237: 474.
31. M. Perše, A. Cerar, J. Biomed. Biotechnol., 2012; 2012: 718617.
32. A. K. Pandurangan, Z. Saadatdoust, N. M. Esa, H. Hamzah, A. Ismail, BioFactors, 2015; 41: 1.
33. K. J. Kim, J. M. Park, J. S. Lee, Y. S. Kim, N. Kangwan, Y. M. Han, E. A. Kang, J. M. An, Y. K. Park, K. B. Hahm, J. Physiol. Pharmacol., 2018; 69: 3.
34. S. Song, Y. Zhang, K. Ma, L. Jackson-Hayes, E. N. Lavrentyev, G. A. Cook, M. B. Elam, E. A. Park, Bioch. Biophys. Acta., 2004; 1679: 164.
35. W. Suthammarak, B. H. Somerlot, E. Opheim, M. Sedensky, P. G. Morgan, Aging Cell, 2013; 12: 1132.