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Elena Kovacs

Department of Pharmaceutical

Policy and Management,

Central European College of

Pharmacy, Budapest, Hungary

Biological activities and functional role of *Helicteres isora* in plant-based therapeutics

Elena Kovacs

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Abstract

Helicteres isora, commonly known as the screw tree, is a significant medicinal plant native to South and Southeast Asia. It has been used in traditional medicine systems, particularly Ayurveda, for the treatment of a variety of ailments including diabetes, gastrointestinal disorders, skin diseases, and infections. The plant contains a variety of bioactive compounds, including flavonoids, phenolic acids, alkaloids, and cucurbitacins, contributing to its broad spectrum of therapeutic activities. The present paper aims to review the biological activities and functional role of *H. isora* in plant-based therapeutics. Emphasis is placed on its antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, and anticancer properties. Through in-vitro and in-vivo studies, the plant has shown remarkable potential in promoting human health, with future research focusing on its clinical applications and therapeutic formulations.

Keywords: *Helicteres isora*, phytochemistry, pharmacology, therapeutic potential, antioxidant, antidiabetic

1. Introduction

Helicteres isora L., a member of the Malvaceae family, is a small to medium-sized tree or shrub that grows primarily in the tropical and subtropical regions of South Asia, including India, Sri Lanka, and Southeast Asia. This plant is well-regarded in traditional medicinal systems, such as Ayurveda, where it is used for the treatment of a range of diseases including digestive issues, inflammation, infections, and skin disorders (Rattanamanerum et al., 2018, Mahajan & Kaur, 2020) ^[1, 2]. The tree is characterized by its distinctive spiral-shaped fruit, which gives it the name "screw tree."

The phytochemical profile of *H. isora* is rich in several bioactive compounds, including flavonoids, alkaloids, cucurbitacins, and polyphenolic compounds. These compounds are responsible for the plant's diverse pharmacological properties. Modern research has increasingly validated the traditional uses of this plant, confirming its antioxidant, antimicrobial, anti-inflammatory, antidiabetic, and anticancer activities. The objective of this paper is to critically review the biological activities and functional roles of *H. isora*, shedding light on its therapeutic potential and applications in modern medicine. The hypothesis is that *H. isora* could play a significant role in plant-based therapeutics, offering natural alternatives to synthetic drugs with fewer side effects. This paper will delve into the various aspects of the plant's biological activities and the molecular mechanisms behind its pharmacological effects.

2. Phytochemical Profile of *Helicteres isora*

Phytochemical analysis of *Helicteres isora* reveals a wide array of bioactive compounds that contribute to its therapeutic properties. These compounds have been isolated from various parts of the plant, including the roots, bark, leaves, and fruits.

Corresponding Author:

Elena Kovacs

Department of Pharmaceutical

Policy and Management,

Central European College of

Pharmacy, Budapest, Hungary



Fig 1. Fruits of *H. isora* (Source: https://en.wikipedia.org/wiki/Helicteres_isora)

2.1 Phenolic Compounds

Phenolic compounds, such as gallic acid, caffeic acid, and p-coumaric acid, have been identified in *H. isora* and are known for their potent antioxidant and anti-inflammatory activities. These compounds work by scavenging free radicals and preventing oxidative damage to cells, which is essential in the prevention of many chronic diseases, including cancer and cardiovascular diseases (Rattanmaneermee *et al.*, 2018) [1].

2.2 Flavonoids

Flavonoids such as quercetin and kaempferol are abundant in *H. isora*. These flavonoids are known to exhibit a variety of biological effects, including anti-inflammatory, antidiabetic, and anticancer properties. Studies have shown that these compounds inhibit the expression of pro-inflammatory cytokines and enzymes like COX-2, thus reducing inflammation and the risk of chronic diseases (Mahajan & Kaur, 2020) [2].

2.3 Alkaloids

Alkaloids present in *H. isora*, particularly in the root and bark, have been found to possess antimicrobial and analgesic properties. The presence of these alkaloids makes the plant useful in the treatment of pain and infections, and they may also contribute to its anticancer effects (Kumar, 2014) [3].

2.4 Cucurbitacins

Cucurbitacins, specifically cucurbitacin B and isocucurbitacin B, have been isolated from *H. isora* and show significant anticancer activity. These compounds are believed to exert their effects by inducing cell cycle arrest and apoptosis in cancer cells, making *H. isora* a promising candidate in cancer therapy (Tambekar & Bhutada, 2008) [5].

3. Biological Activities of *Helicteres isora*

The biological activities of *Helicteres isora* are vast and multifaceted, supporting its traditional use in treating a wide range of ailments. The following sections provide a detailed review of these activities.

3.1 Antioxidant Activity

H. isora has demonstrated strong antioxidant activity, which is crucial in protecting cells from oxidative damage. The plant's extracts, especially from the fruit and bark, have been shown to possess high free radical scavenging abilities in several in-vitro assays, such as DPPH and FRAP assays. This antioxidant potential is attributed to the high

concentration of phenolic compounds, which can neutralize reactive oxygen species (ROS), thereby preventing oxidative stress-related diseases like cancer, diabetes, and neurodegenerative disorders (Rattanmaneermee *et al.*, 2018) [1].

3.2 Antimicrobial Activity

The antimicrobial properties of *H. isora* are well-documented in the literature. Studies have shown that extracts of the plant, especially those derived from the bark and fruit, exhibit significant antibacterial and antifungal activities. The plant has been tested against a range of pathogens, including *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*, showing promise as a natural antimicrobial agent. This makes *H. isora* a potential candidate for the development of natural antibiotics and antifungals (Tambekar & Bhutada, 2008) [5].

3.3 Anti-inflammatory Activity

Inflammation is a common pathway in many chronic diseases, including arthritis, cardiovascular diseases, and cancer. *H. isora* has been shown to modulate inflammatory pathways by inhibiting the expression of pro-inflammatory cytokines such as TNF- α and IL-1 β , as well as reducing the activity of enzymes like COX-2. These findings suggest that the plant could be beneficial in the treatment of inflammatory disorders. In-vitro studies indicate that the flavonoids and phenolic compounds in *H. isora* play a key role in its anti-inflammatory effects (Kumar, 2014) [3].

3.4 Antidiabetic Activity

Animal studies have highlighted the antidiabetic potential of *H. isora*. The root and leaf extracts of the plant have been shown to enhance insulin secretion and improve glucose tolerance in diabetic rats. These effects are thought to be due to the plant's ability to modulate the activity of enzymes involved in carbohydrate metabolism, as well as its ability to reduce oxidative stress, which contributes to insulin resistance. Given the rising prevalence of diabetes globally, *H. isora* presents an interesting candidate for developing natural antidiabetic therapies (Mahajan & Kaur, 2020) [2].

3.5 Hepatoprotective Activity

The hepatoprotective properties of *H. isora* have been demonstrated in several animal models. Research has shown that extracts of the plant can protect the liver from damage caused by toxins such as carbon tetrachloride. The protective effects are believed to be due to the plant's antioxidant activity, which helps in reducing lipid peroxidation and restoring the normal function of liver enzymes. This makes *H. isora* a valuable plant in managing liver disorders such as hepatitis and cirrhosis (Rattanmaneermee *et al.*, 2018) [1].

3.6 Anticancer Activity

Cucurbitacins, compounds isolated from *H. isora*, have shown significant anticancer activity in various cancer cell lines. These compounds inhibit cell proliferation and induce apoptosis in cancer cells, particularly in colon and breast cancer models. Furthermore, animal studies have shown that *H. isora* extracts can inhibit tumor growth, making it a promising candidate for the development of anticancer therapies. More studies are needed to understand the full

potential of *H. isora* in cancer treatment and its mechanisms of action (Mahajan & Kaur, 2020)^[2].

4. Functional Role in Plant-Based Therapeutics

The diverse pharmacological properties of *Helicteres isora* make it a valuable plant for therapeutic use. Its antioxidant properties help in the prevention of oxidative stress-related diseases, while its antimicrobial and anti-inflammatory actions contribute to the treatment of infections and chronic inflammatory conditions. The plant's antidiabetic and hepatoprotective effects further enhance its therapeutic potential, especially in managing metabolic and liver diseases. Finally, its anticancer properties suggest that *H. isora* could be an important natural product in cancer treatment. These findings support the plant's inclusion in plant-based therapeutics, particularly in the formulation of natural medicines for managing chronic diseases.

5. Conclusion

Helicteres isora L. is a medicinal plant with a rich phytochemical profile and a broad spectrum of biological activities. From its antioxidant and antimicrobial effects to its potential as an anti-inflammatory, antidiabetic, hepatoprotective, and anticancer agent, the plant offers a wide array of therapeutic benefits. The traditional uses of *H. isora* are substantiated by modern scientific evidence, confirming its role in plant-based therapeutics. However, further clinical studies and pharmacokinetic evaluations are necessary to fully understand its efficacy and safety in human health applications.

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