



HEPATOPROTECTIVE EFFECT OF AN INDIAN MEDICINAL PLANT “*TERMINALIA ARJUNA*”; A REVIEW ON RECENT ADVANCEMENT

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Abstract

This study explores the development and evaluation of hepatoprotective properties of *Terminalia arjuna*, a renowned medicinal plant in traditional medicine. The study investigates the potential of *Terminalia arjuna* in promoting liver health through its pharmacological actions. Various aspects of hepatoprotection, including antioxidant, anti-inflammatory, and detoxification properties, are examined through in vitro and in vivo experiments. The research focuses on elucidating the mechanisms underlying *Terminalia arjuna* hepatoprotective effects, shedding light on its therapeutic potential in treating liver disorders. Additionally, the manuscript discusses the phytochemical composition of *Terminalia arjuna* and its correlation with hepatoprotection, providing insights into the active constituents responsible for its medicinal properties. The findings contribute to a better understanding of the pharmacological profile of *Terminalia arjuna* and its application in liver health management. Overall, this study underscores the significance of *Terminalia arjuna* as a promising candidate for the development of hepatoprotective agents, highlighting its potential as a natural alternative for liver disease management.

Keywords

Terminalia arjuna,
hepatoprotective,
Pharmacognostic, Evaluation,
Traditional uses.

INTRODUCTION

Hepatoprotective activity refers to the ability of certain substances or compounds to safeguard the liver from damage caused by various factors such as toxins, drugs, and infections. The liver plays a crucial role in detoxification and metabolism, making it susceptible to harm from external agents. Hepatoprotective agents are essential in preventing and mitigating liver disorders, promoting overall liver health. It is the ability to protect the liver from damage caused by various factors, such as toxins, drugs, infections, and metabolic disorders. Hepatoprotective agents are

substances that can help prevent or mitigate liver damage by promoting the regeneration of liver cells, reducing inflammation, and inhibiting oxidative stress. These agents having natural compounds derived from plants, animals, or minerals, as well as synthetic drugs developed specifically for liver protection (Mangwani et al., 2020; Shakya, 2020; Thilagavathi et al., 2023; Verma, 2018).

Natural compounds such as silymarin (from milk thistle), curcumin (from turmeric), and flavonoids (found in fruits and vegetables) have been studied for

their hepatoprotective effects. Additionally, synthetic drugs like ursodeoxycholic acid and N-acetylcysteine are used for liver protection in certain medical conditions. Research into hepatoprotective activity is ongoing, with their goal of identifying new compounds and understanding their mechanisms of action. The development of effective hepatoprotective agents is essential for preventing and treating liver diseases, considering the liver's vital role in maintaining overall health. Medicinal plants have been integral to human healthcare since time immemorial, serving as the foundation of traditional medicine systems across diverse cultures worldwide. These plants, endowed with bioactive compounds, possess therapeutic properties that have been harnessed for treating and preventing various ailments. The uses of medicinal plants predate modern pharmaceuticals, and their importance remains undiminished in contemporary medicine (Bhanot et al., 2011; Maya et al., 2013; Srinivasan et al., 2014).

The rich diversity of flora harbors an extensive reservoir of potential remedies, with countless species exhibiting pharmacological significance. From the rainforests to arid deserts, each ecosystem contributes unique plant species with medicinal value. The knowledge surrounding these plants is often passed down through generations within indigenous communities, forming the basis of traditional healing practices. In recent times, scientific exploration has sought to validate and understand the efficacy of these botanical remedies. Researchers can identify their chemical composition of medicinal plants, identifying bioactive compounds responsible for their therapeutic effects. The study of medicinal plants not only holds promise for discovering new drugs but also emphasizes the importance of sustainable practices in harvesting and preserving biodiversity. In the face of emerging health challenges and the pursuit of alternative and complementary therapies, the significance of medicinal plants endures. As humanity continues to explore the intricate relationship between nature and healing, medicinal plants stand as a testament to the profound interconnection between the plant kingdom and the well-being of individuals and communities –(Gaurav, 2022; Gaurav et al., 2023, 2022; Salar et al., 2023).

REVIEW FINDINGS

Characteristic of *Terminalia arjuna*

Terminalia arjuna, a tree native to the Indian

subcontinent, has gained recognition for its potential hepatoprotective properties. Traditionally used in Ayurvedic medicine, *Terminalia arjuna* has been revered for its diverse medicinal benefits. The bark of this tree contains bioactive compounds such as tannins, flavonoids, and saponins, which exhibit antioxidant and anti-inflammatory properties. These compounds are believed to contribute to the hepatoprotective effects of *Terminalia arjuna*. Several studies have explored the hepatoprotective activity of *Terminalia arjuna* in various experimental models. Research suggests that its extracts may help prevent liver damage, enhance liver function, and alleviate oxidative stress. As liver disorders continue to be a global health concern, investigating natural remedies like *Terminalia arjuna* provides valuable insights into potential therapeutic options for maintaining liver health and preventing hepatic ailments. Arjuna consists of the stem bark of *Terminalia arjuna* W.& A. (Family Combretaceae); a large deciduous tree with a spreading crown and drooping branches., commonly found throughout the greater parts of the country. It is very commonly found in Chhota Nagpur area, Baitful in Madhya Pradesh, India and also in Dehradun, usually found growing on river banks or near dry river beds in Bangladesh, Uttar Pradesh, Madhya Pradesh, south and central India. *Terminalia arjuna* is about 20-25 meters tall; usually has a buttressed trunk, and forms a wide canopy at the crown, from which branches drop downwards —(Ali et al., 2013; Dev et al., 2021; Uddin et al., 2021).

It has oblong, conical leaves which are green on the top and brown below; smooth, grey bark; it has pale yellow flowers which appear between March and June; its glabrous, 2.5 to 5 cm fibrous woody fruit, divided into five wings, appears between September and November commonly known as Arjuna or Arjun tree in English and Marudhamaram in Tamil. The tree components are widely used in traditional medicine in several continents in the world for the treatment of numerous diseases including, abdominal disorders, bacterial infections, colds, sore throats, conjunctivitis, diarrhoea, dysentery, fever, gastric ulcers, headaches, heart diseases, hookworm, hypertension, jaundice, leprosy, nosebleed, edema, pneumonia and skin diseases (Bushra et al., 2023; Hossain et al., 2022; Meena et al., 2023; Ramesh and Palaniappan, 2023).

Table 1: Taxonomical classification of *Terminalia arjuna*.

Sr. No	Kingdom	Plantae
1.	Phylum	Angiosperms
2.	Class	Eudicots
3.	Order	Myrtales
4.	Family	Combretaceae
5.	Genus	<i>Terminalia</i>
6.	Species	<i>Terminalia arjuna</i>
7.	Assamese	Arjun
8.	Marathi	Arjun, Anjan, Sadura
9.	Bengali	Arjun, Arjhan
10.	Oriya	Hanjali
11.	English	Arjun, White Marudah
12.	Punjabi	Arjon
13.	Gujarati	Sadada, Salado
14.	Sanskrit	Kakubha, Partha, Indradru, Dhavala
15.	Hindi	Anjan, Anjani, Arjun,
16.	Tamil	Vella marda, Vella maruthu, Vella matti
17.	Kannada	Hole matti, Maddi, Matti
18.	Telugu	Vella marda, Vella matti, Yer maddi, Tella madu

Properties of *Terminalia arjuna*

Terminalia arjuna, a revered herb in Ayurveda, exhibits unique properties that contribute to its therapeutic effects. Its taste (Rasa) is astringent (Kashaya), which provides drying and tightening effects, beneficial for reducing swelling and controlling excess moisture in the body. The post-digestive taste (Vipaka) is pungent (Katu), which means it has a stimulating and heating effect on digestion, promoting metabolic activity. The herb's potency (Virya) is cool (Shita), indicating its cooling effect that can help in reducing inflammation and calming heat-related conditions in the body. The qualities (Guna) of *Terminalia arjuna* are light (Laghu) and dry (Ruksha), aiding in easy digestion and assimilation while absorbing excess moisture, which is particularly useful in managing conditions associated with high Kapha. In terms of doshic effect, *Terminalia arjuna* pacifies Kapha and Pitta doshas. This means it helps balance excess Kapha by reducing moisture and heaviness, and it calms Pitta by mitigating heat and inflammation, thereby promoting overall bodily harmony and supporting cardiovascular health (Amalraj and Gopi, 2017; Carvalho et al., 2022; Shahid Chatha, 2014; Verma and Jogdand, 2021).

Macroscopic description of *Terminalia arjuna*

Terminalia arjuna is a large, deciduous tree that can reach heights of up to 25 meters, featuring a wide, spreading crown with horizontal branches. The bark is smooth and greyish-white when young, becoming brown and cracked with age. The leaves are simple, opposite, and elliptical, measuring about 5-12 cm long and 2-5 cm wide. They have a leathery texture and glossy appearance. The flowers are small, greenish-yellow, and borne in dense, spike-like axillary panicles. The fruits are ovoid or oblong drupes, about 2-2.5 cm in length, often with five wings. The outer surface of the bark is smooth and pale greenish-yellow, while the inner surface is finely striated and pinkish. The bark pieces are flat, curved, and recurved in shape. The wood of *Terminalia arjuna* is hard and durable, making it useful for various applications (Cota et al., 2019; Desai and Chanda, 2014; Dhingra et al., 2013).

In microscopic description of *Terminalia arjuna*, it has been characterized by the presence of cork cells in the outer layers. Cork cambium and secondary phloem can be observed in cross-sections. The inner bark contains fibres, parenchyma cells, and vessels. The epidermis of the leaves has stomata, which are more

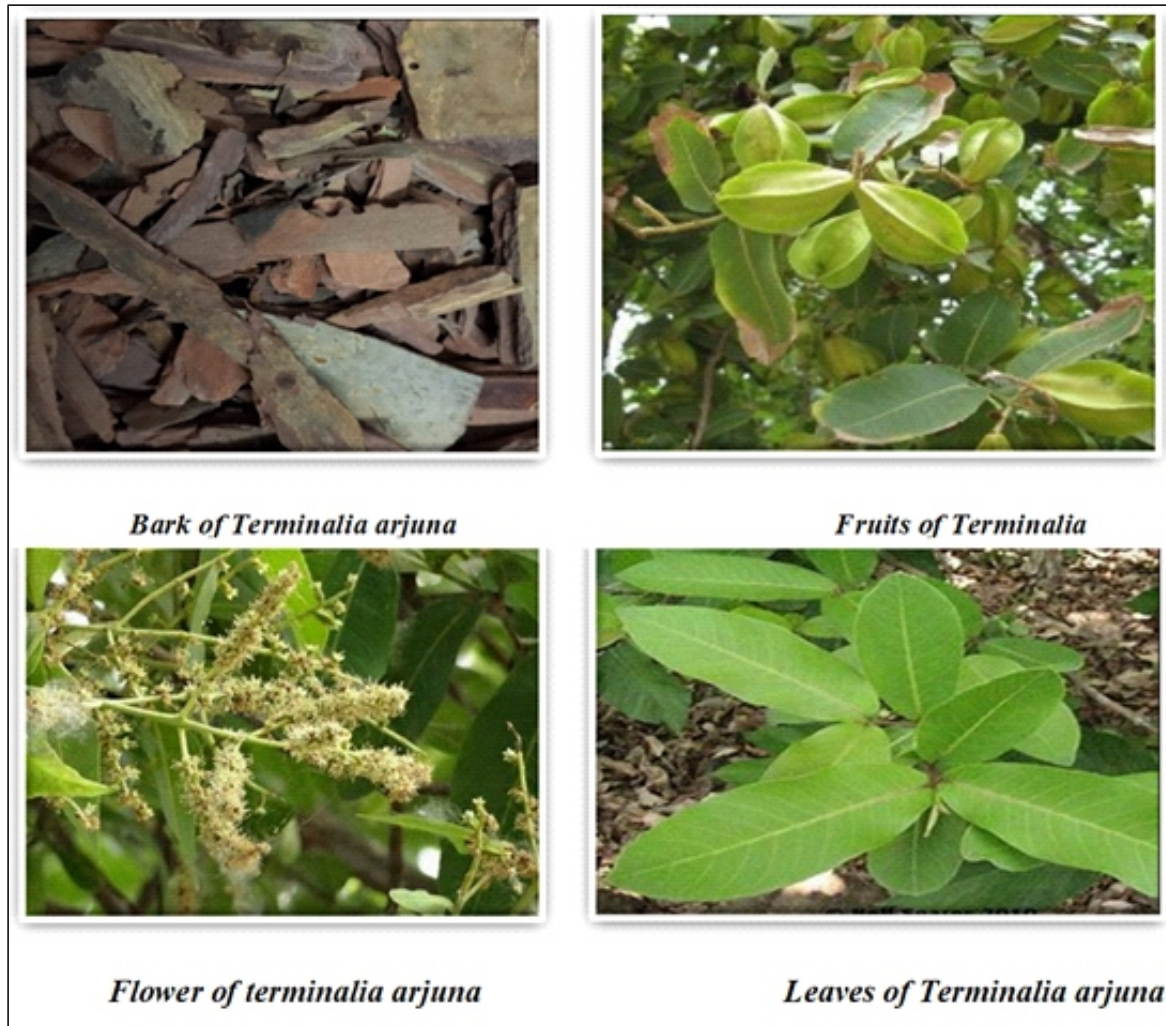


Fig. 1: Morphological appearance of Termonalia arjuna.

abundant on the lower surface. The mesophyll tissue consists of palisade and spongy parenchyma cells. Vascular bundles are collateral and arranged in a continuous ring. The floral anatomy includes typical reproductive structures such as stamens, pistil, and ovary. T.S. (transverse section) of the floral parts reveals the arrangement of tissues and cells involved

in reproduction. Cross-sections of the fruit show the arrangement of the seed and the pericarp layers. The seed may have an embryo surrounded by endosperm tissue. The wood exhibits typical characteristics of hardwood, with vessels, fibres, and parenchyma cells (Desai and Chanda, 2014; Dhingra *et al.*, 2013; Sivalokanathan *et al.*, 2006; Yallappa *et al.*, 2013).

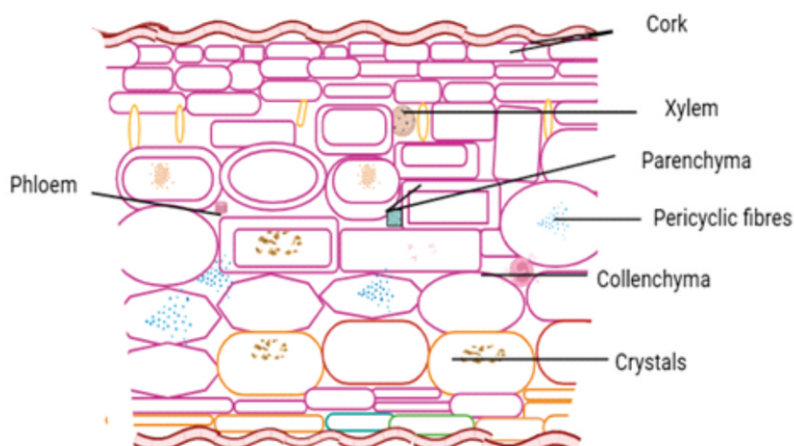


Fig.2: Microscopy of Terminalia arjuna.

Phytochemistry of *Terminalia arjuna*

Terminalia arjuna, a tree widely used in traditional medicine, is rich in a variety of phytochemicals contributing to its therapeutic properties. The main constituents include flavonoids, tannins, triterpenoids, and glycosides. Flavonoids such as arjunone, arjunolone, and arjunolic acid exhibit strong antioxidant properties, helping to reduce oxidative stress and protect against cellular damage. Tannins, which give the bark its astringent quality, aid in wound healing and possess antimicrobial activity. Triterpenoids, including arjunic acid and arjunolic acid, contribute to the cardioprotective effects of the

tree, supporting heart health by improving cardiac function and reducing blood pressure. Glycosides, such as arjunetin and arjunosides, have been found to enhance myocardial strength and regulate lipid levels. Additionally, the bark contains minerals like calcium and magnesium, essential for maintaining cardiovascular health. These diverse phytochemicals collectively render *Terminalia arjuna* a potent medicinal plant with applications in treating cardiovascular diseases and promoting overall health (Amalraj and Gopi, 2017; Kapoor et al., 2014; Nerkar et al., 2023; Paarakh, 2010).

Table 2: Major phytoconstituents of various parts of *Terminalia arjuna*.

S. No	Plant Part	Phytochemical Constituents
1.	Stem bark	Arjunolic acid, Arjungenin, Arjunetin, Arjunin, Arjunic acid, Arjunanin, Arjunolone, Catechin, Flavonoids, Tannins, β -sitosterol, Ellagic acid, Gallic acid, Gallo tannins, Oleanolic acid, Rutin, Quercetin, Terpenoids, Saponins, Glycosides, Lactone, phenolics, Gallocatechin, Epicatechin, Terminoic acid, Arjunoglucoside IV, V Terminoside A, Terminoglucoside I, II, Ursane triterpenoids 5, 6 Arjunahomosesquiterpenol & Stigmasteryl digalactoside 7 oleaterminaloic acid A, B & C, oleaterminolide and termiarjunoside I
2.	Leaves	Arjunolic acid, Arjungenin, Arjunetin, Arjunic acid, Flavonoids, Tannins, β -sitosterol, Ellagic acid, Gallic acid, Gallo tannins, Oleanolic acid, Rutin, Quercetin, Terpenoids, Saponins, Glycosides
3.	Fruits	Arjunolic acid, Arjungenin, Arjunetin, Arjunic acid, Flavonoids, Tannins, β -sitosterol, Ellagic acid, Gallic acid, Gallo tannins, Oleanolic acid, Rutin, Quercetin, Terpenoids, Saponins, Glycosides
4.	Seeds	Arjunolic acid, Arjungenin, Arjunetin, Arjunic acid, Flavonoids, Tannins, β -sitosterol, Ellagic acid, Gallic acid, Gallo tannins, Oleanolic acid, Rutin, Quercetin, Terpenoids, Saponins, Glycosides
5.	Heartwood	Arjunolic acid, Arjungenin, Arjunetin, Arjunic acid, Flavonoids, Tannins, β -sitosterol, Ellagic acid, Gallic acid, Gallo tannins, Oleanolic acid, Rutin, Quercetin, Terpenoids, Saponins, Glycosides

Terminalia arjuna in traditional Ayurvedic herbalism

Terminalia arjuna, commonly known as Arjuna, holds a revered place for its multifaceted uses. Primarily, it is recognized for its cardiovascular benefits, acting as a potent cardi tonic that supports heart function and regulates blood pressure. Arjuna is employed to alleviate conditions such as hypertension, angina, and cardiac palpitations. Additionally, its astringent and anti-inflammatory properties make it valuable for gastrointestinal health, addressing issues like diarrhoea and dysentery. Renowned as a Rasayana (rejuvenating) herb, Arjuna is integral to Ayurvedic

formulations, contributing to holistic well-being and promoting longevity.

Pharmacological action of *Terminalia arjuna*

Terminalia arjuna, a revered plant in Ayurveda, offers a multitude of medicinal benefits, particularly in supporting cardiovascular health. It strengthens cardiac muscles, regulates blood pressure, and improves overall cardiovascular function, owing to its antioxidant properties that combat oxidative stress in the cardiovascular system. Additionally, it aids in managing cholesterol levels, making it beneficial for individuals with high cholesterol and aiding in the

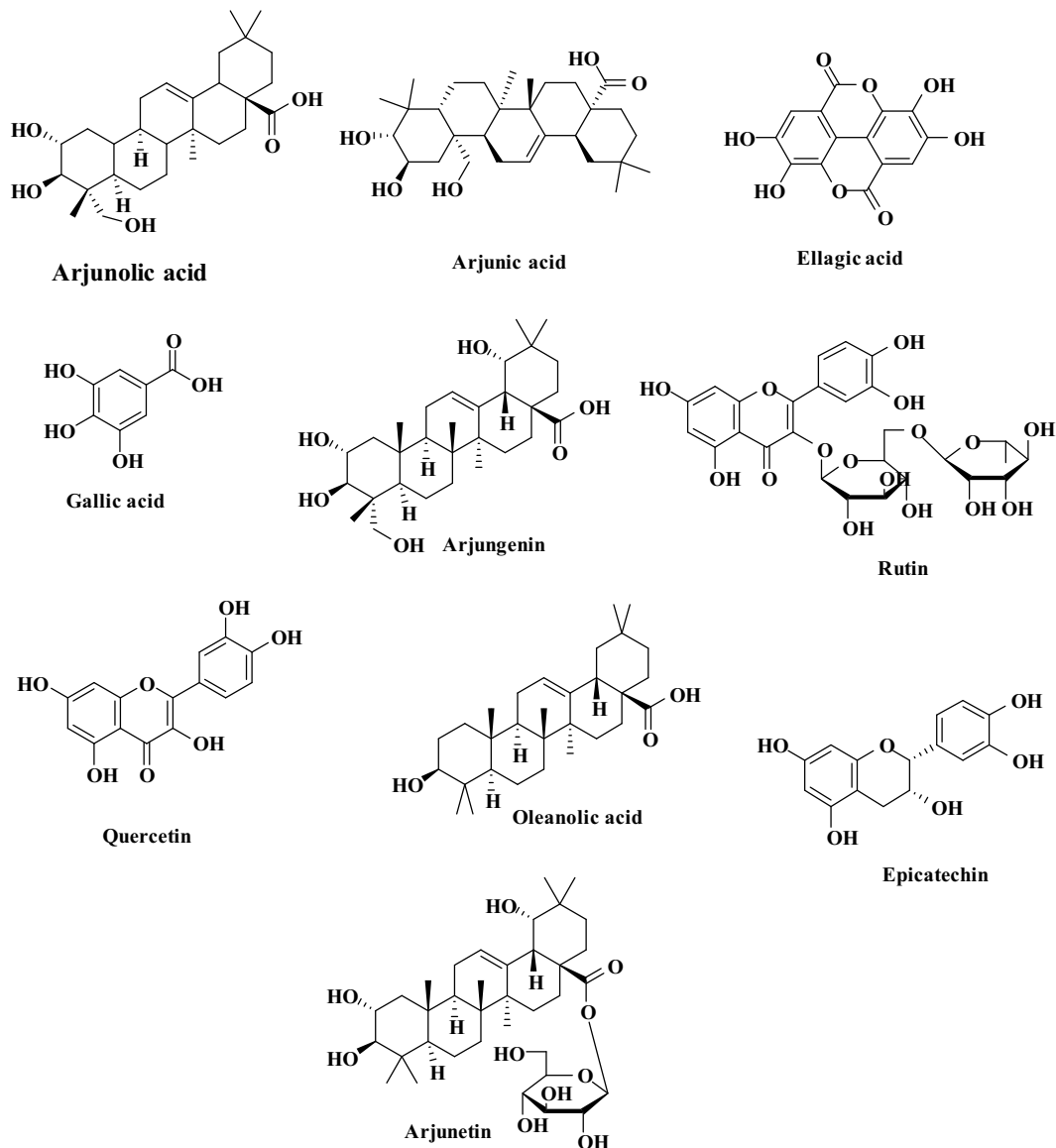


Figure 3: Reported structure of chemical constituents of *Terminalia arjuna*.

prevention of atherosclerosis. The bark of Arjuna also harbors anti-inflammatory compounds, useful in treating arthritis and other inflammatory conditions. Furthermore, it exhibits hepatoprotective effects, promoting liver health and aiding in detoxification. Its astringent properties make it effective in managing digestive issues such as diarrhoea, while its antimicrobial properties facilitate wound healing. Arjuna's benefits extend to respiratory health, with potential relief for asthma and bronchitis symptoms. Its antioxidant activity combats free radicals, potentially reducing the risk of chronic diseases. Moreover, its diuretic and adaptogenic properties contribute to fluid balance, stress management, and overall well-being — (Jawal et al., 2024; Md., 2013; Nerkar et al., 2023; S. et al., 2013).

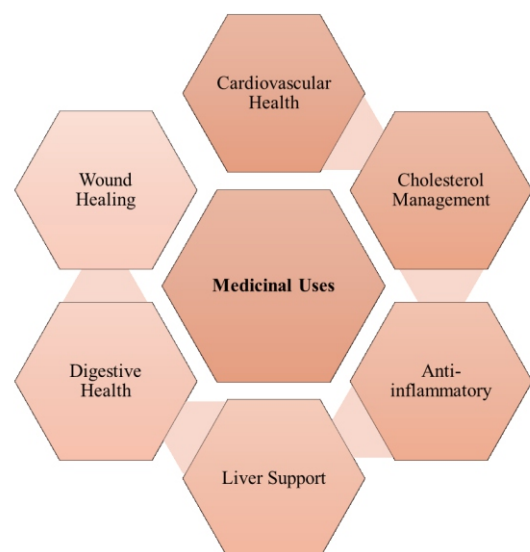


Fig. 4: Pharmacological activities of *Terminalia arjuna*.

Table 3: Diverse medicinal uses of *Terminalia arjuna* and their associated benefits, providing a comprehensive overview of its therapeutic potential in promoting overall health and well-being.

S. No	Medicinal Uses	Benefits
1.	Cardiovascular Health	Strengthens cardiac muscles, regulates blood pressure, improves cardiovascular function, reduces oxidative stress in the cardiovascular system
2.	Cholesterol Management	Helps regulate cholesterol levels, aids in preventing atherosclerosis
3.	Anti-inflammatory	Manages inflammatory conditions such as arthritis and joint disorders
4.	Liver Support	Promotes liver health, aids in detoxification
5.	Digestive Health	Manages digestive issues like diarrhoea, contributes to gastrointestinal health
6.	Wound Healing	Topically promotes wound healing, prevents infections
7.	Respiratory Health	Alleviates symptoms of asthma and bronchitis, thanks to anti-inflammatory and bronchodilator effects
8.	Antioxidant Activity	Neutralizes free radicals, reduces the risk of chronic diseases
9.	Diuretic Properties	Aids in eliminating excess fluids from the body, beneficial for conditions like edema
10.	Adaptogenic Properties	Helps the body adapt to stress, promotes resilience and general well-being

CONCLUSION

Terminalia arjuna stands out as a promising medicinal plant, particularly valued for its hepatoprotective properties. Extensive research supports its efficacy in promoting liver health, making it a valuable natural remedy. As a versatile medicinal plant, *Terminalia arjuna* contributes to traditional and alternative medicine practices, offering potential benefits for various health conditions. The continued exploration of its bioactive compounds and therapeutic mechanisms underscores its significance in the realm of herbal medicine, paving the way for the development of novel treatments and nutritional supplements for liver-related disorders.

Conflict of interest

The authors declare no conflict of interest.

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