



A Review on Phytoconstituents and Therapeutic Properties of Ancient Plant: *Terminalia arjuna* (Roxb)

Harshita^a and Reena Sharma^{a*}

^a Department of Biosciences (University Institute of Biotechnology), Chandigarh University, Gharuan, District-Mohali, Punjab, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Terminalia arjuna also known as arjun or arjuna, is a member of Combretaceae family. Medicinal or therapeutic plant plays a crucial role to cure various diseases and *Terminalia arjuna* is one such therapeutic plant. This comprehensive review helps in studying various aspects like phytochemical, pharmacological, ethnomedical, phytological and clinical significance. Alkaloids, flavonoids, triterpenoids, glycosides and mineral ions present in different parts of the plant are discussed. *Terminalia arjuna* is used mainly in cardiovascular treatment, shows antibacterial, antimicrobial and antifungal properties.

Keywords: Antimicrobial; antifungal; alkaloids; cardiovascular; medicinal plant.

1. INTRODUCTION

Healing herbs of compatible worth can be found on mother earth. The solution to heal wounds holds in hands of nature. Healing plants play an important part in healthcare sector and are

significant for both conventional and traditional medicine. Traditional medicinal practice has expanded around the world. It is generally created on the skills, knowledge, suppositions and practices of folks. Major texts like Charaka Samhita consist of studies on traditional

*Corresponding author: E-mail: reena148@gmail.com;

medicinal plants [1]. In the past years, there has been around 2.5% to 12% increase in usage of therapeutic medicine [2]. *Terminalia arjuna* has major contribution in research areas like medication, energy and material due to which there is surge in demands of nanoparticles [3].

During ancient times many traditional plants were used as curative to avoid different fatal disease in different medicinal systems like Ayurveda, Unani and Siddha etc. In the current scenario, awareness about the use of traditional medicine has spread tremendously. Herbal medicines are inexpensive, efficacious, approachable and have very less side effects. Medicinal plants have certain organic compounds which perform physiological functions in human body. The compounds include carbohydrates, tannins, resins, terpenoids, flavonoids, alkaloids and phenols. There are numerous plants described in Indian customary healing system for different treatments of different diseases. One such therapeutic tree is *Terminalia arjuna* (Roxb.) [2].

Terminalia arjuna also known as "arjuna". It is distributed in major parts of Sri Lanka, Burma and India like Himachal Pradesh, Madhya Pradesh, Sub-Himalayan regions of Uttar Pradesh and Delhi etc [4]. The plant belongs to family Combretaceae. It is a huge tree with buttressed trunk and smooth grey bark. The tree generally attains a height of 20-25 m with sub opposite pale dark green leaves and yellowish white flowers. The fruits are ovaloid (2.5 -5.0 m) fibrous woody and smooth that is without hairs. The tree is found on the banks of rivers and streams. Various heart diseases like, heart failure, myocardium necrosis, coronary artery disease atherosclerosis and cardiomyopathy can be cured with the help of *Terminalia arjuna* [1,5]. This can also be used in other problems like blood pressure, anaemia, viral infections, ulcers and hepatic diseases. The first person to support the use of bark powder of stem of arjuna in heart diseases was Vagabhatta. The tree has antimicrobial, antioxidant, antiallergic, antibacterial, antitumoral, antifeedant and antimicrobial properties. The aim of this review to summarise the medicinal properties of *Terminalia arjuna* and its phytoconstituents from the research data available [6,7].

2. METHODOLOGY

Systematic literature searches were carried out and the information available on plant *Terminalia*

arjuna was collected via peer reviewed journals, library articles and electronic search like google scholar, science direct, PubMed and ResearchGate.

Table 1. Classification of *Terminalia arjuna*

Kingdom	Plantae
Phylum	Angiosperms
Class	Dicotyledonae
Order	Myrtales
Family	Combretaceae
Genus	<i>Terminalia</i>
Species	<i>Arjuna</i>

3. HABIT AND HABITAT

The tree of arjuna is around 60-80 ft in tall, generally found near the rivers and around watercourses in the Himalayan regions of India. It can be grown in all types of soil, but majorly grows in humid, fertile and loamy soil [4,8,9]. This tree can also be propagated by seeds, germinates in 60-70 days with approx. 50-70 % of total germination. Leaves of the *Terminalia arjuna* are simple, mostly crenulations and borne sub-opposite. Drupe fruit is found, fruits are oval in shape with fibrous and woody nature. The bark of the stem is smooth and simple with pinkish grey colour [4].

4. PHYTOCONSTITUENTS

The bark of the tree, fruit, leaves and seeds have major phytoconstituents. The preliminary analysis of phytochemicals was carried according to standard protocols mentioned by Harbone. From the medicinal point of view bark is considered as the important constituent, the bark is reported have 33% ash of calcium carbonate. Aqueous extract of bark of *Terminalia arjuna* is reported to have 16% tannins and 23% calcium salts. Using sequential methods along with organic solvents like ethyl acetate, chloroform, hexane, ethanol etc. to prepare organic extracts of bark of *T. arjuna* for the phytochemical extraction. The obtained chemical structures were later confirmed using advance techniques like UPLC, LC-ESI—MS/MS and HPLC. Major constituents of the *Terminalia arjuna* consist of triterpenoids, polyphenols, flavonoids, sterols, saponins, and glycosides. The aim of this review is to summarise the medicinal properties of *Terminalia arjuna* and its phytoconstituents from the research data available [6,7].

Table 2. Phytoconstituents present in *Terminalia arjuna*

Plant part	Phytoconstituent	Compounds found
Bark (stem)	Triterpenoids	Arjunolic acid [15,16] Terminic acid,[17] Arjunin, arjunic acid,[18] Terminoltin,[19]
Bark	Triterpenoids (Ursane)	2 α ,3 β ,23-trihydroxyurs-23-trihydroxyurs-12,19-dien-28-oic acid 28-O- β -D-glucopyranosyl ester.[20] 2 α ,3 β -dihydroxyurs-12,18- dien-28-oic acid-28-O- β -D-glucopyranosyl ester,[20]
Bark	Minerals, elements	Zinc [4,9] Magnesium [9] Copper [4,9,21] Silica [9,21] Aluminium [9,21] Calcium [4,9,21]
Bark	Phenolic compounds and flavonoids	Arjunolone [6,22,10] Luteolin [23] Gallic acid
Bark	Tannins	Pyrocatechols [24,25] Terflavin C Castalaigen [26] Casuarinin [26]
Bark	Glycosides	Arjunolone,[1,4,8] Arjunoltin, Arjunaphthanolside Arjunetin,[8,9,27–29] Terminarjunoside I and II [30] Terminoside A [1,21,31,12]
Roots	Triterpenoids	Arjunolic acid [8,17,29] Arjunic acid Oleanolic acid Terminic acid [9,17,32]
Roots	Glycosides	Arjunetosie (3-O- β -D-glucopyranosyl-2 α , 3 β , 19 α -trihydroxyolean-12-en-28-oic acid [19,20,30,32] 28-O- β -D-glucopyranoside
Seeds, leaves	Flavonoids, glycosides	14,16-dianhydrogitoxygenin 3- β -D-xylopyranosyl-(1 > 2)-O- β -D-galactopyranoside [33] Luteolin [23]
Fruits	Flavonoids, triterpenoids	Arjunone, [1,4,6,7] Arachidic stearate,[7] Gallic acid[7] Hentriacontane[7] Arjunic acid, [7] Methyl oleolate,[7] Cerasidin,[7]

5. MEDICINAL IMPORTANCE

Bark of *Terminalia arjuna* is also known as “ancient cardiovascular drug” because of its medicinal properties. Various experimental and clinical studies show the evidences that proves that bark of *Terminalia arjuna* possess anti-

oxidant, antiviral, antibacterial and anticancer properties [1,4,6,8,10,11].

5.1 Cardiovascular Importance

The bark of arjun has anti-ischemic effect which was trailed on many patients, as a result of

which it was learnt that it is good for heart [2,4,8,12,13]. Phytoconstituents like terpenoids and flavonoids are known to show this effect. It is used in treating cardiomyopathy, hypolipidemic condition, rheumatic heart disease, myocardial infarction, and many other heart conditions. It is generally advised to heart patients to consume bark powder of arjun to have speedy recovery.

5.2 Analgesic Properties of Leaf

Leaf of arjuna also has pain relieving and antioxidant properties. Studies show that leaves exhibit analgesic i.e., pain relieving, antioxidant and anti-inflammatory properties [1,8,14].

5.3 Antimicrobial Effect

Bark extract of *Terminalia arjuna* is known to exhibit anti-microbial activity against many microorganisms like *Plasmodium aerogenes*, *Plasmodium vulgaris* and *Escherichia coli*. [5]

5.4 Platelet Aggregation

The extract from bark of stem also helps in decreasing platelets activation and possesses antithrombotic properties. Arjunolic acid is a phytoconstituent, which provides cardiovascular protection and is present in the bark of arjuna [1,5,6,8].

5.5 Anticancerous Properties

Anticancerous properties are shown by many species of *Terminalia arjuna*. Traditionally it is used for treating cancer from a very early period. Chemical constituents present in arjuna may acts as antimutagenic and anticancerous, they trap the electrophile of carcinogen by nucleophilic chemical reactions to form harmless products. Terpenoids and flavonoids phytoconstituents present in bark show anticancerous properties [1,4,6,8]. *T. arjuna* is known to regulate anaerobic metabolism by preventing the activity of lactate dehydrogenase in lymphatic cancer bearing mice. Casuarinin, a constituent present in bark of *T. arjuna* is also known to inhibit the breast cancer. The presence of antioxidant properties in bark makes it more effective in anticancerous properties.

6. HARMFUL ASPECT

During clinical studies, 1g to 2g per day dosage of *Terminalia arjuna* has been used and found as optimum dosage for patients suffering from

coronary artery disease. But in many patients, symptoms of different health issues were reported by after consuming this plant, such as headache, body ache, constipation, gastritis and insomnia. Blood issues, metabolic activity and renal issues has not been testified even after 24 months of its intake and observations. Parmar et al reported decrease in thyroid concentration as well as increase in hepatic LPO with increase in dosage of arjuna [34]. In contrast to this, recently outcomes from some latest studies of oral toxicologic labs show that the use of ethanolic extract of 2000mg/kg did not produce any kind of side effects in gut of animals [1,24,25]. There is a need for well controlled clinical trials for exploring the therapeutic effects of *Terminalia arjuna*.

7. CONCLUSION

On basis of studies available and literary evidences, *Terminalia arjuna* is a very important medicinal plant which is majorly used in treatment of cardiovascular diseases like cardiomyopathy, heart attack, high blood pressure and chest pain etc [1,4,6,8]. It is an antioxidant, antibacterial, anti-fungal and anti-ischemic in nature. The effectiveness of *Terminalia arjuna* as a potent antioxidant and anti-ischemic agent has been demonstrated under clinical and experimental studies. Still, author advices not to neglect the side effects of this plant. More clinical trials are suggested to overcome this problem. The eternal interest and researches have led to the development of chemical constituents and their pharmacological effects. However, continuous researches on *Terminalia arjuna* can also help in discovering its many other properties. Shakeel et al demonstrated the green synthesis of silver nanoparticles, which are important in the field of nanotechnology using *Terminalia arjuna* extract [3]. In biological field, evaluation of silver nanoparticles was studied against gram positive (*S. aureus*) and gram negative (*E. coli*) bacteria for their further biomedical applications. This plant extracts can be majorly used in drug administration, drug interactions and toxicological studies [1,4–8,18]. *T. arjuna* leaf extract has been used as stabilising and reducing agent in biosynthesis of AgNps and degradation of organic dyes using TEM, XRD UV-vis and SEM analysis [35]. Recent research studies reveal the extraction of natural dyes from fruits of *Terminalia arjuna* and their uses in textile industry [36]. Every part of plant *Terminalia arjuna* is of great significance in

ethnopharmacological and pharmaceutical sector. Research and clinical trials should be carried to explore the full potential of the plant.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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