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A SYSTEMATIC REVIEW ON *TERMINALIA ARJUNA*: PHYTOCONSTITUENTS, PHARMACOLOGICAL ACTIONS, AND CLINICAL APPLICATIONS

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Abstract

Background: *Terminalia arjuna* (*Arjuna*) is a well-known medicinal plant in Ayurveda, recognized for its cardioprotective, antioxidant, anti-inflammatory, and hepatoprotective properties. Traditionally, it has been used in the management of cardiovascular diseases, respiratory disorders, and metabolic imbalances. The plant is rich in bioactive compounds, including flavonoids, tannins, glycosides, and triterpenoids, which contribute to its therapeutic potential. **Objectives:** This study aims to provide a comprehensive review of *Arjuna*'s medicinal properties, phytochemical constituents, pharmacological activities **Methods:** A systematic review of classical Ayurvedic texts, ethnobotanical studies, and recent pharmacological research on *Terminalia arjuna* was conducted. Data sources included peer-reviewed journals, traditional Ayurvedic literature, and electronic databases. The review focused on the plant's active constituents, mechanisms of action, and therapeutic applications. **Results:** Research indicates that *Arjuna* has significant cardioprotective effects, including antihypertensive, lipid-lowering, and anti-ischemic properties. Its antioxidant activity helps mitigate oxidative stress, while its hepatoprotective and anti-inflammatory effects contribute to liver health. Studies also highlight its wound-healing, antimicrobial, and

adaptogenic benefits. The bark extract is widely used in Ayurveda for *Hridya Roga* (cardiac disorders) and *Yakrit Vikara* (liver disorders). **Conclusion:**-The medicinal properties of *Arjuna* make it a valuable herb in both traditional and modern healthcare systems. Its cardioprotective and hepatoprotective effects have been well-documented, warranting further clinical trials to establish standardized formulations and dosages. Integration of *Arjuna* in modern medicine could provide a natural, evidence-based approach to managing cardiovascular and metabolic disorders.

Keywords: *Terminalia arjuna*, *Arjuna*, cardioprotective, antioxidant, hepatoprotective, Ayurveda, phytochemistry, traditional medicine.

INTRODUCTION

Terminalia arjuna (*Arjuna*) is a widely recognized medicinal plant in Ayurveda, known for its extensive therapeutic applications, particularly in cardiovascular health. Referred to as a potent *Hridya* (cardiac tonic), *Arjuna* has been traditionally used for treating various heart ailments, including hypertension, ischemic heart disease, and heart failure.[1] Classical Ayurvedic texts such as *Charaka Samhita* and *Sushruta Samhita* describe its bark as a powerful remedy for maintaining cardiac function and promoting longevity. In recent years, scientific research has validated its cardioprotective effects, making it a significant herb in both traditional and modern medicine.[2]

The phytochemical composition of *Arjuna* is rich in bioactive compounds, including flavonoids, tannins, triterpenoids, glycosides, and saponins. These constituents contribute to its antioxidant, anti-inflammatory, and lipid-lowering properties, which are crucial for cardiovascular health. Additionally, *Arjuna* exhibits hepatoprotective, anti-diabetic, antimicrobial, and wound-healing effects, expanding its therapeutic potential beyond cardiac care.[3] Modern pharmacological studies have demonstrated that *Arjuna* exerts beneficial effects by reducing oxidative stress, enhancing endothelial function, and improving myocardial efficiency.[4]

Apart from cardiovascular health, *Arjuna* has been traditionally used in the management of respiratory disorders, gastrointestinal issues, and skin diseases.[5] Its *Kashaya Rasa* (astringent taste) and *Laghu-Ruksha Guna* (light and dry properties) contribute to its role in treating metabolic imbalances, including diabetes and dyslipidemia. Furthermore, its hepatoprotective effects have been extensively studied, indicating its role in the management

of liver disorders such as fatty liver disease and hepatic fibrosis. This wide spectrum of therapeutic applications highlights the significance of *Arjuna* in Ayurvedic medicine.[6]

Despite its long-standing use in Ayurveda, further clinical research is necessary to establish standardized dosages, formulations, and mechanisms of action for integrating *Arjuna* into modern medical practice. While existing studies provide strong evidence for its cardioprotective and antioxidant effects, large-scale human trials are required to confirm its efficacy and safety. The growing interest in herbal medicine and natural cardioprotective agents underscores the need for further exploration of *Arjuna*'s therapeutic benefits in contemporary healthcare.[7]

AIM AND OBJECTIVES:

This study aims to provide a comprehensive review of *Arjuna*'s medicinal properties, phytochemical constituents, and pharmacological activities.

MATERIAL AND METHODS:

A systematic review of classical Ayurvedic texts, ethnobotanical studies, and recent pharmacological research on *Terminalia arjuna* was conducted. Data sources included peer-reviewed journals, traditional Ayurvedic literature, and electronic databases. The review focused on the plant's active constituents, mechanisms of action, and therapeutic applications.

CLASSIFICATION OF *TERMINALIA ARJUNA*:

Taxonomic Rank	**Classification**
Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta (Angiosperms)
Class	Magnoliopsida (Dicotyledons)
Order	Myrtales
Family	Combretaceae
Genus	*Terminalia*
Species	*Terminalia arjuna*

VERNACULAR NAME:

Language	**Vernacular Name**
Sanskrit	*Arjuna*
Hindi	Arjun
English	Arjuna Tree
Tamil	Marutham Pattai
Telugu	Tella Maddi
Kannada	Hole Matthi
Malayalam	Neer Maruthu
Bengali	Arjun
Marathi	Arjun Sadada
Gujarati	Arjun Sadad
Punjabi	Arjuna
Odia	Arjuna
Assamese	Arjun Gachh

SYNONYMS:

Sanskrit Synonym	**Meaning / Significance**
Arjuna	Named after the warrior Arjuna, symbolizing strength and resilience
Nadisarja	Found near riverbanks (*Nadi* means river)
Dhanvi	Strength-giving, associated with vitality
Veeravriksha	Tree of warriors, known for its strength-enhancing properties
Indradruma	Sacred tree associated with divine strength
Kakubha	A widely used synonym in Ayurvedic texts
Partha	Another name for Arjuna (hero of Mahabharata), highlighting its protective nature

Shita Virya	Possessing cooling properties
Mrittika Varna	Having a soil-like color (grayish bark)
Hritpatraka	Beneficial for heart health (*Hridya* means heart)

Geographical Distribution:

Region	**Distribution**
India	Widely found in the Sub-Himalayan region, Central India, and along riverbanks in Uttar Pradesh, Bihar, West Bengal, Odisha, Madhya Pradesh, Maharashtra, and South India.
Sri Lanka	Naturally occurring in tropical forests and riverine habitats.
Bangladesh	Found in forested regions and cultivated for medicinal purposes.
Nepal	Grows in subtropical and tropical regions, especially in the Terai belt.
Pakistan	Found in some parts of Punjab and Sindh, mainly near riverbanks.
Myanmar (Burma)	Distributed in moist deciduous forests.
Southeast Asia	Found in tropical regions, mainly in Thailand, Malaysia, and Indonesia.
Africa	Introduced and cultivated in some regions for medicinal and agroforestry purposes.
Australia	Grown in botanical gardens and as part of herbal plantations.
United States & Europe	Cultivated in botanical gardens and used in Ayurvedic formulations.

Morphology of *Terminalia arjuna* (Arjuna Tree)

The *Arjuna* tree (*Terminalia arjuna*) is a large, deciduous tree with distinctive morphological characteristics. It is primarily found in tropical and subtropical regions and is widely recognized for its therapeutic, ecological, and medicinal value.[9]

Habit & Growth Pattern

- *Terminalia arjuna* is a large deciduous tree that can grow up to 20–30 meters in height.
- It has a spreading crown with dense foliage, providing ample shade.

- The tree has a moderate to fast growth rate and thrives in moist, well-drained soil near riverbanks and water bodies.[10]

Bark

- The bark is smooth, grayish-white to pinkish-brown in color.
- It has a flaky, exfoliating texture, which peels off in thin sheets.
- The inner bark is reddish and is rich in bioactive compounds, including tannins, flavonoids, and glycosides, which contribute to its medicinal properties.[11]

Leaves

- The leaves are simple, oblong or elliptic, and arranged oppositely or sub-oppositely on branches.
- They measure about 10–15 cm in length and 4–7 cm in width.
- The upper surface of the leaves is glossy green, while the lower surface is pale with a slightly hairy texture.
- The petiole (leaf stalk) is short and sometimes has glandular dots.[12]

Flowers

- The flowers of *Terminalia arjuna* are small, pale yellow or greenish-white, and appear in dense terminal or axillary spikes.
- They are polygamous, meaning the tree bears both bisexual and unisexual flowers on the same plant.
- The flowers have a mild fragrance and usually bloom during April to June.
- They are inconspicuous as they lack petals, but they attract pollinators like bees due to their nectar production.[13]

Fruit

- The fruit is a woody, fibrous drupe, measuring 2.5–5 cm in length.
- It is oval or ovoid, greenish-brown when young, turning dark brown at maturity.
- The fruit has 5–7 prominent longitudinal ridges, which give it a characteristic ribbed appearance.
- Fruits mature between September and November and contain seeds within a hard, protective shell.[14]

Seeds

- The seeds are small, oval, and brownish in color.
- They are enclosed within the hard fruit shell and require scarification for germination.
- Propagation of *Terminalia arjuna* is primarily through seeds or vegetative cuttings.[15]

Root System

- The tree has a deep, well-developed taproot system, allowing it to access underground water sources.
- It is drought-resistant but thrives best in areas with high moisture content, particularly along riverbanks.[16]

Habitat & Ecological Importance

- *Terminalia arjuna* is commonly found in moist deciduous forests, particularly near riverbanks, lakes, and streams.
- It is native to India, Sri Lanka, Nepal, and Bangladesh, but it is also cultivated in parts of Southeast Asia and Africa.
- The tree plays an important role in soil conservation and helps prevent erosion due to its extensive root system.[17]

Medicinal Importance of Morphological Parts

Plant Part	Medicinal Uses
Bark	Used for cardioprotective, antioxidant, and anti-inflammatory purposes. It is rich in tannins, glycosides, and flavonoids.
Leaves	Used for treating wounds, ulcers, and skin diseases due to their astringent and antimicrobial properties.
Fruits	Used as an astringent, digestive tonic, and for treating diarrhea and dysentery.
Seeds	Occasionally used for oil extraction and medicinal formulations.
Roots	Traditionally used in Ayurvedic formulations for tonic and rejuvenating effects.

Phytoconstituents of *Terminalia arjuna* (Arjuna Tree)

The phytochemical composition of *Terminalia arjuna* is rich in bioactive compounds that contribute to its diverse medicinal properties. The major phytoconstituents present in different parts of the plant, particularly in the bark, leaves, and fruits, include tannins, flavonoids, triterpenoids, glycosides, and alkaloids.[18]

PHYTOCONSTITUENTS AND THEIR MEDICINAL SIGNIFICANCE:

Phytoconstituent	Chemical Class	Medicinal Significance
Tannins (Arjunic acid, Arjunolic acid, Ellagic acid, Gallic acid)[19]	Polyphenols	Strong antioxidant, cardioprotective, anti-inflammatory, and hepatoprotective properties. Helps in cholesterol reduction and prevents oxidative stress.
Flavonoids (Quercetin, Kaempferol, Luteolin)[20]	Polyphenolic compounds	Antioxidant, anti-inflammatory, anti-diabetic, and neuroprotective effects. Enhances endothelial function and reduces cardiovascular risk.
Triterpenoids (Arjunolic acid, Arjunic acid, Betulinic acid)[21]	Triterpenes	Exhibits cardioprotective, hepatoprotective, and anticancer properties. Strengthens cardiac muscles and reduces oxidative damage.
Saponins (Arjunasaponins I–IV)[22]	Glycosides	Supports cardiac health, reduces cholesterol levels, and has immunomodulatory effects.
Glycosides (Arjunetin, Arjunone)[23]	Bioactive compounds	Helps in cardiac tonicity, improves heart function, and has diuretic properties.
Alkaloids[24]	Nitrogenous compounds	Exhibits antimicrobial, analgesic, and hepatoprotective activity.
β-Sitosterol[25]	Phytosterol	Reduces cholesterol absorption, has anti-inflammatory properties, and helps in prostate health.
Gallic Acid[26]	Phenolic Acid	Strong antioxidant, anticancer, and anti-inflammatory effects.
Ellagic Acid[27]	Polyphenol	Exhibits antioxidant, anti-diabetic, and neuroprotective properties.
Proanthocyanidins[28]	Flavonoids	Known for anti-aging, cardioprotective, and skin-rejuvenating properties.
Calcium, Magnesium, Zinc[29]	Essential minerals	Supports bone health, enzymatic activity, and cardiovascular functions.

Medicinal Importance of Phytoconstituents

- **Cardioprotective Action** – Triterpenoids, tannins, and flavonoids strengthen heart muscles and reduce oxidative stress.
- **Antioxidant & Anti-Inflammatory Effects** – Polyphenols such as gallic acid and ellagic acid neutralize free radicals and prevent inflammation.
- **Cholesterol-Lowering Properties** – Saponins and β-sitosterol help reduce LDL (bad cholesterol) and increase HDL (good cholesterol) levels.
- **Hepatoprotective Action** – Arjunolic acid and flavonoids protect liver cells from damage caused by toxins and oxidative stress.
- **Antimicrobial Activity** – Tannins, alkaloids, and glycosides have antibacterial, antiviral, antifungal, and antiprotozoal properties.

Chemical Constituents of *Terminalia arjuna* with Their Biological Uses:

Parts of *T. arjuna*	**Phytochemicals Present**	**Biological Uses**
Bark	Tannins (*Arjunic acid, Arjunolic acid, Ellagic acid, Gallic acid*), Flavonoids, Saponins, Glycosides, Triterpenoids	Cardioprotective, Antioxidant, Anti-inflammatory, Hepatoprotective, Cholesterol-lowering
Leaves	Flavonoids (*Quercetin, Kaempferol, Luteolin*), Tannins, Alkaloids	Antioxidant, Antimicrobial, Anti-inflammatory, Wound healing
Fruits	Triterpenoids, Phenolic compounds, Saponins	Digestive tonic, Antidiarrheal, Astringent, Antioxidant
Seeds	Fixed oils, Phytosterols, Saponins	Lipid-lowering, Antioxidant, Immunomodulatory
Roots	Tannins, Glycosides, Alkaloids	Tonic effects, Antimicrobial, Anthelmintic

Phytochemicals Present in *Terminalia arjuna* –

1. Flavonoids (Quercetin, Kaempferol, Luteolin)[30]

Flavonoids are polyphenolic compounds known for their antioxidant, anti-inflammatory, and cardioprotective properties. The primary flavonoids found in *Terminalia arjuna* include Quercetin, Kaempferol, and Luteolin, each with unique medicinal benefits:

- Quercetin: A potent antioxidant and anti-inflammatory agent that helps reduce oxidative stress, improve endothelial function, and regulate blood pressure. It also possesses neuroprotective and anticancer properties.
- Kaempferol: Known for its cardioprotective, anticancer, and anti-inflammatory effects. It helps in reducing the risk of atherosclerosis, promoting vascular health, and improving metabolic balance.
- Luteolin: Exhibits anti-inflammatory, immune-modulating, and neuroprotective properties. It helps in reducing inflammation, protecting neurons, and supporting cardiovascular health.
- These flavonoids play a significant role in protecting the heart, liver, and blood vessels from oxidative damage and inflammation, making *Terminalia arjuna* a potent cardioprotective and hepatoprotective herb.

2. Tannins[31]

Tannins are water-soluble polyphenols known for their astringent, antioxidant, and antimicrobial properties. The major tannins in *Terminalia arjuna* include:

- Ellagic Acid: Acts as a potent antioxidant, protecting cells from free radical damage and supporting cardiovascular and liver health.
- Gallic Acid: Exhibits anti-inflammatory, antimicrobial, and anticancer effects, helping in digestive and skin health.
- Arjunolic Acid & Arjunic Acid: These are unique tannins found in *Arjuna* that help strengthen heart muscles, lower cholesterol, and support liver function.
- Tannins contribute to the wound-healing, anti-aging, and cardioprotective properties of *Terminalia arjuna*.

3. Alkaloids[32]

Alkaloids are naturally occurring organic compounds with antimicrobial, analgesic, and hepatoprotective properties. In *Terminalia arjuna*, alkaloids contribute to its anti-inflammatory, anti-hypertensive, and neuroprotective effects. They play a role in modulating blood pressure, enhancing circulation, and improving liver detoxification.

4. Triterpenoids[33]

Triterpenoids are bioactive compounds that exhibit anti-inflammatory, hepatoprotective, and cardioprotective effects. The key triterpenoids in *Terminalia arjuna* include:

- Arjunolic Acid: Supports heart health, reduces oxidative stress, and protects against ischemic damage.
- Betulinic Acid: Known for its anticancer, antiviral, and hepatoprotective properties.
- Arjunic Acid: Helps in cardiac muscle strengthening and cholesterol reduction.
- These triterpenoids make *Terminalia arjuna* a vital herb in cardiovascular and liver health management.

5. Phenolic Compounds[34]

Phenolic compounds are strong antioxidants that help neutralize free radicals, thereby protecting the body from oxidative stress-related diseases. The phenolics found in *Arjuna* include Ellagic acid, Gallic acid, and Quercetin, which provide anti-inflammatory, anticancer, and hepatoprotective benefits.

6. Saponins[35]

Saponins are bioactive glycosides with foam-producing properties that play an essential role in reducing cholesterol, boosting immune function, and supporting heart health. The Arjunasaponins (I-IV) found in *Terminalia arjuna* help in:

- Lowering LDL cholesterol and improving HDL cholesterol.
- Reducing oxidative stress and protecting the heart from damage.
- Modulating the immune response to improve overall health.
- Saponins contribute to the lipid-lowering and adaptogenic properties of *Terminalia arjuna*.

7. Fixed Oils[36]

Fixed oils in *Terminalia arjuna* seeds and bark contain essential fatty acids, which help in:

- Reducing inflammation and improving cardiovascular health.
- Supporting skin regeneration and wound healing.
- Enhancing nutrient absorption and metabolic function.
- These oils play a role in lipid metabolism and cellular protection.

8. Phytosterols[37]

Phytosterols are plant-derived sterols that are structurally similar to cholesterol and have cholesterol-lowering effects. The phytosterols in *Arjuna* help:

- Inhibit cholesterol absorption in the intestine.
- Reduce LDL cholesterol levels.
- Support cardiovascular health and prevent atherosclerosis.
- This makes *Arjuna* a natural lipid-lowering agent, beneficial for individuals with high cholesterol levels.

9. Glycosides[38]

Glycosides in *Terminalia arjuna* (e.g., Arjunetin, Arjunone) are essential for heart health and circulation improvement. These compounds:

- Enhance myocardial function and improve cardiac output.
- Support diuretic effects, helping to regulate blood pressure.
- Exhibit antioxidant properties, protecting the heart from damage.
- Glycosides make *Terminalia arjuna* an effective natural cardiotonic.

Pharmacological Actions of *Terminalia arjuna*

Terminalia arjuna exhibits a wide range of pharmacological properties, making it a highly valued medicinal plant in Ayurvedic and modern medicine. Its therapeutic effects are primarily due to its rich phytochemical composition, including tannins, flavonoids, glycosides, triterpenoids, saponins, and phenolic compounds.

1. Cardioprotective Activity[39]

- *Terminalia arjuna* is one of the most well-known herbs for heart health and is widely used as a cardiotonic (*Hridya*).
- The tannins (arjunolic acid, arjunic acid), flavonoids (quercetin), and glycosides (arjunetin, arjunone) help in strengthening cardiac muscles, improving myocardial function, and enhancing coronary circulation.
- It helps in the management of ischemic heart disease (IHD), hypertension, and heart failure by reducing oxidative stress and lipid peroxidation.

2. Antioxidant Activity[40]

- *Terminalia arjuna* contains polyphenols, flavonoids (kaempferol, luteolin), and tannins (ellagic acid, gallic acid), which act as powerful antioxidants.
- These compounds help neutralize free radicals, reducing oxidative damage to the heart, liver, and nervous system.
- Its antioxidant effect also contributes to anti-aging, neuroprotection, and reduced risk of chronic diseases.

3. Anti-inflammatory Activity[41]

- The flavonoids and triterpenoids in *Arjuna* exhibit anti-inflammatory properties, making it useful in the management of inflammatory disorders.
- It reduces the production of pro-inflammatory cytokines, helping in conditions like arthritis, cardiovascular inflammation, and chronic inflammatory diseases.
- The bark extract is known to reduce inflammation in blood vessels, thereby lowering the risk of atherosclerosis and heart disease.

4. Anti-hypertensive Activity[42]

- *Terminalia arjuna* has been found to regulate blood pressure levels by acting as a vasodilator.
- It improves endothelial function and relaxes blood vessels, leading to a reduction in high blood pressure (hypertension).

- The presence of saponins, flavonoids, and tannins helps in reducing vascular resistance and improving circulation.

5. Lipid-Lowering (Hypolipidemic) Activity[43]

- The phytosterols, saponins, and flavonoids in *Terminalia arjuna* help in reducing LDL (bad cholesterol) and triglycerides while increasing HDL (good cholesterol).
- It prevents the deposition of plaque in arteries (atherosclerosis), reducing the risk of heart attacks and strokes.
- The bark extract is traditionally used in dyslipidemia (abnormal lipid levels) management.

6. Hepatoprotective Activity[44]

- *Terminalia arjuna* has been found to protect the liver from toxins and oxidative stress.
- The tannins (ellagic acid, gallic acid) and flavonoids prevent liver damage, reduce inflammation, and promote detoxification.
- It is used in the treatment of fatty liver disease, hepatitis, and liver cirrhosis.

7. Antimicrobial Activity[45]

- The alkaloids, tannins, and flavonoids present in *Terminalia arjuna* exhibit strong antimicrobial effects against bacteria, fungi, and viruses.
- It has shown activity against common pathogens like *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa,* and *Candida albicans*.
- Due to its antibacterial and antifungal properties, it is used in the treatment of skin infections, respiratory infections, and urinary tract infections (UTIs).

8. Anti-diabetic Activity[46]

- *Terminalia arjuna* exhibits anti-diabetic effects by reducing blood glucose levels and improving insulin sensitivity.
- The flavonoids and polyphenols in *Arjuna* help in regulating carbohydrate metabolism and reducing complications of diabetes.
- It is beneficial in preventing diabetes-induced cardiovascular diseases.

9. Gastroprotective Activity[47]

- *Terminalia arjuna* is known for its protective effects on the gastrointestinal tract.
- It helps in the treatment of ulcers, gastritis, and acid reflux by reducing gastric acidity and inflammation.
- The tannins and glycosides present in the bark act as natural astringents, supporting gut health and preventing diarrhea and dysentery.

10. Wound Healing and Skin-Protective Activity[48]

- *Terminalia arjuna* has excellent wound-healing properties due to its astringent, antimicrobial, and antioxidant effects.
- The tannins and flavonoids in the bark help in faster wound contraction, collagen synthesis, and tissue regeneration.
- It is traditionally used for treating cuts, burns, and skin infections.

11. Anti-stress and Adaptogenic Activity[49]

- *Terminalia arjuna* acts as a natural adaptogen, helping the body combat stress, anxiety, and fatigue.
- It supports the adrenal glands and reduces cortisol levels, which helps in improving overall resilience to stress.

12. Anticancer Activity[50]

- The polyphenols, flavonoids, and triterpenoids present in *Terminalia arjuna* exhibit anticancer properties by inhibiting tumor cell growth and inducing apoptosis (programmed cell death).
- It has been studied for its protective effects against breast cancer, prostate cancer, and liver cancer.

13. Diuretic Activity[51]

- *Terminalia arjuna* promotes urine production (diuresis), helping in reducing water retention, detoxifying the kidneys, and lowering blood pressure.
- It is useful in the treatment of kidney stones and urinary tract infections (UTIs).

Clinical Applications of *Terminalia arjuna*

Terminalia arjuna is widely used in traditional Ayurvedic medicine and modern herbal formulations due to its cardioprotective, hepatoprotective, anti-inflammatory, and antimicrobial properties. Its diverse pharmacological activities make it beneficial for the prevention and treatment of multiple diseases, particularly in cardiovascular and metabolic disorders.

1. Cardiovascular Disorders (Heart Health)

- **Treatment of Ischemic Heart Disease (IHD) and Angina**
    - *Terminalia arjuna* is an established cardioprotective agent that strengthens cardiac muscles, improves coronary circulation, and enhances myocardial function.
    - Clinical studies show that it reduces angina (chest pain), improves oxygen supply to the heart, and reduces ischemic damage.
    - It is used as a natural alternative to conventional anti-anginal medications like nitrates and beta-blockers.
- **Congestive Heart Failure (CHF) and Left Ventricular Dysfunction**
    - *Terminalia arjuna* improves left ventricular ejection fraction (LVEF), which is crucial for patients with heart failure.
    - It supports cardiac contractility, enhances heart rate variability, and reduces fatigue and breathlessness in CHF patients.
- **Hypertension (High Blood Pressure)**
    - The vasodilatory properties of *Arjuna* help relax blood vessels, reduce vascular resistance, and regulate blood pressure.
    - It is used as an adjunct therapy for hypertension to support conventional medications.
- **Hyperlipidemia (Cholesterol Reduction)**
    - *Terminalia arjuna* lowers LDL (bad cholesterol), triglycerides, and total cholesterol while increasing HDL (good cholesterol).

- It prevents atherosclerosis (plaque buildup in arteries), reducing the risk of heart attacks and strokes.

2. Hepatic (Liver) Disorders

- **Fatty Liver Disease & Liver Detoxification**
    - The antioxidant and hepatoprotective effects of *Terminalia arjuna* help in treating non-alcoholic fatty liver disease (NAFLD) and alcohol-induced liver damage.
    - It enhances liver enzyme function (ALT, AST, ALP) and reduces hepatic inflammation.
- **Jaundice and Hepatitis**
    - The tannins and flavonoids present in *Arjuna* support liver detoxification and bile secretion, making it beneficial in jaundice and hepatitis.

3. Diabetes and Metabolic Syndrome

- *Terminalia arjuna* helps regulate blood sugar levels and improve insulin sensitivity, making it beneficial for type 2 diabetes management.
- It reduces the risk of diabetes-induced cardiovascular complications, supporting heart health in diabetic patients.

4. Gastrointestinal Disorders

- Used in the treatment of gastric ulcers, acidity, and acid reflux due to its gastroprotective effects.
- The tannins and glycosides present in *Arjuna* support gut health and help in conditions like diarrhea, dysentery, and irritable bowel syndrome (IBS).

5. Wound Healing and Skin Disorders

- *Terminalia arjuna* promotes faster wound healing due to its astringent, antimicrobial, and tissue-repairing properties.
- It is used in burns, ulcers, and chronic wounds to promote collagen synthesis and regeneration of damaged tissues.

- It is also beneficial in acne, eczema, and skin infections due to its antibacterial effects.

6. Kidney and Urinary Disorders

- The diuretic properties of *Terminalia arjuna* help in kidney detoxification, flushing out toxins, and reducing fluid retention.
- It is used in the treatment of urinary tract infections (UTIs), kidney stones, and edema.

7. Stress, Anxiety, and Neuroprotection

- *Terminalia arjuna* acts as a natural adaptogen, helping the body cope with stress, anxiety, and fatigue.
- It helps balance cortisol levels, reducing the impact of chronic stress on heart health.
- The flavonoids and polyphenols exhibit neuroprotective effects, potentially reducing the risk of neurodegenerative disorders like Alzheimer's and Parkinson's disease.

8. Antimicrobial and Immunomodulatory Effects

- *Terminalia arjuna* exhibits strong antibacterial, antiviral, and antifungal activity, making it effective against respiratory infections, skin infections, and gastrointestinal pathogens.
- It boosts immunity, helping the body defend against infections and chronic inflammatory diseases.

9. Cancer Prevention and Chemoprotective Potential

- The polyphenols (ellagic acid, gallic acid, quercetin) and triterpenoids in *Terminalia arjuna* have shown anticancer properties by inhibiting tumor cell growth and inducing apoptosis (cell death) in cancer cells.
- It is being studied for its role in preventing breast, liver, and prostate cancers.

10. Respiratory Disorders

- Traditionally used for treating bronchitis, asthma, and chronic cough due to its anti-inflammatory and expectorant properties.
- The flavonoids and glycosides present in *Arjuna* help in reducing airway inflammation and promoting lung function.

Discussion

The present review highlights the phytochemical composition, pharmacological activities, and clinical applications of *Terminalia arjuna*, a well-documented medicinal plant in Ayurvedic and modern medicine. The therapeutic benefits of *Arjuna* are primarily attributed to its rich bioactive compounds, including tannins, flavonoids, glycosides, saponins, and triterpenoids, which exhibit cardioprotective, antioxidant, hepatoprotective, anti-inflammatory, and antimicrobial properties.[52]

One of the most significant findings from research on *Terminalia arjuna* is its cardioprotective effect, making it a valuable herb in the treatment of ischemic heart disease (IHD), hypertension, heart failure, and hyperlipidemia. Studies have demonstrated its ability to strengthen cardiac muscles, improve coronary circulation, regulate blood pressure, and reduce LDL cholesterol levels. These effects are primarily mediated by arjunolic acid, arjunic acid, and flavonoids like quercetin and kaempferol, which have been shown to improve endothelial function and myocardial efficiency. Clinical studies support its role as a natural alternative or adjunct therapy for conventional cardiovascular drugs, with a better safety profile and fewer side effects. However, further large-scale human trials are necessary to establish standardized dosages and confirm long-term safety.[53]

The polyphenolic compounds, flavonoids, and tannins present in *Terminalia arjuna* contribute to its strong antioxidant and anti-inflammatory effects. These properties make it useful in reducing oxidative stress-related disorders, such as cardiovascular diseases, neurodegenerative disorders, and metabolic syndrome. The free radical scavenging activity of *Arjuna* helps in preventing lipid peroxidation, reducing inflammatory mediators, and protecting tissues from oxidative damage. This mechanism provides scientific support for its traditional use in rejuvenation therapy (*Rasayana Chikitsa*) and longevity enhancement in Ayurveda.[54]

The hepatoprotective potential of *Terminalia arjuna* has been demonstrated in studies showing its ability to reduce liver enzyme levels, prevent hepatotoxicity, and improve liver detoxification function. It is effective in treating fatty liver disease (NAFLD), alcoholic liver disease, and viral hepatitis due to its antioxidant and anti-inflammatory effects. Additionally, *Arjuna* has shown promise in diabetes management, as its flavonoids and saponins improve insulin sensitivity, regulate glucose metabolism, and reduce diabetes-induced cardiovascular

risks. However, further clinical investigations are required to explore its potential as a complementary therapy in metabolic disorders.[55]

The presence of tannins, flavonoids, and alkaloids contributes to the antimicrobial and wound-healing properties of *Terminalia arjuna*. It has demonstrated activity against pathogenic bacteria, fungi, and viruses, supporting its traditional use in skin infections, wound healing, and oral health management. The astringent properties of tannins facilitate faster tissue repair, collagen synthesis, and wound contraction, making it an effective herbal remedy for burns, ulcers, and surgical wounds.[56]

Recent studies suggest that *Terminalia arjuna* may possess anticancer properties due to the presence of ellagic acid, betulinic acid, and flavonoids, which have been shown to inhibit tumor growth, induce apoptosis, and prevent oxidative DNA damage. While preliminary research indicates its potential use in chemoprevention, more in vivo and clinical studies are needed to evaluate its efficacy in cancer therapy.[57]

Conclusion

Terminalia arjuna is a highly valued medicinal plant in both Ayurvedic and modern medicine, known for its cardioprotective, hepatoprotective, antioxidant, anti-inflammatory, and antimicrobial properties. Its rich phytochemical composition, including tannins, flavonoids, glycosides, saponins, and triterpenoids, contributes to its therapeutic potential in managing cardiovascular diseases, liver disorders, metabolic syndrome, wound healing, and immune modulation. Clinical studies and pharmacological investigations have confirmed its efficacy in ischemic heart disease, hypertension, heart failure, hyperlipidaemia, and hepatic disorders. Its ability to reduce oxidative stress, regulate lipid metabolism, and support cardiac function makes it a natural alternative or adjunct to conventional cardiovascular medications. Furthermore, its diuretic, anti-diabetic, and antimicrobial properties expand its applications in metabolic disorders and infectious diseases. Despite its strong pharmacological potential, challenges remain in terms of standardizing formulations, optimizing dosages, and conducting large-scale clinical trials to further validate its long-term safety and efficacy. Future research should focus on identifying precise molecular mechanisms, improving bioavailability, and developing pharmaceutical-grade formulations for its wider clinical acceptance. Its integration into modern medicine, along with further

research, will pave the way for enhanced herbal-based treatment strategies in cardiovascular and metabolic health management.

CONFLICT OF INTEREST -NIL

SOURCE OF SUPPORT -NONE

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