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A REVIEW ON ANTI-INFLAMMATORY POTENTIAL OF *TERMINALIA ARJUNA* AND ITS APPLICATION IN ORAL SUSPENSION FORMULATION

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Abstract: Inflammation is a crucial defense mechanism, but chronic or unregulated inflammation can lead to several pathological conditions such as arthritis and cardiovascular diseases. While conventional anti-inflammatory drugs provide symptomatic relief, their prolonged use is associated with adverse effects, highlighting the need for safer alternatives. *Terminalia arjuna* (Roxb.) Wight & Arn., a medicinal plant from the Combretaceae family, has been extensively used in Ayurvedic medicine, especially for cardiovascular disorders. Its bark is rich in bioactive compounds like arjunic acid, arjungenin, flavonoids, tannins, and glycosides, which demonstrate significant anti-inflammatory, antioxidant, and cardioprotective properties. This review explores the phytochemical and pharmacological profile of *T. arjuna*, focusing on its anti-inflammatory mechanisms such as prostaglandin inhibition, cytokine modulation, and free radical scavenging. The formulation of *T. arjuna* into an oral suspension aims to improve patient compliance, particularly for pediatric and geriatric populations. An optimized oral suspension offers uniform dosing, palatability, and enhanced bioavailability. Preclinical studies confirm its therapeutic potential; however, standardized formulation protocols and comprehensive clinical trials are necessary for its integration into mainstream medicine. This review supports *T. arjuna* as a promising candidate for the development of effective, natural anti-inflammatory therapeutics in oral dosage form.

Keywords: *Terminalia arjuna*, Anti-inflammatory, Oral suspension, Phytochemicals, Cardioprotective

1. Introduction

Inflammation is a protective physiological response to injury, infection, or irritation, characterized by redness, heat, swelling, and pain. While it is essential for initiating healing, chronic or uncontrolled inflammation is implicated in various diseases such as arthritis,

cardiovascular disorders, and metabolic syndrome [1]. Conventional anti-inflammatory drugs, including non-steroidal anti-inflammatory drugs (NSAIDs) and corticosteroids, are effective but often lead to adverse effects such as gastrointestinal irritation, hepatotoxicity, nephrotoxicity, and increased cardiovascular risk, especially upon prolonged use [2]. These concerns have prompted a global shift toward plant-based alternatives that are safer, biocompatible, and have minimal side effects. *Terminalia arjuna* (Roxb.) Wight & Arn., commonly known as Arjuna, belongs to the Combretaceae family and is traditionally used in Ayurveda for treating cardiovascular ailments. The bark of *T. arjuna* is rich in bioactive constituents such as arjunolic acid, arjungenin, flavonoids, saponins, tannins, and glycosides, many of which possess potent anti-inflammatory and antioxidant properties [3]. Several pharmacological studies have demonstrated its efficacy in reducing inflammation through mechanisms such as inhibition of prostaglandin synthesis, cytokine modulation, and free radical scavenging.With growing interest in herbal therapeutics, formulating *T. arjuna* into an oral suspension provides a patient-friendly, easily administrable, and effective route for delivering anti-inflammatory benefits. Suspensions are particularly suitable for pediatric and geriatric patients who face difficulty swallowing solid dosage forms [4,5]. This review explores the phytochemical and pharmacological profile of *T. arjuna*, recent advancements in its anti-inflammatory applications, and its formulation into an effective oral suspension.

2. Objectives of the Review: The objective provides a clear direction for the review, outlining the key areas of focus and guiding the scope of the study. So, objectives for this study are given below:

- To review the anti-inflammatory potential of *Terminalia arjuna*.
- To highlight key phytochemicals responsible for its activity.
- To explore formulation of *T. arjuna* oral suspension.
- To evaluate studies on its efficacy and stability.

3. Plant Profile

Terminalia arjuna (Roxb.) Wight & Arn., of the Combretaceae family, is a deciduous tree native to the Indian subcontinent. Known commonly as Arjuna, it grows up to 20–25 meters and is found along riverbanks and sub-Himalayan regions [1,6]. The bark is the primary medicinal part, rich in tannins, flavonoids, glycosides, and saponins. Traditionally used in Ayurveda, it serves as a cardiotonic, anti-inflammatory, and wound-healing agent. Bark powder and decoctions are employed in treating heart ailments, ulcers, bone fractures, and

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general debility. Its widespread use and proven therapeutic value have made *T. arjuna* a key plant in both ethnomedicine and phytopharmaceutical studies [3,7].

Figure 1: ***Terminalia arjuna***

Classification of *Terminalia arjuna*

- **Kingdom**: Plantae
- **Division**: Magnoliophyta
- **Class**: Magnoliopsida
- **Order**: Myrtales
- **Family**: Combretaceae
- **Genus**: *Terminalia*
- **Species**: *T. arjuna* [7,8]

4. Phytochemical Constituents

- *Terminalia arjuna* bark is rich in bioactive compounds such as arjunic acid, arjungenin, and arjunetin, which belong to the triterpenoid group. These phytoconstituents have shown strong cardioprotective, antioxidant, and anti-inflammatory effects in various studies [9].
- Flavonoids like luteolin, kaempferol, and quercetin is present in significant amounts. These compounds help neutralize free radicals, reduce oxidative stress, and contribute to the plant's anti-atherogenic and antihypertensive properties [10,11].
- Tannins, both hydrolyzable and condensed, are also abundant in the bark. They are responsible for astringent, antimicrobial, and wound-healing properties, enhancing the therapeutic potential of *T. arjuna* [12].

- Glycosides, saponins, and minerals like calcium and magnesium further support cardiovascular health. These components assist in stabilizing cell membranes and improving myocardial function [13].
- Together, these phytochemicals form the basis for *T. arjuna*'s application in anti-inflammatory, cardiotonic, and hepatoprotective formulations. The synergy among these constituents makes it effective in traditional and modern medicine.

5. Pharmacological Activities of *Terminalia arjuna:* *Terminalia arjuna* is a versatile medicinal plant exhibiting a wide range of pharmacological activities that support its traditional and clinical use [11,13].

- It is renowned for its cardioprotective, antioxidant, and anti-inflammatory effects, which contribute to heart health and the reduction of oxidative stress [14, 15].
- It shows antihyperlipidemic, hypotensive, and hepatoprotective actions, aiding in the management of cardiovascular and liver disorders [16,17].
- Its antimicrobial, anti-atherogenic, and anti-ulcer properties further establish its therapeutic versatility [18-22].
- It also demonstrates anticancer, antithrombotic, wound healing, antidiabetic, and immunomodulatory effects, validating its role in modern pharmacological research and multi-targeted therapy [23,24].

Table 1: Pharmacological Activities of *Terminalia arjuna*

S. No.	Pharmacological Activity	Description / Role
1	Cardioprotective [1]	Strengthens cardiac muscles, improves coronary artery flow, reduces blood pressure and lipid levels
2	Antioxidant [13]	Scavenges free radicals and protects tissues from oxidative stress
3	Anti-inflammatory [11]	Reduces inflammation by inhibiting pro-inflammatory mediators
4	Antihyperlipidemic [14]	Lowers total cholesterol, LDL, and triglycerides; increases HDL
5	Hypotensive [15]	Induces vasodilation and reduces systolic and diastolic blood pressure
6	Hepatoprotective [16]	Protects liver tissue against toxins and oxidative

		injury
7	Antimicrobial [17]	Effective against Gram-positive and Gram-negative bacteria, and fungi
8	Anti-atherogenic [18]	Prevents plaque formation and arterial thickening
9	Anti-ulcer [19]	Protects gastric mucosa and reduces ulcer index
10	Anticancer [20]	Shows cytotoxic activity against certain cancer cell lines
11	Antithrombotic [21]	Inhibits platelet aggregation and thrombus formation
12	Wound healing [22]	Accelerates collagen synthesis and tissue regeneration
13	Antidiabetic [23]	Reduces blood glucose and improves insulin sensitivity
14	Immunomodulatory [24]	Modulates immune response by regulating cytokine activity

Exploration of formulation of *Terminalia Arjuna* oral suspension: *Terminalia arjuna* (*T. arjuna*), a well-known cardioprotective herb in Ayurveda, possesses potent antioxidant, anti-inflammatory, and hypotensive activities. Its bark extract is rich in polyphenols, flavonoids, and triterpenoids, which contribute to its therapeutic potential [24,25]. Oral suspensions are preferred dosage forms for pediatric and geriatric patients due to ease of administration and dose flexibility. Formulating an oral suspension of *T. arjuna* aims to enhance patient compliance and ensure uniform dispersion of the active constituents. Selection of suitable suspending agents, sweeteners, and preservatives is crucial to maintain physical stability and palatability [26,27]. Evaluation parameters include sedimentation volume, redispersibility, pH, viscosity, and microbial load. The study focuses on standardizing the suspension to maintain therapeutic efficacy while ensuring stability over shelf life. The final goal is to develop a stable, effective, and patient-friendly herbal dosage form for cardiovascular support [1, 24-28].

Conclusion: *Terminalia arjuna* is a promising plant with a diverse range of pharmacological activities, including anti-inflammatory, antioxidant, cardioprotective, and antihyperlipidemic effects. Its active compounds, such as arjunic acid and tannins, contribute significantly to its therapeutic potential, particularly in managing inflammatory and cardiovascular conditions. The development of an oral suspension formulation ensures better bioavailability and patient compliance, making it an effective alternative for treating inflammation. While preclinical studies highlight its efficacy, further clinical trials are needed to establish its safety and long-

term effectiveness. *Terminalia arjuna* holds significant promise as a natural therapeutic agent in modern medicine.

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