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REVIEW ARTICLE

Phytochemistry, Traditional Uses, and Pharmacological Properties of *Polyalthia longifolia*

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Abstract: *Polyalthia longifolia* (Annonaceae) is a valuable medicinal plant widely distributed across South and Southeast Asia. The plant exhibits distinct morphological characteristics, including a tall, evergreen habit with a pyramidal crown and pendulous branches. Various parts of *P. longifolia* contain bioactive compounds such as alkaloids, flavonoids, terpenoids, and phenolic compounds. Traditional medicine systems have utilized *P. longifolia* for treating fever, skin diseases, diabetes, hypertension, and helminthiasis. Recent pharmacological studies demonstrate its potential in managing various health conditions. The leaves exhibit anti-ulcer, antiplasmodial, and anti-inflammatory properties, while the bark shows promising results in wound healing and antimicrobial applications. The main therapeutic effects include antihyperglycemic activity through α-amylase and α-glucosidase inhibition, anticancer properties against prostate cancer cells, and immunomodulatory effects on B and T lymphocytes. The plant also demonstrates antiviral activity against paramyxoviruses and antileishmanial properties through DNA topoisomerase inhibition. Modern scientific investigations validate many traditional uses while revealing new therapeutic applications. Various studies related to pharmacological activities of *P. longifolia* proves it as a valuable source for developing novel therapeutic agents.

Keywords: Annonaceae; Medicinal plant; Phytoconstituents; Pharmacological activities; Traditional medicine.

1. Introduction

Medicinal plants continue to serve as invaluable resources in healthcare systems worldwide, particularly in developing nations where traditional medicine remains a primary source of healthcare [1]. Plant-based medicines have demonstrated significant therapeutic potential while often presenting fewer side effects compared to synthetic drugs [2]. The growing interest in natural products has led to increased scientific investigation of traditional medicinal plants, aiming to validate their therapeutic properties and identify novel bioactive compounds [3]. *Polyalthia longifolia*, belonging to the family Annonaceae, stands out as a significant medicinal plant with diverse therapeutic applications [4]. The genus Polyalthia encompasses approximately 120 species distributed across tropical and subtropical regions [5]. The etymology of Polyalthia derives from Greek, meaning "many cures," while longifolia refers to its characteristic long leaves [6]. The species is native to Sri Lanka and has naturalized across South Asia, particularly in India, where it grows at elevations up to 1500 meters [7].

Morphologically, *P. longifolia* presents as a tall evergreen tree reaching heights of 12-15 meters, characterized by a distinctive symmetrical pyramidal crown [8]. The tree exhibits either short branches measuring 1-2 meters or long, glabrous, pendulous branches [9]. The leaves are lanceolate, measuring 13-20 cm in length and 4-6 cm in width, with distinctive wavy margins [10]. The flowers appear in clusters, while the fruits develop in groups of 10-20, transitioning from green to purple-black upon ripening [11]. The species holds significant economic importance beyond its medicinal applications. The lightweight wood has historically been utilized for manufacturing masts in sailing vessels, earning it the common name "Indian Mast Tree" [12]. In urban landscapes, *P. longifolia* serves as an effective noise barrier and popular ornamental species due to its symmetric crown and dense foliage [13].

Phytochemical analyses have revealed a complex profile of bioactive compounds across different plant parts [14]. The leaves contain alkaloids, steroids, phenolic compounds, tannins, and flavonoids, while the bark yields terpenoids, flavonoids, and various alkaloid derivatives [15]. These compounds contribute to the plant's diverse pharmacological activities, including antimicrobial, anti-inflammatory, and antidiabetic properties [16]. Traditional medicine systems across South Asia have employed various parts of *P. longifolia* for centuries [17]. The bark has been used to treat fever, skin diseases, and diabetes, while the leaves have shown efficacy against hypertension and helminthiasis [18]. Modern scientific investigations continue to validate these traditional applications while

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uncovering new therapeutic potential [19]. This review provides current knowledge regarding *P. longifolia*'s botanical characteristics, phytochemical constituents, traditional applications, and pharmacological properties, supported by recent scientific investigations.

Figure 1. Fruits and Leaves of *P. longifolia*

2. Taxonomy and Botanical Description

2.1. Taxonomical Classification

P. longifolia's systematic position in plant kingdom taxonomy follows a clear hierarchical structure. The species belongs to the kingdom Plantae, division Magnoliophyta, and class Magnoliopsida [20]. Within the order Magnoliales, it is classified under family Annonaceae, genus Polyalthia, with the specific epithet longifolia [21].

Table 1. Taxonomical Classification of *Polyalthia longifolia*

Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Magnoliales
Family	Annonaceae
Genus	Polyalthia
Species	*P. longifolia*
Botanical name	*Polyalthia longifolia* (Sonn.) Thwaites

2.2. Synonyms and Vernacular Names

The species has several botanical synonyms including Uvaria longifolia Sonn., Guatteria longifolia (Sonn.) Wallich, and Unona longifolia (Sonn.) [22]. The plant is recognized by various vernacular names across different regions: 'Devdar' in Marathi, 'Asoka' in Hindi, 'Naramamidi' in Telugu, and 'Asopalov' in Gujarati [23]. These diverse names reflect its widespread distribution and cultural significance across different linguistic regions.

2.3. Morphological Characteristics

The tree exhibits a characteristic straight trunk with symmetrically arranged branches forming a compact, pyramidal crown [24]. The bark appears gray-brown, smooth in young trees, developing shallow fissures with age [25]. Leaves are arranged alternately, displaying lanceolate shape with undulate margins, glossy surface, and prominent venation patterns [26]. Flowers emerge in axillary clusters, appearing greenish-yellow with three sepals and six petals arranged in two whorls [27]. The androecium consists of numerous stamens, while the gynoecium comprises multiple free carpels [28]. Fruits develop as aggregate structures, with individual drupes measuring 2.5-3.0 cm, turning purple-black upon maturation [29].

3. Geographical Distribution and Habitat

3.1. Natural Distribution

P. longifolia shows a natural distribution across tropical and subtropical regions of South and Southeast Asia [30]. The species occurs naturally in Sri Lanka and various parts of India, extending to Malaysia, Indonesia, and the Philippines [31]. In India, it is found across diverse ecological zones from coastal regions to elevations of 1500 meters in the Western Ghats and Eastern Himalayas [32].

3.2. Cultivated Range

Beyond its natural range, *P. longifolia* has been successfully introduced to numerous tropical countries [33]. It is extensively cultivated in urban areas across Asia and Africa, particularly in Nigeria, Ghana, and East African nations [34]. The species demonstrates remarkable adaptability to various soil types and climatic conditions, contributing to its successful establishment in new regions [35].

4. Phytochemical Composition

4.1. Alkaloids

The plant contains diverse alkaloids including liriodenine, anonaine, and asimilobine [36]. Notable compounds like (+)-isoboldine and hordenine have been isolated from leaves, while the bark yields berberine derivatives and N-trans-feruloyldopamine [37].

4.2. Terpenoids

Significant terpenoid compounds include clerodane diterpenoids, particularly 16α-hydroxy-cleroda-3,13(14)Z-dien-15,16-olide and kolavenic acid [38]. The leaves contain essential oil components such as caryophyllene, longifolene, and various sesquiterpenes [39].

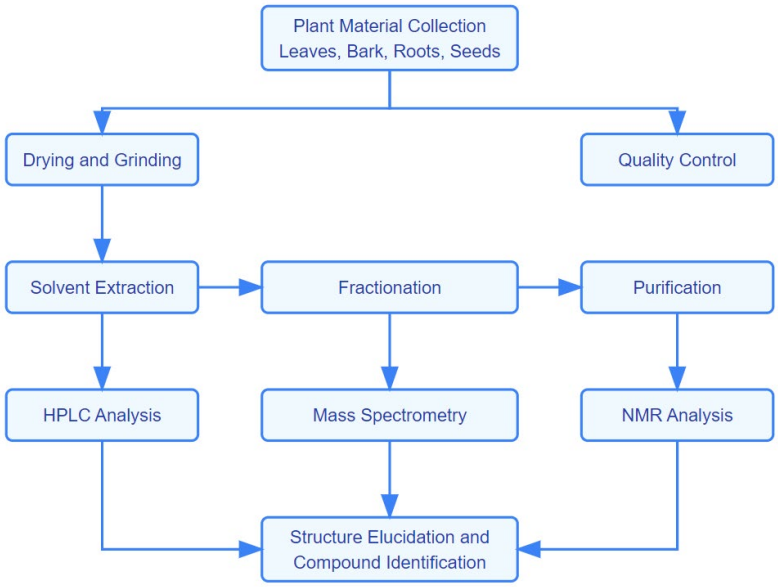

Figure 1. Extraction of Bioactive Compounds from *P. longifolia*

4.3. Flavonoids and Phenolics

Various flavonoids have been identified, including quercetin derivatives, kaempferol glycosides, and rutin [40]. Phenolic compounds such as proanthocyanidins and gallic acid contribute to the plant's antioxidant properties [41].

Table 2. Major Phytochemical Constituents Isolated from Different Parts of *P. longifolia*

Plant Part	Class of Compounds	Major Constituents
Leaves	Alkaloids	Liriodenine, Oliveroline, Hordenine
	Diterpenes	Clerodane diterpenes, 16α-hydroxycleroda-3,13(14)Z-dien-15,16-olide
	Flavonoids	Quercetin, Kaempferol glycosides, Rutin
Bark	Alkaloids	Berberine derivatives, N-trans-feruloyldopamine
	Terpenoids	Longifolene, β-caryophyllene
	Phenolics	Proanthocyanidins, Gallic acid
Seeds	Diterpenes	Kolavenic acid, 16-oxo-cleroda-3,13(14)E-dien-15-oic acid
	Steroids	β-sitosterol, Stigmasterol
Roots	Alkaloids	Azafluorene alkaloids, Aporphine alkaloids
	Phenolics	Tannins, Proanthocyanidins

5. Traditional Applications

Traditional medicine practitioners across different regions have utilized *P. longifolia* extensively [42]. Various plant parts serve distinct therapeutic purposes, reflecting deep cultural knowledge of their medicinal properties [43].

5.1. Bark

The stem bark holds particular significance in traditional medicine systems. Fresh bark juice traditionally addresses digestive disorders and pyrexia [44]. In West African traditional medicine, particularly in Côte d'Ivoire, bark preparations treat hemorrhoids and fever-related pain [45]. Indigenous communities in Gujarat, India, employ dried bark powder combined with butter for treating gonorrhea, while bark decoctions address mouth ulcers [46].

5.2. Leaf

Traditional healers utilize leaf preparations for various therapeutic purposes. In Nigerian traditional medicine, leaves treat skin diseases, diabetes, and hypertension [47]. The leaves also find application in treating microbial infections and inflammatory conditions [48]. Decoctions of leaves serve as febrifuge and possess antimalarial properties in traditional systems [49].

5.3. Root and Seed

Root preparations, often combined with other medicinal plants like Morinda citrifolia and Curcuma longa, form traditional snake bite remedies [50]. Seeds traditionally serve as febrifuge in certain regions of India, particularly in Orissa [51].

Table 3. Traditional Medicinal Applications of *P. longifolia* in Different Regions

Region	Plant Part Used	Traditional Uses	Mode of Administration
India	Bark	Fever, Diabetes, Skin diseases	Decoction, Powder
	Leaves	Hypertension, Helminthiasis	Infusion, Fresh juice
Sri Lanka	Bark	Digestive disorders, Fever	Fresh bark juice
	Leaves	Wounds, Skin infections	Poultice
Nigeria	Leaves	Malaria, Diabetes	Decoction
	Roots	Snake bite	Root paste
West Africa	Bark	Hemorrhoids, Pain	Decoction
	Seeds	Fever	Powder

6. Pharmacological Properties

6.1. Gastrointestinal Effects

6.1.1. Anti-ulcer Activity

Experimental studies demonstrate significant gastroprotective effects of *P. longifolia* leaf extracts against ethanol-induced ulcers in rat models [52]. The protective mechanism involves strengthening of gastric mucosal defense and reduction of oxidative stress [53].

6.2. Antimicrobial Activities

6.2.1. Antiplasmodial Properties

Stem bark extracts exhibit potent antiplasmodial activity against chloroquine-resistant strains [54]. The activity relates to specific compounds, supporting traditional antimalarial applications [55].

6.2.2. Antileishmanial Effects

The compound 16α-hydroxycleroda-3,13(14)Z-dien-15,16-olide demonstrates significant antileishmanial activity through specific targeting of parasite DNA topoisomerase [56]. This activity shows both *in vitro* and *in vivo* efficacy without cytotoxicity [57].

6.3. Metabolic Effects

P. longifolia exhibits glucose-lowering properties through multiple mechanisms [58]. The ethanol and chloroform extracts inhibit α-amylase and α-glucosidase enzymes, thereby reducing glucose absorption [59]. This activity provides scientific validation for traditional antidiabetic applications [60].

6.4. Immunological and Anti-inflammatory Effects

6.4.1. Immunomodulatory Properties

Ethanolic extracts of *P. longifolia* leaves demonstrate significant effects on immune system function [61]. Studies reveal modulation of both B and T lymphocyte activities, suggesting potential applications in immunodeficiency disorders [62]. The immunomodulatory effects appear dose-dependent and show minimal toxicity [63].

6.4.2. Anti-inflammatory Activity

Multiple studies confirm the anti-inflammatory properties using various experimental models [64]. Cotton pellet granuloma studies demonstrate reduced tissue formation and inflammation [65]. Both ethanolic and aqueous extracts show significant anti-inflammatory effects, attributed to flavonoids and phenolic compounds [66]. Carrageenan-induced paw edema models validate these properties at different time intervals [67].

6.5. Wound Healing Properties

Ethanolic leaf extracts promote wound healing in excision wound models [68]. The healing mechanism involves enhanced epithelialization and accelerated myofibroblast contraction [69]. Various solvent extracts of bark, including methanol, n-hexane, and ethyl acetate, contain active compounds contributing to wound healing activity [70].

6.6. Antiviral and Anticancer Properties

6.6.1. Antiviral Activity

Leaf extracts demonstrate significant activity against paramyxoviruses through dual mechanisms [71]. The extract inhibits both viral entry and budding processes, suggesting potential development as an antiviral agent [72].

6.6.2. Anticancer Effects

Methanolic extracts show promising activity against prostate cancer cells [73]. The mechanism involves cell cycle arrest at G1/S phase and activation of the intrinsic apoptotic pathway [74]. These findings suggest potential applications in cancer therapy [75].

6.7. Antihyperuricemic Effects

Studies demonstrate significant xanthine oxidase inhibitory activity in leaf extracts [76]. This property suggests potential applications in managing hyperuricemia and related conditions [77].

6.8. Antipyretic Properties

Methanol extracts from various plant parts show dose-dependent antipyretic activity [78]. Root extracts demonstrate superior antipyretic effects compared to leaf and stem bark extracts in LPS-induced models [79, 80].

Table 4. Pharmacological Activities of *P. longifolia* Extracts

Activity	Part Used/Extract Type	Study Model	Major Findings	Reference
Antimicrobial	Leaf/Methanol	*In vitro*	Active against S. aureus, E. coli	[28]
Anti-inflammatory	Leaf/Ethanol	Carrageenan-induced edema	Significant reduction in inflammation	[64]
Antidiabetic	Bark/Aqueous	Streptozotocin-induced diabetes	Reduced blood glucose levels	[11]
Anticancer	Leaf/Methanol	Human cancer cell lines	Cytotoxic against prostate cancer cells	[73]
Wound healing	Leaf/Ethanol	Excision wound model	Enhanced epithelialization	[68]

7. Conclusion

P. longifolia represents a valuable medicinal plant with diverse therapeutic applications. Phytochemical investigations reveal a complex profile of bioactive compounds contributing to its pharmacological properties. Scientific studies validate many traditional uses while uncovering new therapeutic potential. The plant demonstrates significant activities including anti-inflammatory, antihyperglycemic, anticancer, and immunomodulatory effects. Various extracts show promising results in managing conditions ranging from microbial infections to metabolic disorders. The documented safety profile supports its therapeutic use, though additional research regarding

long-term effects remains necessary. The accumulated evidence establishes *P. longifolia* as a significant source for developing new therapeutic agents. Future research directions should focus on mechanism elucidation, standardization of preparations, and clinical validation of promising applications.

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