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A RECAP ON POLYALTHIA LONGIFOLIA

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ABSTRACT

Medicinal plants are nature gift to human beings to lead a disease free, healthy life. They play a vital role in preserving our health.[1] Herbal plants act as a significant source for discovering new compounds with potential therapeutic activities. Polyalthia longifolia, which is commonly known as an Indian mast tree, has various pharmacological properties, such as an anticancer, ulcer protective, hypoglycemic, hypotensive, a corrosion inhibitor, a bio-adsorbent, and few more.[2] Polyalthia longifolia cv. pendula (Annonaceae) is native to the drier regions of India and is locally known as Ashoka and is commonly cultivated in Pakistan and Sri Lanka.[1] Moreover, it is known as false Ashoka owing to its close resemblance with Saraca indica (Ashoka tree). Various compounds have been reported from the extract of some parts of the plant, such as leaves, bark, root, and seeds. This review is an effort to explore and gather plant information in an organized manner. It reveals detailed information about the propagation, synonyms, vernaculars, varieties of plant, medicinal significance, ecology and distribution, botanical and ethnobotanical description, phytochemical constituents, and pharmacological activity of the plant.[2]

KEYWORDS: Polyalthia longifolia, Pharmacological Properties, ethnobotanical Distribution, Ecology and Distribution.

INTRODUCTION

The use of plants and their extracts as medicine has a long history. According to the World Health Organization, over 80% of the global population, mainly in economically disadvantaged and underdeveloped regions, rely on traditional plant-based treatments for their primary health needs.[1] Plants endlessly offer oxygen for us to breathe, nutrients through consumable plants, and health-boosting bioactive substances via phytochemicals.[3] The genus Polyalthia (Annonaceae) includes around 120 species, with just 14 being native to India. The name Polyalthia comes from Greek, meaning 'many cures,' while longifolia, a Latin term, describes the length of the plant's leaves.[1] The plant is predominantly found in the hot climates of India. Polyalthia longifolia, a key indigenous medicinal species in Indian herbal medicine, is also prevalent in Malaysia and is widely employed in traditional remedies as a febrifuge and tonic. Nearly all parts of this plant are utilized in traditional medicine for treating various conditions, with its significant medicinal benefits further supported by scientific research. Despite this, detailed information on Polyalthia longifolia is still limited. Therefore, this review aims to address the plant's botany, phytochemistry, pharmacology, toxicity, safety, and ethnomedicinal applications.[3]

BOTONY[3]

Scientific Name: Polyalthia longifolia

Common Names: False Ashoka, buddha tree, green champa, Indian mast tree, and Indian fir tree.

Synonym: Uvaria longifolia (sonn), Wallich, Unona longifolia (sonn)

Classification of Polyalthia longifolia[3]

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliophyta
Subclass	Magnolidae
Order	Magnolids
Family	Annonaceae
Tribe	Annoneae
Genus	Polyalthia
Species	Longifolia

Distribution of Polyalthia longifolia[3]

Native to India and Sri Lanka and it has been introduced in gardens of many tropical countries across the world.

TAXONOMY

Macromolecular Components

General Overview

- **Distribution**: The plant is prevalent in tropical and subtropical regions of India.
- **Growth Range**: It can grow up to 1500 meters above sea level.
- **Tree Form**: An evergreen with a notable columnar and pyramid-like structure.

Trunk and Branches

- **Trunk**:
  - **Description**: Straight, single, and undivided
  - **Height**: Can extend over 12 meters.
- **Branches**:
  - **Description**: Slender, smooth, and drooping.
  - **Length**: Typically 1-2 meters long.

Leaves

- **Arrangement**
  - **Pattern**: Alternate.
  - **Organization**: In two vertical rows.
- **Dimensions**:
  - **Length**: 7.5-23 cm.
  - **Width**: 1.5-3.8 cm.
- **Shape**: Lanceolate with a pointed tip.
- **Surface**: Shiny and smooth.
- **Texture**: Leathery or somewhat tough.
- **Margin**: Wavy.
- **Petiole**: Short, approximately 6 mm long.
- **Aroma**: Mild.

Flowers

- **Appearance**
  - **Size**: 2.5-3.5 cm in diameter.
  - **Color**: Yellowish-green.
  - **Arrangement**: In clusters or short-stemmed umbels.
- **Petals**:
  - **Shape**: Lance-shaped.
  - **Arrangement**: Six petals arranged in two series.
  - **Base**: Flat.
  - **Tips**: Spreading.
- **Sepals**:
  - **Shape**: Broad, short, triangular.
  - **Tips**: Reflexed.
- **Stamens**:
  - **Shape**: Wedge-shaped.
  - **Connective**: Abruptly expanded beyond the cells.
- **Ovary**:
  - **Structure**: Indefinite.
  - **Ovules**: One to two.
  - **Style**: Oblong.

Fruits and Seeds

- **Fruits**:
  - **Shape**: Ovoid.
  - **Length**: 1.8-2 cm.
  - **Quantity**: Numerous.
  - **Stalk**: Short and smooth, about 1.3 cm long.
- **Seeds**:
  - **Surface**: Smooth and glossy.

Blooming Period

- **Timing**: February to June.

Micromolecular Components

Leaves

- **Detailed Leaf Structure**
  - **Shape**: Lanceolate with a distinct tapering tip.
  - **Margins**: Wavy, providing a textured edge.
  - **Vein Pattern**: Pinnate venation that adds to the structural support.
- **Surface Characteristics**
  - **Texture**: Shiny, which may be due to a waxy cuticle layer.
  - **Color**: Typically a rich green, contributing to its evergreen nature.
- **Petiole Details**
  - **Length**: About 6 mm, supporting the leaf blade.
  - **Surface**: Smooth and thin, allowing flexibility.

Flowers

- **Petals**
  - **Detailed Shape**: Lance-shaped with specific length-to-width ratio contributing to their overall form.
  - **Petal Arrangement**: Series of two, affecting the flower's symmetry and aesthetics.
- **Sepals**
  - **Shape**: Broad and triangular with reflexed tips which may provide protection to the flower bud.
- **Stamens**
  - **Wedge Shape**: Contributing to the flower's reproductive structure.
  - **Connective Expansion**: An adaptation that may facilitate pollen transfer.
- **Ovary Structure**
  - **Indefinite Ovary**: Contributing to its reproductive versatility.
  - **Style**: Oblong, possibly aiding in pollen reception and fertilization.

Fruits

- **Detailed Fruit Characteristics**
  - **Shape**: Ovoid for efficient seed dispersal.
  - **Stalk**: Short and smooth, possibly facilitating attachment to branches and ease of dispersal.

Seeds

- **Surface**
  - **Glossy and Smooth**: Likely aiding in seed dispersal and protection.[1]

PHYTOCHEMISTRY

P. longifolia mainly contains diterpenoids,[5] alkaloids, tannins, and mucilage. The chief components of the plant are O-methylbulbocapnine-*N*-oxide (1), polyfothine (2), *N*-methylnandigerine-*N*-oxide (3), oliveroline- *N*-oxide (4), pendulamine A (5), *N*-pendulamine B (6), 8-oxopolyalthiane (7), 16-oxo-5, 13-halimadien- 15-oic acid (8), 16-Oxo-3, 13-clerodadien-15-oic acid (9), 16-hydroxycleroda-3, 13-dien-16, 15-olide (10).

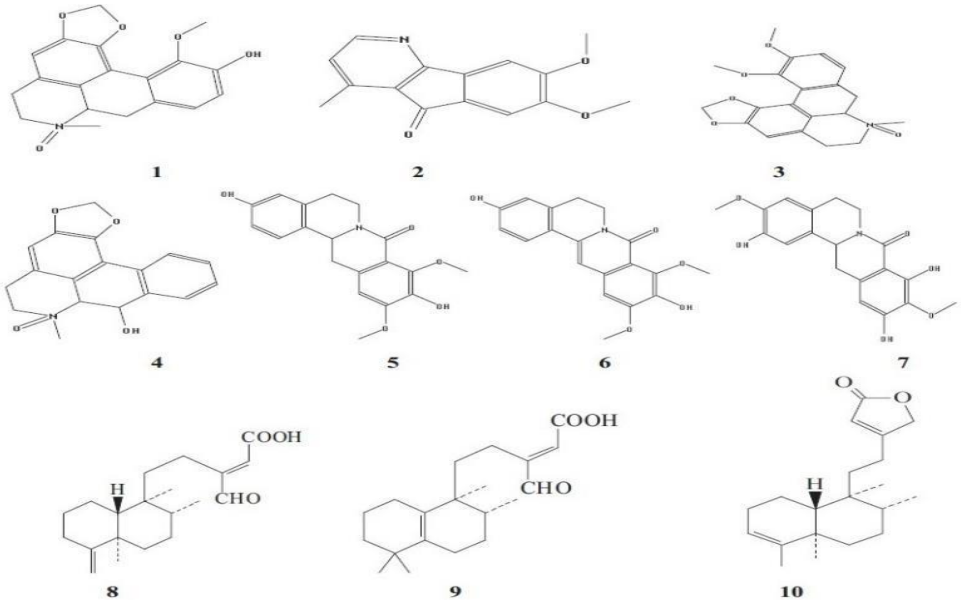
Two clerodane-type diterpenoids, with antifeedant properties have been isolated from polyalthia longifolia and identified as 16α-hydroxy-cleroda-3, 13(14)Z-dien-15, 16-olide and 16-oxo-cleroda-3, 13(14)E-dien-15- oic acid on the basis of spectral properties. Configuration of the olide at C-16 was established by X-ray crystallographic analysis.[6] A new ϒ-methoxybutenolide clerodane diterpene 2 has been isolated from the petroleum ether extract of the bark of P. longifolia.[7]

Apophorphine and azafluorene alkaloids, proantho-cyanidins, h-sitosterol, and leucocyanidin, clerodane, and ent-helimane, diterpenoids were isolated from the leaves, stem and stem bark. Carbohydrate was isolated from the seeds. A novel azafluorene alkaloid, polylongine (5-hydroxy-6-methoxy-1-methyl-4-azafluoren-9- ol), and 3 new aporphine *N*-oxide alkaloids named (+)-O-methylbulbocapnine-β-*N*-oxide, (+)-O-methylbulbocapnine-α-*N*-oxide, and (+)-*N*-methylnandigerine-β-*N*-oxide were isolated from the leaves of *P.longifolia* (Sonn.) Thwaites (Annonaceae).[1]

The essential oils of the leaf and stem bark of P.longifolia Thw.(Annonaceae) have been studied for their constituents by means of gas chromatography and mass spectrometry.

The leaf oil was almost exclusively composed of sesquiterpene derivatives, being represented by allo-aromadendrene(19.7%), caryophyllene oxide(14.4%), β -caryophyllene(13.0%), β-selinene(7.9%), α-humulene(7.0%) and ar-curcumene(6.8%).

In the oil of bark sample α-copaene and α-muurolol (approximately8.7%), β-selinene (8.6%), viridiflorene (8.1%), α-guaiene(7.8%), allo-aromadendrene(7.4%), and δ-cadinene(7.0%) are the major constituents. All the other sesquiterpenoid compounds were observed in amount greater than 1%. A-pinene(0.5%) and camphene(tr), which are the 2 monoterpenoids present in the leaf oil, could not be detected from the bark essential oil.[8]



Mineral composition of polyalthia longifolia seeds[9]

Mineral	Level(µg/g)
Potassium	259.37±0.05
Magnesium	23.08±0.02
Calcium	16.02±0.01
Iron	12.19±0.05
Sodium	6.03±0.02
Manganese	4.86±0.01
Copper	3.11±0.01
Zinc	1.79±0.01
Nickel	0.47±0.02
Cobalt	0.018±0.02
Lead	0.07±0.00
Chromium	0.05±0.00

PHARMACOLOGICAL ACTIVITIE

Antimicrobial activity

This research was performed to investigate the bactericidal and fungicidal competence of extracts (methanol and petroleum ether extract) of Polyalthia longifolia leaf. Moreover, the major active compounds present in the effective crude extract (either methanol or petroleum ether extract) was determined through initially with UV-Vis spectra, FTIR, and GC-MS analyses. The methanol extract alone showed remarkable bactericidal and fungicidal activity against the bacterial (S. pyogenes > E. coli > S. aureus > S. pneumoniae > C. difficile > P. aeruginosa) and fungal (A. clavatus > C. albicans > A. niger > A. fumigatus > C. tropicalis > C. auris) pathogens at increased concentration (12.5 mg mL^{-1}) than petroleum ether extract. The MIC and MBC values of methanol extract were found as 10-20 mg mL^{-1} and 30-40 mg mL^{-1} respectively. The MFC value of methanol extract was found as 10-20 mg mL^{-1}. These MIC, MBC, and MFC values of methanol extract were considerably greater than petroleum ether extract. The FTIR and GC-MS characterization studies revealed that the presence of more acre functional groups belonging to bioactive compounds such as Z)-7-Hexadecenal, Aromandendrene, α-Curcumene, Caryophyllene, Methyl 14-methyl Pentadecanoat, Methyl trans-13-Octadecenoate, 9-Octadecenoic acid (Z)-, and 2-hydroxy-1-(hydroxymethyl)ethyl. As a result of these findings, it is possible that P. longifolia leaf methanol extract contains medicinally important bioactive substances with bactericidal and fungicidal properties.[18]

Anticancer activity

Hepatocellular carcinoma (HCC) is a leading and severe cancer, representing around 85% of primary liver malignancies and ranking as the third most prevalent cancer type. According to A.J.M. Christina et al. (2014), the methanolic extract of Polyalthia longifolia fruit exhibits antioxidant properties, mitigating DNA mutations induced by Diethylnitrosamine in rats in a dose-dependent manner. S. Rupachandra and D.V.L. Sarada (2014) demonstrated that a cytotoxic peptide from Polyalthia longifolia seeds, with an average mass of 679.8 as determined by LC-ESI-MS/MS, effectively inhibits proliferation of lung (A549) cancer cells at a concentration of 10 µg/ml and cervical (HELA) cancer cells at 30 µg/ml. Verma Monika et al. (2008) found that Polyalthia longifolia leaf extract (A001) and its chloroform fraction (F002) significantly suppressed the growth of various human cancer cell lines, with colon cancer cells SW-620 showing the greatest inhibition with an IC50 of 6.1 µg/ml. Gaurav Mahesh Doshi and Hemant D. Une (2015) reported that extracts from the leaves of Polyalthia longifolia and the roots of Carissa congesta displayed notable anticancer activity against the human leukemia cell line MCF7, as measured by the sulforhodamine B (SRB) assay.[10]

Antiulcer activity

The ethanolic extract of P.longifolia (sonn) Thw. Leaves was investigated for its antiulcer activity against aspirin plus pylorous ligation-induced gastric ulcer in rats, Hcl-ethanol-induced ulcer in mice, and water immersion stress-induced ulcer in rats at 300mg/kg body weight p.o. A significant ($P<0.01$) antiulcer activity was observed in all the models. Pylorous ligation showed significant ($P<0.01$) reduction in the gastric volume, free acidity, and ulcer index as compared with those of control. It also showed 89.71% ulcer inhibition in Hcl-ethanol-induced ulcer and 95.3% ulcer protection index in stress-induced ulcer.[19]

Antifungal activity

Satish S et al. (2010) demonstrated that the petroleum ether extract of Polyalthia longifolia leaves exhibited highly significant antifungal activity against various test fungi such as Fusarium equiseti, Fusarium lateritium, Aspergillus candidus, and Penicillium chrysogenum, using the poisoned food technique. Similarly, Dileep N et al. (2013) reported that the antifungal activity of the leaf and pericarp of Polyalthia longifolia was effective against the mycelial growth of the pathogenic fungi Fusarium oxysporum and Pythium aphanidermatum, which were isolated from soft rot specimens of ginger, also employing the poisoned food technique. Additionally, K.V. Katkar et al. (2010) found that diterpenoids such as 16α- hydroxy-cleroda-3,13(14)-Z-diene-15,16-olide and 16-oxo-cleroda-3,13(15)-E-diene-15-oic acid, extracted from Polyalthia longifolia seeds using hexane, exhibited notable antibacterial and antifungal activities through bioassay-monitored isolation. Furthermore, Swami Narsinghchandra Dev and Kantishree De (2016) indicated that the ethanolic and methanolic extracts of Polyalthia longifolia bark and leaves demonstrated antifungal potential against Candida albicans and Candida krusei, as determined by the agar well diffusion method.[10]

Antiplasmodial activity

Aqueous, 70% hydroethanolic, and ethyl acetate extracts of leaves were prepared using established procedures. Their antiplasmodial effects were evaluated in vitro with the chloroquine-sensitive NF54 malaria parasite strain. To assess parasite growth inhibition and cytotoxicity following extract treatment, SYBR® Green and tetrazolium-based calorimetric assays were conducted. Total antioxidant capacity was measured using a free radical scavenging assay. The findings revealed that the extracts shielded red blood cells from damage caused by Plasmodium falciparum. The 50% inhibitory concentration (IC50) values were 24.0±1.08 µg/ml for the aqueous extract, 22.5±0.12 µg/ml for the hydroethanolic extract, and 9.5±0.69 µg/ml for the ethyl acetate extract. The hydroethanolic extract contained flavonoids, tannins, and saponins, whereas the aqueous extract had only saponins. Aqueous and hydroethanolic extracts demonstrated greater antioxidant activity compared to the ethyl acetate extract. Overall, P.

longifolia extracts showed antiplasmodial activity with minimal toxicity to human red blood cells, indicating their potential as viable alternatives to conventional antimalarial drugs. These results corroborate traditional uses of P. longifolia decoctions as effective antimalarial agents.[20]

Antioxidant activity

The scavenging activity of 4H against O2 and free radicals was assessed through the 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay and a cell-free xanthine oxidase system at concentrations up to 10µM. 4H did not alter the reduction rates of DPPH or water-soluble tetrazolium salts-1 (WST-1), which implies that its inhibition of O2 release results from scavenging free radicals and O2. Additionally, 4H did not facilitate O2 removal in the presence of superoxide dismutase (0.5U/ml), indicating that 4H lacks superoxide anion-scavenging and antioxidant properties.[14] Sashidhara et al. isolated and assessed three compounds-quercetin, quercetin-3-O-β-glucopyranoside, and rutin-for their free radical scavenging properties. They reported that 2C showed that greatest antioxidant activity (4.10mm), followed by rutin (2.38mm) and quercetin-3-O-β-glucopyranoside (1.91mm).[15] Furthermore, the antioxidant potential of the rutin metabolite from the ethanolic extract of Polyalthia longifolia leaves was noted, with an IC50 value of 14.67±0.023µg/ml.[17]

Anti-inflammatory activity

The methanolic extract of P. longifolia roots at doses of 20 and 400 mg/kg exhibited a maximum reduction in edema of 18.6% and 33.7% at 3 hours with carrageenin, and 22.2% and 40.5% at 5 hours with serotonin-induced paw edema, respectively. This anti-inflammatory effect of the extract was comparable to that of phenylbutazone. Moreover, 16-oxo-cleroda-3,13E-dien-15-oic acid was purified from the petroleum ether extract of P. longifolia twigs using bioactivity-guided methods, and it showed potent inhibition of 1KBα kinase with an IC50 value of 14.9 µM.[1]

Wound healing property

The potential of Polyalthia longifolia ethanolic leaf extract, at 5% and 10% concentrations, for wound healing was investigated through topical application in rats. An excision wound model, which involved removing a 500 mm² section of skin from the anterio-dorsal region of the rats, was utilized to evaluate the efficacy of the extract. Povidone iodine ointment was used as a control. Wound healing, assessed by measuring wound contraction, was monitored over a 14-day period. Both concentrations of the ethanolic leaf extract significantly promoted wound healing, as indicated by marked wound contraction. Additional phytochemical research is needed to pinpoint the active compounds responsible for these effects.[21]

Hypoglycemic activity

In vitro experiments were conducted with α-amylase and α-glucosidase enzymes, followed by enzyme kinetics analysis using the Lineweaver-Burk plot. Acute toxicity was assessed according to OECD guidelines 423, and type 1 diabetes mellitus in rats was induced with streptozotocin (60 mg/kg b.w., i.p.). Evaluations included body weight changes, blood glucose levels, serum marker enzymes, serum lipid profiles, enzymatic and non-enzymatic antioxidants in liver homogenates, and pancreatic tissue histopathology. The IC50 values for α-amylase inhibition were 154.3 ± 2.42 µg/ml for the ethanol extract (PLEE) and 180.3 ± 1.35 µg/ml for the chloroform extract (PLCE). For α-glucosidase inhibition, the IC50 values were 208.7 ± 2.54 µg/ml for PLEE and 271.6 ± 0.85 µg/ml for PLCE. Acute toxicity studies indicated that the extracts were safe at a dosage of 2000 mg/kg b.w. Both extracts effectively reversed abnormal changes in untreated diabetic rats in a dose-dependent manner, with the ethanol extract demonstrating slightly superior effects compared to the chloroform extract. These findings suggest that the ethanol and chloroform extracts of Polyalthia longifolia leaves exhibit inhibitory activity against α-amylase and α-glucosidase and provide protection against streptozotocin-induced type 1 diabetes mellitus in rats.[22]

Antipyretic activity

Methanol extracts of the plant's leaves, stem bark, and root were assessed for their antipyretic properties using doses of 30, 100, and 300 mg/kg body weight in an LPS-induced fever model. All extracts demonstrated significant ($p < 0.001$) antipyretic activity in a dose-dependent manner. At the 300 mg/kg dose, the extracts surpassed the effectiveness of Acetylsalicylic acid (Aspirin), which had an 86% pyrexia inhibition rate. The root extract was the most effective, achieving a 127.5% inhibition, followed by the leaf extract at 123.0% and the stem bark extract at 99.2%. This study validates P. longifolia as a potent antipyretic agent, suggesting its potential as a complementary treatment for various other health issues.[23]

Analgesic activity

For the analgesic test, the mice were split into four groups. Each group consists of six mice. The first group is for distilled water and is a controlled group. Group 2 was the control group, which received diclofenac sodium BP ($10\ mg\ kg^{-1}$). Alcoholic extract ($250\ mg\ kg^{-1}$ and $500\ mg\ kg^{-1}$) was given to groups 3 and 4. After 45 minutes, each mouse was given a $10\ ml\ kg^{-1}$ body weight injection of 0.7 percent acetic acid. After 15 minutes of IP administration of acetic acid, the number of writhing responses for each animal was recorded for 3 minutes, and the mean abdominal writhes for each group were calculated. The percentage inhibition was calculated using the following formula:[24]

$$\text{inhibition } (\%) = \frac{\text{mean number of writhes (control)} - \text{mean number of writhes (drugs)}}{\text{mean number of writhes (control)}}.$$

CONCLUSION

Longifolia is a key element in Indian traditional medicine, with an extensive review of the literature showcasing its diverse pharmacological effects and outstanding therapeutic benefits validated by preclinical research. It combines botanical, phytochemical, pharmacological, toxicological, and ethnomedical data on Polyalthia longifolia, a traditional medicinal herb and ancient remedy that warrants investigation for new therapeutic applications.

It comprises various chemical constituents, including clerodane-type diterpenoids, alkaloids, tannins, mucilage, carbohydrates, essential oils, and sesquiterpene derivatives. Its pharmacological properties encompass antimicrobial, anticancer, antiulcer, antifungal, antiplasmodial, antioxidant, anti-inflammatory, wound-healing, hypoglycemic, antipyretic, and analgesic activities.

To ensure the welfare of humanity, it will be important to advance clinical trials and formulate effective plant-based solutions with practical uses.

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