Minireview Article

Biological Activity and Phytochemical Screening of *Atalantia ceylanica* - A mini review

ABSTRACT

Atalantia ceylanica, also known as Yakinaran in Sinhala and Pey Kuruntu in Tamil, is a medicinal plant belonging to the Rutaceae family. This herbaceous shrub is native to Sri Lanka, India, and Vietnam, thriving in seasonally dry tropical regions. The plant's various parts, including its leaves, bark, seeds, and roots, are rich in phytochemicals such as polyphenols, tannins, flavonoids, alkaloids, oximes, and coumarins, which contribute to its therapeutic potential. These bioactive compounds are believed to be responsible for the plant's diverse medicinal properties, which include antioxidant, antimicrobial, antifungal, and hepatoprotective activities. Traditionally used in Ayurveda and folk medicine, *A. ceylanica* has been employed to treat a range of conditions, including asthma, flu, liver diseases, and skin disorders. Notably, steam inhalation of its leaves gained prominence during the COVID-19 pandemic for respiratory protection. This mini-review examines the biological activities, therapeutic uses, and phytochemical profile of *A. ceylanica,* focusing on its antimicrobial, hepatoprotective, and antioxidant properties, shedding light on its traditional and scientific relevance. Research highlights its significant antibacterial and antifungal effects, particularly against *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Additionally, its hepatoprotective activity has been demonstrated through its ability to mitigate ethanol-induced liver toxicity. The plant's antioxidant capacity has been evaluated through various assays, confirming its potential as a free radical scavenger. Furthermore, the plant's phytochemical composition, including bioactive compounds like caryophyllene and unique oximes, contributes to its medicinal efficacy. The review underscores the importance of *A. ceylanica* as a valuable therapeutic agent with broad potential for future pharmacological applications.

Key Words : *Atalantia ceylanica,* Biological activities-antioxidant, antimicrobial, antifungal, hepatoprotective, Phytochemicals, Therapeutic uses

1. INTRODUCTION

Atalantia ceylanica commonly referred to as (Yakinaran in Sinhala and Tamil Pey Kuruntu), is a native plant species belonging to the family Rutaceae which is predominantly distributed in Sri Lanka, India, and Vietnam [1]. Leaves, bark, seeds, roots of *A. ceylanica* are known to contain phytochemicals like polyphenols, tannins, flavonoids, alkaloids, oximes, coumarins [2-6]. These particular phytochemical constituents may be associated with therapeutic effects as well the bioactivities such as antioxidant, antibacterial, antifungal, hepatoprotective activity [6-10]. The leaves, seeds, and bark of *A. ceylanica* are widely used in Ayurveda and traditional folk medicine in Sri Lanka and India [11-14]. These plant materials are often processed into various therapeutic forms, including decoctions, porridges, steams, leaf pastes, and medicinal oils. Each of these preparations is individually tailored to target particular diseases and health conditions like flu, asthma, high fat level in blood [11-14]. A recent notable example is the widespread use of steam inhalation from *A. ceylanica* leaves as a preventive measure against COVID-19 during the pandemic [7], with many individuals perceiving it as a beneficial therapeutic practice. This practice, rooted in traditional medicine, was regarded by many communities as a potential complement to conventional treatments for managing viral infections. Moreover, traditional medical practitioners have extensively studied the pharmacological potency of this specific plant through centuries of practical use [11-14]. The

aim of this mini review is to provide a comprehensive analysis of biological activities, therapeutic potential and phytochemical profile of *A. ceylanica*.

2. BOTANICAL DESCRIPTION

2.1 Taxonomy [15]

Kingdom - Plantae
Phylum - Streptophyta
Class - Equisetopsida
SubClass - Magnoliidae
Order - Sapindales
Family - Rutaceae
Genus - Atalantia
Species - *Atalantia ceylanica*

Common Names:
English - Ceylon Atalanta
Sinhala - Yakinaran
Tamil - Pey Kuruntu

Synonyms: *Limonia citrifolia*, *Rissoa ceylanica*

National conservation status: LC-Least Concern

Origin: Native

2.2 Distribution

Atalantia ceylanica is a native plant, primarily grown in the seasonally dry tropical biomes distributed in Sri Lanka, India and Vietnam [1].

2.3 Morphology

Atalantia ceylanica is a herbaceous, densely branched shrub that can grow up to 2.5 meters tall, with sharp spines reaching lengths of up to 2.5 cm. The leaves are pointed, and shape is ovate to ovate-lanceolate or elliptic. The petiole is about 3.6 mm long, thick and glabrous. Blades are mostly 4 –12 cm long, 2–6 cm wide. The margins of the blades are entire, the upper surface is very dark dull green. The lower surface of the blade is pale or yellowish green. The inflorescence of *A. ceylanica* is axillary, short and cymose or racemose. The pedicels are 2 – 3 mm long and calyx is saucer-shaped. Flower in white color with 4 sepals, 4 petals (rarely 3 or 5). Stamens usually 8, free. Ovary is sessile. 2.5 – 3 mm long including stigma. Fruit sub globose with 2, 4 seeds. Fruit vesicles are very few (Figure 1) [16,17].

(a)

(b)

(c)

Figure 1 – a) Leaves of *A. ceylanica* b) Inflorescence of *A. ceylanica* c) Fruit of *A. ceylanica* (18)

3. THERAPEUTIC USES

Traditional medicinal practitioners have identified *A. ceylanica* as a plant with significant multipurpose medicinal potential. According to the ayurveda literature, leaves, roots and various other parts of *A. ceylanica,* locally known as“Yakinaran”, have been used to treat asthma, dyspepsia, flu, anorexia, arthritis, skin diseases [11-14]. Traditional practices suggest that inhaling steam from *A. ceylanica* leaves can help prevent or treat respiratory system-related infectious diseases. The widespread use of steam inhalation from *A. ceylanica* leaves as a preventive measure against COVID-19 during the pandemic was based in this traditional practice [11-14]. Additionally, extract of leaves is used to make pills, which are taken for conditions such as catarrh, bronchitis and chest complaints [11-14]. Since ancient times decoction prepared from leaves has been used to treat liver diseases such as fatty liver [11-14]. A special porridge prepared using fresh leaves, which is prescribed in ayurveda medicine, is used to (hyperlipidemia) regulate fat in blood [11-14]. The roots of *A. ceylanica* used in ayurveda medicine to treat malaria “ague” [11-14]. In Ayurveda, ground paste of leaves is applied as a treatment for arthritis [11-14]. Furthermore, the essential oil extracted from fruit is used to treat swelling of joints, sprains, cramps. In addition to these uses, washing with boiled leaves is employed as a remedy for itchy skin conditions [14]. The smoke from *A. ceylanica* leaves has been used as a natural mosquito repellent [14].

4. BIOLOGICAL ACTIVITY

4.1 Antimicrobial Activity

A. ceylanica has been extensively studied for its antimicrobial potential. Aqueous, alcoholic, acetone & steam distillate of *A. ceylanica* leaves have been screened for *in vitro* antibacterial and antifungal activity against different types of standard bacterial and fungal strains, like *Pseudomonas aeruginosa*, *Escherichia coli, Staphylococcus aureus*, and Methicillin resistant *Staphylococcus aureus*, *Cladosporium cladosporioides* [7,9,10]. According to the literature methanol and acetone extracts of leaves of *A. ceylanica* have exhibited significant antibacterial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa* [10]. However, another study [7] reported that both steam distillate and aqueous extract of leaves of *A. ceylanica* [7] have shown no antibacterial effect for the tested strains of *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus* and *Staphylococcus aureus* (MRSA). The antifungal activity of steam distillates from *A. ceylanica* leaves exhibited relatively low efficacy, as demonstrated through the Thin Layer Chromatography (TLC)-bioassay technique against *Cladosporium cladosporioides* [9]. Based on some research findings, *A. ceylanica* leaves may contain volatile, alcohol soluble phytochemicals antibacterial and antifungal properties. GC-MS analyses of volatile compounds from *A. ceylanica* leaves have shown “caryophyllene” as the active Phyto-constituents with strong antibacterial, antifungal and also antiviral properties [2]. In a study, to examine the steam of boiled leaves of *A. ceylanica* as a remedy for respiratory tract illnesses, steam has been tested against several bacterial strains. The results indicate that all the tested bacteria *Pseudomonas aeruginosa*, *Escherichia coli*, *Staphylococcus aureus*, and Methicillin-resistant *Staphylococcus aureus* were resistant to the neat watery extract of the plant. It is possible that *Atalantia* contains phytochemicals with antiviral properties (since influenza is often caused by viruses), which could explain the therapeutic effects of the steam from boiled leaves of *A. ceylanica*. Additionally, the plant may contain compounds that help reduce inflammation. These two factors may account for the long-standing use of *Atalantia* by ancestors in treating respiratory ailments [7].

4.2 Hepatoprotective Activity

The liver plays a vital role involved in various functions like detoxifying harmful substances, metabolizing drugs, producing bile for digestion, and regulating blood sugar. The liver is vulnerable to damage from various factors, including alcohol, toxins, viral infections (such as hepatitis), medications, and certain metabolic diseases. Substances that help to prevent or alleviate liver damage are referred to as hepatoprotective agents. Hepatoprotective activity is the capability of a particular substance to protect the liver from potential damages [6].

One of the studies has revealed that a decoction prepared from the *A. ceylanica* leaves has effective hepatoprotective activity against ethanol induced toxicity in porcine liver slices [6]. In this study, the hepatoprotective activity was investigated by espousing the porcine liver slices into certain concentrations of ethanol and *A. ceylanica* aqueous extract for a period of time and detecting the enzyme leakage percentage of AST (Aspartate transaminase), ALT (Alanine transaminase), LDH (Lactate dehydrogenase) and loss of functional integrity of the cell membrane [6]. The test results demonstrated significant positive outcomes, including a reduction in the percentage release of ALT, AST, and LDH following treatment with *A. ceylanica*. This confirms the protective effect of the decoction prepared from *A. ceylanica* against ethanol induced hepatic damage. The prevention of intracellular enzyme leakage may be due to the membrane-stabilizing effects of the phytochemicals found in the plant extract [6].

The oxidative stress is the main reason in the pathogenesis of ethanol induced liver injuries [6]. The free radicals produced from ethanol consumption interact with various cellular components, leading to tissue damage and the formation of products like lipoperoxides, conjugated dienes, and malondialdehyde (MDA), while simultaneously reducing the levels of antioxidants such as Vitamin E and glutathione in the tissues.

The test results indicated that the porcine liver slices being treated with ethanol produced a high amount of lipid peroxides compared to the untreated liver slices [6]. Treatment of porcine liver slices with ethanol with *A. ceylanica* plant extract for a certain period of time has reduced the formation of lipid peroxides significantly compared to the sample treated with ethanol alone. The plant extracts alone in KRHB (Krebs-Henseleit Buffer) did not show any toxicity on liver tissue over the concentrations studied. Hence, the results showed the contribution of the secondary metabolites of *A. ceylanica* to reduce or scavenge lipid peroxides generated from free radicals. This study indicates that the decoction prepared from *A. ceylanica* leaves has effective hepatoprotective activity against ethanol induced toxicity in porcine liver slices. This can be the attribution of free radical scavenging capacity of the plant extract hence justifying the use of this plant material in the treatment of various liver diseases in traditional medicine [6].

4.3 Antioxidant Activity

An antioxidant is a substance that possesses a significant ability to delay or hinder the oxidation of specific substrates that are prone to oxidation, even when present at low concentrations [19]. The imbalance between production of free radicals and necessary antioxidant defense system, leads to the oxidative stress, which is the main causative factor of numerous chronic diseases like cancer, cardiovascular diseases, inflammatory diseases. In accordance with that antioxidants play a crucial role in mitigating cellular damage, preventing oxidative harm and support overall health [20]. However, among the major antioxidant groups, synthetic and natural antioxidants, natural phytoconstituents have diverse antioxidant activity. Thus, phytochemical constituents like polyphenolic compounds, nitrogen compounds, vitamins exhibit wide spectrum of free radical scavenging ability. Hence, *A. ceylanica* might be a valuable source of bioactive compounds with antioxidant activity [6,8].

Antioxidant efficacy of *A. ceylanica* leaves aqueous extract [6,8] has been investigated using four major assays; 1,1-Diphenyl-2-picrylhydrazyl (DPPH) assay, Nitric Oxide Scavenging Assay, Ferric ion reducing power assay, Hydroxyl radical assay. L-Ascorbic acid has been used as the reference standard antioxidant for the DPPH assay [1]. The results of antioxidant activity experiments indicate that *A. ceylanica* leaves have strong potential to scavenge free radicals. These findings suggest that a decoction made from *A. ceylanica* leaves is an effective free radical scavenger [6]. However, another study comparing various species of the Rutaceae family found that the aqueous leaf extract of *A. ceylanica* exhibited relatively lower antioxidant scavenging potential [8].

5. PHYTOCHEMICALS IN *Atalantia ceylanica*

Plants produce primary and secondary metabolites during their biochemical cycles or pathways. Primary metabolites are involved in the plant's essential cellular functions, while secondary metabolites are unique chemical compounds that vary between different plant species. In some cases, chemical constituents are unique within the same species of plants. Secondary metabolites are by-products of the primary metabolic processes. Most of the secondary metabolite-chemical compounds intended for specific purposes such as defense against the pathogenic infections and predators, to tolerate the abiotic stress (ex: temperature, salinity, water, osmotic stress) to attract insects and animals for fertilization. Additionally, these secondary phyto-metabolites display various pharmaceutical and therapeutic effects on humans. According to the literature, the phytochemical constituents have been shown vast range of promising biological activities (6-10). However, there can be a variation of chemical constituents within the same species due to different geographical conditions, soil and climatic conditions (21).

The investigation of phytochemical constituents of *A. ceylanica* has been carried out for certain parts of the plant like seeds, leaves, bark and roots. Polyphenols, tannins, flavonoids, alkaloids, oximes, coumarins are some of the phytochemicals identified in *A. ceylanica* [2-6]. TLC analyses of aqueous leaf extract and leaf oil of *A. ceylanica* revealed the presence of polyphenols, flavonoids, tannins and coumarins [8]. Additionally,

this study quantified the flavonoid and polyphenolic content of *A. ceylanica*, revealing that it had the lowest levels compared to other selected Rutaceae species [8]. Decanal, lauraldehyde, caryophyllene oxide, caryophyllene, and α cardinol (Figure 02) are the major volatile bioactive compounds which were identified in essential oil extract of *A. ceylanica* leaves, using Gas chromatography mass spectroscopy [2]. According to literature [2] among these volatile compounds “caryophyllene” has been identified as a bioactive compound exhibiting strong promising anti-bacterial, antifungal and antiviral activities [2,22,23].

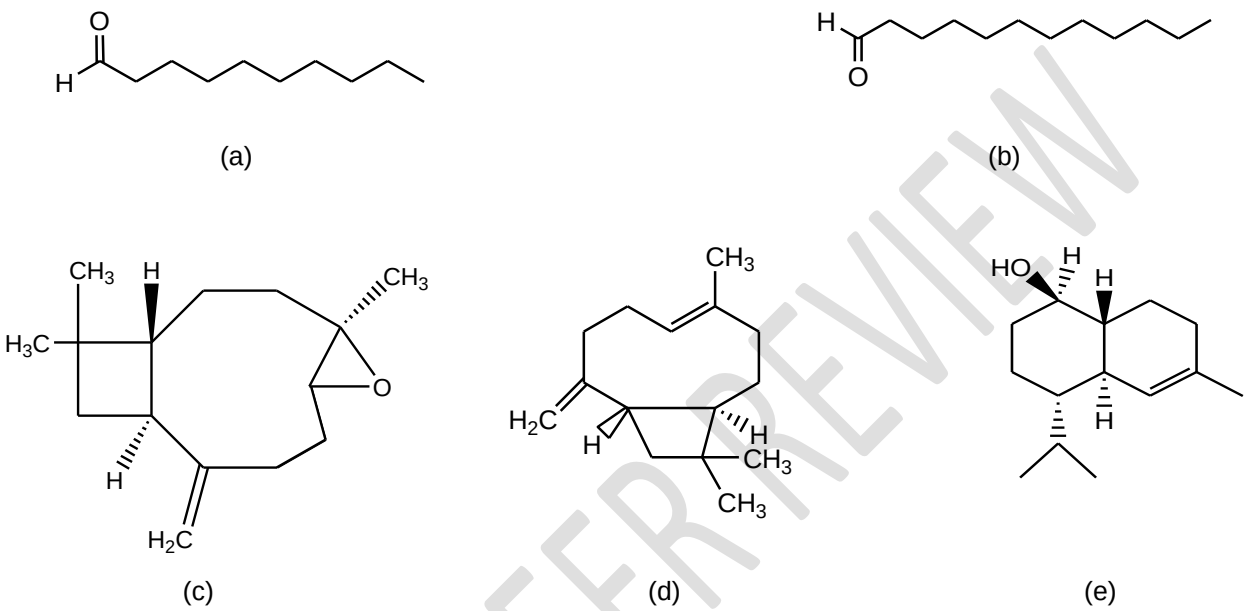
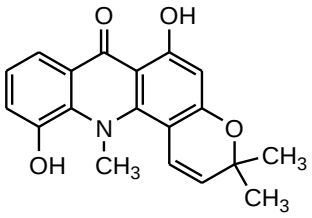


Figure: 02 – Bioactive compounds of *A. ceylanica* leaves a) Decanal b) Lauraldehyde c) caryophyllene oxide d) caryophyllene e) α cardinol

Another study stated that the leaf extract of *A. ceylanica* has shown major four compounds including benzyle derivatives 2,4,5-trimethoxy-benzaldehyde, two acridone alkaloids 1,5-dihydroxy-3-methoxy-10-methyl-9(10H)-acridinone and 11-hydroxynoracromycine, pyranoflavone carpachromene (Figure 03). Carpachromene is the first flavone isolated from *Atalania* species [3,4].



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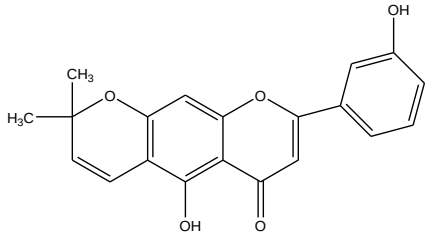

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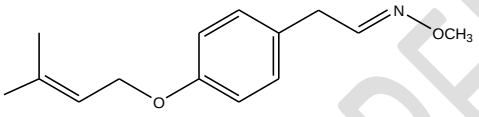
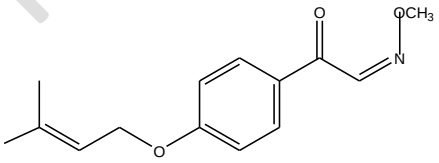
Figure: 03 – Bioactive compounds of *A. ceylanica* leaves a) 2,4,5-trimethoxy-benzaldehyde b) 1,5-dihydroxy-3-methoxy-10-methyl-9(10H)-acridinone c) 11-hydroxynoracromycine d) pyranoflavone carpachromene

The lipophilic seed's methanolic extract of *A. ceylanica* characterized two new isomeric oximes [5]. Ataloxime A {(E)-2[4-(3-methyl-2-butenyloxy)-phenyl]-ethanaloxime-methylether} *trans* isomer and Ataloxime B {(Z)-2-butenyloxy)-phenyl]-ethanaldoxime-methylether} *cis* isomer (Figure 04), moreover contains known furanocoumarins, bergapten, imperatorin, xanthotoxin, oxypeucedanin and large amounts of heraclenin which were elucidated by HPLC (High-Performance Liquid Chromatography), UV and TLC comparisons with authentic samples [2,8].



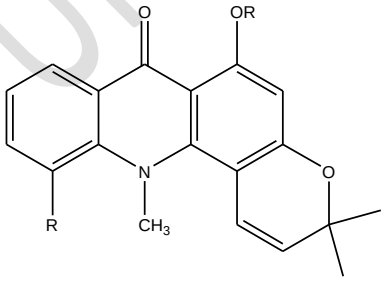
(a)



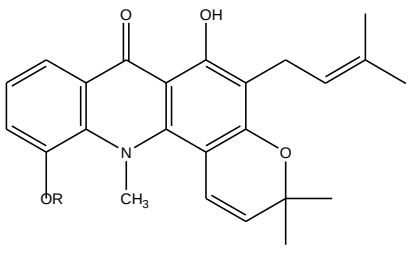
(b)

Figure: 04 - Isomeric oximes of *A. ceylanica* seeds a) Trans isomer b) cis isomer

From the wood of *A. ceylanica* has been isolated two acronycine analogues compounds 3, 12-dihydro-6, 11 -dihydroxy-3, 3, 12-trimethylpyrano [2, 3-c] acridin-7-one and its derivative b)3, 12-dihydro-6, 11 -dihydroxy-3, 3, 12-dimethyl-5-(3-methylbut-2-enyl)pyranon[2,3-c] acridin-7-one (Figure 05) [3].



(a)



(b)

Figure: 05 – Bioactive compound of *A. ceylanica* wood a) 3, 12-dihydro-6, 11 -dihydroxy-3, 3, 12-trimethylpyrano [2, 3-c] acridin-7-one b)3, 12-dihydro-6, 11 -dihydroxy-3, 3, 12-dimethyl-5-(3-methylbut-2-enyl)pyranon[2,3-c] acridin-7-one

6. CONCLUSION

In conclusion, *Atalantia ceylanica* is a plant with notable therapeutic potential, widely used in traditional medicine in Sri Lanka, India, and Vietnam. Its various parts, including, the leaves, bark, seeds, and roots contain diverse range of bioactive compounds like polyphenols, tannins, flavonoids, and alkaloids, contributing to its antimicrobial, antioxidant, and hepatoprotective properties. Traditionally, it has been used to treat wide array of conditions such as, respiratory issues, liver diseases, and inflammation. While its antimicrobial effects are limited, its steam distillate has been especially valued for respiratory health, including during the COVID-19 pandemic. Given its diverse biological activities, further research could unlock additional medicinal applications, supporting its integration into modern treatments.

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