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Review Article

Exploring Naringi Crenulata: A Jewel of The Plant Kingdom

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ABSTRACT

The growing interest in herbal medicine has highlighted the therapeutic potential of plants, with the Rutaceae family, particularly Naringi crenulata (Elephant Nettle), emerging as a valuable source of medicinal compounds. Native to regions across India, Southeast Asia, and Indo-China, Naringi crenulata has been traditionally used for a variety of ailments, including heart pain, colic, and epilepsy. Phytochemical analyses reveal the presence of alkaloids, carbohydrates, glycosides, saponins, phenolic compounds, flavonoids, and terpenoids, which contribute to the plant's diverse biological activities. Notable pharmacological effects include strong antimicrobial, antioxidant, hepatoprotective, antidiabetic, and larvicidal activities. The plant's bioactive constituents, such as flavonoids and alkaloids, play a pivotal role in its medicinal efficacy. Studies have demonstrated the potential of Naringi crenulata extracts to scavenge free radicals, protect liver cells from oxidative damage, and reduce hyperglycemia. These findings support the medicinal use of Naringi crenulata and underscore its relevance in contemporary herbal therapy.

INTRODUCTION

We are well aware of the significance of plants. The field of herbal medicine has grown rapidly in the last few decades, and the plant kingdom is a treasure trove of possible medications. It is growing widespread in developing and developed countries owing to its natural origin and minimal adverse effects. In the realm of phytopharmaceutical discovery, the professional knowledge of workers has traditionally included the evaluation of plant resources and their generated products. In order to distinguish between the several plant sources that are available, much quantum research has been conducted in the field of verifying the authenticity of the plant source. The Rutaceae is a large family predominantly found in tropical and subtropical regions of the world. It comprises of around 162 genera and 2085 species. This is the largest family in the order Sapindales owing to the number of

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species Roxb. *Naringi crenulata Nicolson* is a wild relative of citrus trees and a member of the Rutaceae family. It is frequently mistakenly thought of as a wood apple (*Limonia acidissima*). Its native range includes northern Thailand, northern and central Myanmar, and northern India [1]. India, Pakistan, Bangladesh, Sri Lanka, Myanmar, Indo-China, South-West China, Bhutan, Thailand, and Java are among its distribution locations. The South Indian states of Andhra Pradesh, Telangana, Karnataka, and Kerela are home to it [2]. It is frequently referred to as elephant nettle. It is usually referred to as "*Benta*" in Odia and "*Bilvaparni*" in Sanskrit, "*Maha vilvam*" in Tamil, and followers of Lord Shiva revere it. Interest in phytochemical substances is growing, which may be related to their involvement in health and illness as well as their nutritional incidence [3]. For the qualitative and quantitative analysis of volatile and semi-volatile substances, GC-MS is the perfect technique since it combines the best identification technique (MS) with the optimal separation technique (GC). This method has shown itself to be useful for analyzing volatile essential oils, fatty acids, lipids,[4] alkaloids, and non-polar components[5]. The relationship between a medicinal plant's pharmacological efficacy and its phytochemical components is becoming more widely recognized [6-13]. New medications that effectively prevent and treat a variety of illnesses, such as cancer [14] and Alzheimer's disease, have been developed as a result of screening active chemicals from plants [15]. The *Naringi crenulata (Roxb.)* Nicolson tree is 8–12 meters tall, with smooth, dull brown, yellow bark, sharp spines, compound, imparipinnate leaves, and alternating rachis with oblong, elliptical wings. In traditional medicine, several components of this plant have been used to treat heart pain, colic, purgative, sudoferic, and antiepileptic effects [16]. The leaves are used to treat epilepsy. Bark is cooling and fragrant, and it helps with Pitta vitiation. From the plant's stem, sixteen crenulatine and twenty recognized indole alkaloids were extracted[17]. From the plant's stem bark, sitosterol, xanthotoxin, and limonin Dios phenol were separated [18]. Folk medicine has made use of it. The root extract is used to treat colic, diarrhea, and vomiting. Leaves are given with milk to youngsters to fix the stomach related issues, solution for epilepsy. The leaves are fragrant very much like some other citrus leaves Insect venom is countered by fruit decoction. For quick sprain relief, the bark juice is applied externally [19]. Its methanol extract reportedly exhibited strong anthelmintic properties [20]. pectic polysaccharides have been isolated from the fruits of *N. crenulata* by extraction with water [21]. Biological activities such as anticancer [22], hepatoprotectivity[23], aphrodisiac [24], anti-inflammatory activities of ethanol extracts of leaf and bark of *N. crenulata* have also been reported.

Botanical Description:

Taxonomy And Classification [25]:

Botanical Name	***Naringi Crenulata***
Family	**Rutaceae (Citrus Family)**
Synonym(S)	***Hesperethusa Crenulata (Roxb.)***
Common Name	**Elephant Nettle**
Kingdom	**Plantae**
Phyllum	**Angiosperms**
Class	**Eudicots**
Order	**Sapindales**
Family	**Rutaceae**
Genus	**Narinji**
Species	**Narinji Crenulata**

Vernacular Names [26]:

Hindi	**Beli**
Kannada	**Kaavata, Aranamullu, Aruna Mullu, Kaadu Baela**
Malayalam	**Dadhiphala, Mahavilvam, Kattunarakam**
Marathi	**Kawat, Naaibel, Tondsha, Naibel**
Sanskrit	**Bilvaparni, Surasi, Vilvaparni**
Tamil	**Mega Vilvam, Magavilvam**
Telugu	**Torri Velaga, Toru-Elaga, Kukka Valaga**

Distribution:

Naringi crenulata, commonly known as Elephant Nettle, is a small evergreen shrub or tree belonging to the *Rutaceae* family. Its native distribution spans from the Western and Central Himalayas through India and Sri Lanka to parts of Indo-China, including Myanmar, Laos, and Vietnam. Within India, *Naringi crenulata* is found in various regions, including the Western Ghats and the states of Karnataka, Kerala, and Tamil Nadu. In Karnataka, it has been documented in districts such as Bangalore, Chikamagalur, Dakshina Kannada, Gulbarga, Hassan, Mysore, Tumkur, and Udupi. The plant thrives in semi-evergreen and moist deciduous forests, as well as in plains, typically up to elevations of 1,200 meters. Given your location in Chennai, Tamil Nadu, it's noteworthy that *Naringi crenulata* is present in the southern regions of India, including Tamil Nadu. The plant's adaptability allows it to grow in various forest types and elevations within these areas.

Morphology:

Root System:

The fibrous and extensive root system of *Naringi crenulate* gives the plant stability and an effective way to absorb nutrients. Its ability to flourish in a range of soil types depends on this adaptability. Plants with fibrous roots typically do better in environments with erratic water supplies [27]. These root systems improve the plant's capacity to take up moisture from a variety of soil types and depths.

Stem And Branching:

The plant includes a somewhat woody stem, which helps its overall growth. This characteristic is frequent in plants that need to survive variable weather conditions and retain structural integrity in their ecosystems. Plants having ridged stems are frequently more resilient to physical harm from environmental factors like wind or intense rain [28]. *Naringi crenulata's* adaptive branching structure maximizes the amount of sunlight that can be captured for photosynthesis.

Leaves:

Naringi crenulata's leaves are distinguished by their opposing orientation and serrated margins. In order to maximize light interception and minimize water loss, this leaf shape is essential. Serrated leaves offer a greater surface area for gas exchange and are more effective at retaining water [29]. The plant is more effective under dry conditions because of the glossy leaf surface, which probably contributes to a decrease in transpiration.

Flowers And Reproduction:

Little, clustered blooms with five petals are among *Naringi crenulata* reproductive organs. The plant uses these flowers as a key component of its pollinator (insect) attraction strategy[30]. Reproductive tactics such as these are essential to preserving genetic variety and guaranteeing the species' survival. Evolutionary adaptations to particular pollinator groups are indicated by the flower's morphology and time of flowering.

Fruit And Seed Dispersal:

Usually small in size, *Naringi crenulata* fruit has hard-coated seeds that shield the seeds from harm while they are being dispersed. The ability of a species to colonize new areas is boosted by seed dispersal through wind and animals, which is crucial for preserving genetic diversity and extending its ecological range [31].

Stem:

The woody stem of *Naringi crenulata* gives the plant structural support and a framework for development. Lignin, a complex polymer that fortifies the cell walls and gives the plant the ability to withstand mechanical stress, is largely responsible for the stem's stiffness [32]. Because it provides the structural stability required to resist damage, this adaptation is crucial for the plant to flourish in situations where wind or physical stress is frequent. Additionally, the vascular conduit for sugars, nutrients, and water is the stem of *Naringi*

crenulata. The xylem and phloem, which carry sugars from the leaves and water and nutrients from the roots, are found there, as in many other plants[33]. Because it facilitates effective energy production and nutrient transport, the vascular tissue is critical to the general health of the plant.

Bark:

Compared to other woody plants, *Naringi crenulata's* bark is smooth and thin, yet as the plant ages, it may start to show some signs of ridging [34]. The main purpose of the bark is to shield the inner vascular tissues from infection, water loss, and physical harm. In many plants, the outer bark layer also helps prevent desiccation, acting as a barrier against excessive water loss. Many plants, like *Naringi crenulata*, have bark that acts as a crucial barrier against infections and herbivores. Though its thinness may enable faster development and the ability to heal any damage more quickly, the smooth bark may be more susceptible to herbivory than more rough or thicker bark[35].

Phytoconstituents:

Test For Alkaloids [36]:

Mayer's Test:

A few drops of Mayer's reagent were added to the filtrate. If a white, creamy precipitate forms, the test is considered positive.(Mayer's Reagent: 1.358 g of mercuric chloride and 5.0 g of potassium chloride dissolved in 100 mL of water.)

Wagner's Test:

A few drops of Wagner's reagent were added to the filtrate. If a reddish-brown precipitate appears, the test is positive. (Wagner's Reagent: 1.27 g of iodine and 2 g of potassium iodide dissolved in 100 mL of water.)

Hager's Test:

A small amount of Hager's reagent (picric acid solution) was added to the filtrate. If a yellow precipitate forms, the test is positive.

Dragendorff's Test:

A few drops of Dragendorff's reagent were added to the filtrate. A yellow precipitate indicated the presence of alkaloids.

Detection Of Carbohydrates [37]:

The extract (100 mg) was dissolved in 5 mL of water, filtered, and tested for carbohydrates and glycosides:

Molish's Test:

To 2 mL of filtrate, 2 drops of alcoholic α-naphthol solution were added. After shaking, concentrated sulfuric acid was added along the test tube's sides. A violet ring formed at the interface, indicating the presence of carbohydrates.

Fehling's Test:

One mL of the filtrate was boiled with Fehling solutions I and II. A red precipitate confirmed the presence of sugars.

Detection Of Glycosides:

Borntrager's Test:

2 mL of the filtrate was mixed with 3 mL of chloroform. After separating the chloroform layer, 10% ammonia solution was added. A pink colour in the ammonia layer indicated the presence of glycosides.

Legal's Test:

The extract was dissolved in pyridine, and sodium nitroprusside solution was added. When made alkaline with sodium hydroxide, the formation of a pink colour confirmed the presence of glycosides.

Detection Of Saponins [38]:

The extract (50 mg) was diluted with distilled water to 20 mL. After shaking in a graduated cylinder for 15 minutes, a 2 cm layer of foam indicated the presence of saponins.

Detection Of Phytosterols[39]:

Libermann-Burchard's Test:

The extract (50 mg) was dissolved in acetic anhydride. After adding a few drops of concentrated sulfuric acid, the colour changes indicated the presence of phytosterols.

Detection Of Fixed Oils and Fats:

Spot Test:

A small amount of extract was pressed between two filter papers. If an oil stain appeared on the paper, it indicated the presence of fixed oils.

Detection Of Phenolic Compounds [40]:

Ferric Chloride Test:

The extract (50 mg) was dissolved in 5 mL of distilled water. A few drops of ferric chloride solution were added, and a dark green colour indicated the presence of phenolic compounds.

Detection Of Flavonoids:

Alkaline Reagent Test:

When the extract was treated with ammonium hydroxide solution, yellow fluorescence under UV light indicated the presence of flavonoids.

Test For Terpenoids:

Noller's test:

The substance was warmed with Tin and Thionyl chloride. Purple coloration indicated the presence of terpenoids.

Phytochemical Profiling [41]:

Extract	Ethanol	Methanol	Water	Chloroform	Benzene
Alkaloids	+	+	+	-	-
Carbohydrates	+	+	+	-	-
Glycosides	+	+	+	+	+
Saponins	+	+	-	-	-
Phytosterols	+	+	-	+	+
Oils and fats	-	-	-	+	-
Phenolic compounds	+	+	-	-	-
flavonoids	+	+	+	-	-
terpenoids	+	+	+	+	-

Pharmacological Action:

Anti-Microbial Activity:

Naringi crenulata presence of aqueous, methanolic, and petroleum ether extracts of Plants bioactive substances such as terpenoids, tannins, alkaloids, flavonoids, and saponins. Strong antibacterial properties are presented by these phytochemicals[42]. The ethanolic extract of *Naringi crenulata* shows strong antibacterial and antifungal action against every bacterial and fungal infection [43].

Anti-Oxidant Activity:

Flavonoids, alkaloids, terpenoids, tannins, and essential oils are among the bioactive substances that give *Naringi crenulata* its antioxidant properties. It has been demonstrated that these substances can scavenge free radicals and enhance the plant's total antioxidant capacity[44]. Several in vitro studies have assessed the antioxidant potential of *Naringi crenulata* using various assays such as DPPH (2,2-diphenyl-1-picrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), and FRAP (Ferric Reducing Antioxidant Power)[45]. In one study, the methanol and ethanol extracts of the plant showed significant free radical scavenging activity, with the ethanol extract demonstrating stronger antioxidant effects. The DPPH assay revealed that the plant's extracts were able to neutralize DPPH radicals effectively, indicating a promising antioxidant capacity[46].

Hepatoprotective Activity:

This hepatoprotective effect may be attributed to the presence of phenolic compounds and

flavonoids, which help in detoxifying harmful free radicals and preventing lipid peroxidation in liver tissues[47]. Furthermore, an in-vitro study reported that *Naringi crenulata* extracts exhibited strong cytoprotective effects in cultured fibroblast cells exposed to oxidative stress. The extract reduced cellular damage and enhanced cell viability, indicating its potential as a therapeutic agent for oxidative stress-related disorders[48]. Its ability to scavenge free radicals, protect against liver damage, and reduce inflammation highlights its importance in herbal medicine [49]

Antidiabetic Activity:

The plant of *Naringi crenulate* exhibited varying degrees of antihyperglycemic activity both in-vitro and in vivo. In streptozotocin-induced multidose-treated diabetic rats, methanol extract and its fractions, particularly NCMF-3, demonstrated strong antihyperglycemic activity due to the presence of phytoconstituents [50].

Anti-Larvicidal Activity:

In the phytochemical screening, secondary metabolites, TLC, HPLC and FT- IR analysis were used to assess the larvicidal activity of various plant part extract and bioassay guided fractions of *narinji crenulata* against the *culex quinquefasciatus.* According to our findings, acetone extract had the highest larvae fatality rate respectively. The plant *naringi crenulata* have the phytochemicals of alkaloids, phenols, tannins and saponins [51].

CONCLUSION:

Naringi crenulata (Elephant Nettle), a member of the Rutaceae family, offers significant pharmacological benefits due to its rich phytochemical profile. Its wide range of bioactive compounds, including alkaloids, flavonoids, saponins, and terpenoids, are responsible for its potent therapeutic properties. The plant has shown promise in treating conditions like infections, oxidative stress, liver damage, diabetes, and mosquito larvae infestations. The documented antimicrobial, antioxidant, hepatoprotective, and antidiabetic activities highlight the plant's potential as a natural therapeutic agent. Further research, including clinical trials, is warranted to fully explore and validate the medicinal efficacy of *Naringi crenulata* and to explore its applications in modern healthcare. The plant's versatility, combined with its traditional use in herbal medicine, makes it an important subject of study for phytopharmaceutical development.

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