

## Review Article

## The Ethnobotany of Rutaceae: Traditional Uses and Cultural Significance

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**Abstract:** The family Rutaceae, comprising of about 150 genera and over 1500 species holds profound ethnobotanical importance across diverse cultures worldwide. The present study is an attempt to explore the ethnobotanical knowledge of Rutaceae and its multifaceted roles in traditional medicine, food systems, rituals and material culture. Members of Rutaceae are used in medicinal applications (digestive disorders, fever and inflammatory conditions); cultural practices (including ritual purification, spiritual protection and ceremonial adornment) and utilitarian functions (natural pesticides, dyes and timber). A framework for prioritizing conservation of culturally significant Rutaceae through community-led biocultural preservation initiatives are needed. Thus, the paper underscores Rutaceae as both a biocultural heritage and an untapped resource for sustainable development, bridging traditional wisdom with modern pharmacological and agroecological applications.

**Keywords:** Rutaceae, Ethnobotany, Traditional Medicine, Biocultural Conservation, Phytochemistry

### INTRODUCTION

The plant family Rutaceae, 'the Rue family' or 'the Citrus fruit family', represents a remarkably diverse and globally significant group of flowering plants. Comprising over 150 genera and 1600 species, its members range from the humble herbaceous rues to towering timber trees, though they are universally united by the presence of aromatic oils contained within schizolysigenous glands, which release their characteristic scents when bruised (Chooi, 1994). This very aroma, a complex bouquet of citrus, spice, and resin has been a primary catalyst for the profound and enduring relationship between humans and Rutaceae species across continents and millennia. The ethnobotany of the Rutaceae, therefore, offers a rich and intricate drapery woven from threads of sustenance, medicine, ritual and commerce, revealing how human cultures have intuitively understood and utilized the unique chemical properties of these plants long before the advent of modern science (Lv *et al.*, 2015).

From a utilitarian perspective, the family's impact is immeasurable, most famously exemplified by the genus *Citrus*. Oranges, lemons, limes and grapefruits are not merely fruits; they are cultural icons and economic powerhouses that have shaped trade routes, sparked expeditions and become dietary staples imbued with symbolic meaning, from prosperity in China to purification in Mediterranean cultures. Yet, beyond the orchard, the Rutaceae family provides a vast pharmacopoeia (Vijayalakshmi and Radha, 2015; Narang and Jiraungkoorskul, 2016). Traditional healers from

the Amazon rainforest to the deserts of Southern Africa and the mountains of India have harnessed the antimicrobial, anti-inflammatory and analgesic properties of countless species of the family. Trees like the Bael (*Aegle marmelos*) in Ayurveda or the Cape Chestnut (*Calodendrum capense*) in Zulu medicine are integral to treating ailments from digestive disorders to fevers, their bark, leaves and roots prepared in precise decoctions and poultices. Thus, the paper underscores Rutaceae as both a biocultural heritage and an untapped resource for sustainable development, bridging traditional wisdom with modern pharmacological and agroecological applications.

### Phytochemistry

The phytochemistry of Rutaceae is notable for the presence of a wide array of secondary metabolites like alkaloids, coumarins, flavonoids, essential oils and terpenoids, many of which contribute to their characteristic aroma, medicinal properties and ecological interactions. These compounds play critical roles in plant defense mechanisms against herbivores, pathogens, and environmental stressors, while also providing significant pharmacological and nutraceutical benefits to humans. One of the most distinctive features of Rutaceae plants is the presence of essential oils stored in specialized oil glands, which give citrus fruits their characteristic fragrance. These volatile compounds primarily include monoterpenes such as limonene, pinene and myrcene, as well as sesquiterpenes and oxygenated derivatives like citral and linalool. Limonene, in particular, is abundant in citrus peel oils

and has demonstrated antimicrobial, antioxidant and anticancer properties, making it a subject of growing interest in pharmaceutical and food industries (Waterman, 1993). The essential oils also have applications in perfumery, flavouring and aromatherapy, further underlining their economic significance.

Alkaloids constitute another major class of phytochemicals in Rutaceae, with acridone and quinoline alkaloids being the most characteristic types. Acridone alkaloids, found in genera such as *Citrus*, *Zanthoxylum* and *Ruta*, exhibit diverse biological activities including antimicrobial, anti-inflammatory, and anticancer effects (Ngoumfo *et al.*, 2010). Quinoline alkaloids, such as dictamnine and skimmianine, have also been reported for their pharmacological potential. Some alkaloids in this family are known to possess bitter properties, serving as natural deterrents to herbivores. Coumarins are widely distributed in Rutaceae and contribute to the distinctive chemical profile of the family. Simple coumarins like umbelliferone, as well as furanocoumarins such as psoralen and bergapten, are present in many genera where these compounds often show phototoxic and antimicrobial activity and some are employed in traditional medicine for the treatment of skin disorders and infections.

Flavonoids are another abundant class of compounds in Rutaceae, including flavones, flavanones and flavonols. Citrus fruits are particularly rich in flavanones such as hesperidin and naringin, which are associated with antioxidant, anti-inflammatory, and cardioprotective properties. These compounds not only contribute to the health-promoting benefits of citrus fruits but also play ecological roles in UV protection and pigmentation. The synergy of flavonoids with vitamin C in citrus enhances their nutritional and therapeutic value, making them widely studied in the context of functional foods. Terpenoids, especially limonoids, represent another unique group of phytochemicals in Rutaceae. The phytochemical richness of Rutaceae has positioned the family as an important source of bioactive compounds with applications in medicine, agriculture, food and cosmetic industries.

#### Traditional medicinal uses

The Rutaceae family's extensive range, rich phytochemistry and medicinal potential have earned it a significant position in traditional medicine across many cultures. Members of the family have been used in traditional medicine for millennia to treat a wide range of illnesses, from infections and digestive issues to skin conditions and respiratory issues. The phytoconstituents of the Rutaceae family, which have a variety of pharmacological characteristics, are directly related to their medicinal usefulness. In addition to reflecting indigenous knowledge systems, these traditional usages have served as a basis for contemporary

pharmacological research. Because of its stomachic and carminative qualities, citrus peels are frequently used in Chinese and Ayurvedic medicine to treat nausea, loss of appetite, and digestive problems. Citrus juice is valued as a source of vitamin C and has long been used to prevent and treat scurvy, while the fruit is also applied in febrile conditions to quench thirst and restore hydration. In folk practices, citrus seed extracts have been used for their anthelmintic effects, while citrus oils are applied for their antimicrobial and soothing properties. Similarly, lemon (*Citrus limon*) has been traditionally used as a detoxifying agent, in wound healing and to alleviate sore throats and coughs.

Another important genus is *Ruta*, particularly *Ruta graveolens*, which has been used in European and Mediterranean folk medicine for centuries. Rue leaves have been employed as antispasmodic, emmenagogue and abortifacient agents, as well as in the treatment of menstrual irregularities and gastrointestinal discomfort. Decoctions of rue have also been applied externally to relieve rheumatism, skin inflammation, and insect bites. However, the plant must be used cautiously, as it can be toxic in higher doses. Despite its potential toxicity, rue remains an important medicinal plant in traditional healing systems.

The genus *Zanthoxylum* with widespread use in traditional medicine, particularly in Asia and Africa. The fruits and seeds of *Zanthoxylum* species, often referred to as Sichuan pepper or prickly ash are employed as spices as well as remedies for toothache, digestive problems and respiratory ailments. Their pungent and tingling properties have been traditionally harnessed to stimulate appetite, enhance circulation, and alleviate pain. In African folk medicine, *Zanthoxylum* bark and roots are used for malaria, fever, and infections, highlighting their broad therapeutic potential. Plants belonging to the genus *Aegle*, especially *Aegle marmelos* hold a sacred and medicinal status in Indian Ayurveda. The fruit pulp is traditionally consumed to treat diarrhea, dysentery and gastrointestinal disorders, while the leaves are used for diabetes management and the treatment of peptic ulcers. The unripe fruit is considered astringent and digestive, whereas the ripe fruit serves as a mild laxative. Bael is also regarded as a cooling agent, helping in the treatment of heat-related ailments.

Several other members are used in traditional systems for their medicinal attributes. *Murraya koenigii*, apart from its culinary value, curry leaves are believed to support digestion, lower cholesterol and control diabetes. They are also applied as a remedy for hair loss and skin problems. Similarly, *Clausena anisata* is used in African herbal medicine for respiratory diseases, malaria, and infections. The traditional medicinal uses of Rutaceae illustrate the deep interconnection between human societies and plant resources. While their effectiveness has been supported

by anecdotal evidence over centuries, modern pharmacological research has begun to validate many of these traditional applications, linking them to specific bioactive compounds.

- **Digestive and anti-inflammatory applications**

The family is a cornerstone of traditional medicinal systems worldwide, with a significant portion of its applications focused on alleviating digestive ailments and reducing inflammation. The most prominent among these are volatile oils, limonoids, coumarins, and alkaloids, which work in concert to produce carminative, stomachic, antispasmodic and anti-inflammatory effects. For digestive health, numerous species are employed as remedies to stimulate appetite, ease dyspepsia and relieve flatulence and cramping. The essential oils found in plants like rue (*Ruta graveolens*) (Águila *et al.*, 2015), curry leaf (*Murraya koenigii*) (Nouman *et al.*, 2015) and various *Zanthoxylum* species act as carminatives, helping to expel gas from the intestines and soothe stomach spasms. The Bael tree (*Aegle marmelos*), are renowned for their stomachic properties, stimulating the production of digestive enzymes and bile flow (Ramakrishna *et al.*, 2015). In Ayurvedic medicine, the unripe fruit of Bael is prepared into a digestive tonic and is a primary remedy for chronic diarrhea and dysentery due to its antimicrobial and antidiarrheal actions. Similarly, the citrus peels of oranges and lemons, used in everything from Chinese medicine to European folk traditions, are valued for their ability to regulate energy level, settle the stomach and counteract nausea.

- **Antimicrobial and fever remedies**

The role of the family in traditional medicine extends powerfully into the realm of treating infectious diseases and fevers, serving as a natural arsenal against a spectrum of microbial pathogens and the pyretic symptoms that accompany them. The antimicrobial efficacy of many Rutaceae species is often broad-spectrum. The volatile oils found in *Ruta graveolens*, citrus peels and the leaves of the *Murraya paniculata* have been demonstrated to disrupt the cellular membranes of bacteria and fungi, leading to cell death (Orlanda and Nascimento, 2015; Dosoky *et al.*, 2016). This rationalizes their traditional use in washing wounds to prevent sepsis, treating skin fungi and managing bacterial dysentery. In many parts of Africa and Asia, preparations from the root or stem bark of *Toddalia asiatica* and *Zanthoxylum* species are used to treat malaria, sexually transmitted infections and gastrointestinal infections driven by their high concentrations of bioactive alkaloids and coumarins (Hu *et al.*, 2014; Venkatadri *et al.*, 2015).

Furthermore, the family is deeply integrated into fever management, not merely as antipyretics that reduce temperature but as holistic remedies addressing the underlying causes, often infections (Roy and Rahman, 2016). The mechanism is frequently dual: directly attacking the microbial source of the fever while stimulating the body's own cooling responses. The pervasive use of citrus fruits rich in vitamin C during cold and flu seasons in modern cultures is a direct echo of this ancient understanding, supporting the immune system's fight against viral invaders. Thus, the family stands as evidence to traditional medicine's sophisticated, observation-based approach to combating infection and fever, offering a rich and still largely untapped resource for the development of novel antimicrobial and antipyretic agents.

- **Pain relief and analgesic properties**

The analgesic and pain-relieving properties of various plants within this family are attributed to a rich and diverse array of bioactive compounds with potent anti-inflammatory activity (Kariuki *et al.*, 2013; Kimang'a *et al.*, 2016). Chronic pain is often linked to inflammation and compounds within these plants can effectively interrupt the inflammatory pathways (Sarmiento-Neto *et al.*, 2015). Compounds like skimmianine, found in various *Skimmia* and *Zanthoxylum* species, have demonstrated significant analgesic effects in experimental models by acting on the central nervous system. Similarly, the genus *Zanthoxylum*, used in many cultures for toothaches and joint pain, contains alkaloids and amides that produce a characteristic tingling or numbing sensation, indicative of a local analgesic effect (Zhang *et al.*, 2017). Flavonoids such as hesperidin and rutin, abundantly present in citrus peels, exhibit strong anti-inflammatory and antioxidant activities. By scavenging free radicals and modulating the activity of enzymes like cyclooxygenase (COX) and lipoxygenase (LOX), they reduce the production of prostaglandins and leukotrienes, which are key mediators of pain and inflammation (Adebayo *et al.*, 2015).

- **Cultural and ritual significance**

The Rutaceae family, holds a profound and enduring place in the cultural and ritual practices of civilizations globally. Its significance transcends its nutritional and medicinal value, deeply embedding itself in the spiritual and symbolic fabric of numerous societies, primarily due to its distinctive fragrance, evergreen nature, and purifying properties. In many traditions, plants from the Rutaceae family are powerful symbols of purity, protection, and prosperity. The most ubiquitous example is the use of Citrus species in East Asian rituals. In China and Japan, branches of citrus trees, particularly those bearing fruit, are used during

New Year celebrations to bring luck and ward off malevolent spirits (Casey, 2015). The custom of presenting kumquats or tangerines as gifts symbolizes abundance and good fortune for the coming year. Similarly, in Jewish culture, the etrog, a yellow citron (*Citrus medica*), is an essential component of the Sukkot festival. Held alongside a palm frond, myrtle and willow branches, the etrog's heart-shaped form and fragrance are integral to prayers for rain and fertility, representing the ideal of a heart devoted to faith and good deeds.

The genus *Ruta*, particularly *Ruta graveolens*, is widely used in Catholic churches for sprinkling holy water, a practice symbolizing purification and blessing for the congregation. This association with sanctity bled into folk magic, where rue was considered a potent charm against witchcraft and the evil eye. People would hang it in their homes or carry it as an amulet for protection. In parts of Mexico and South America, this tradition continues, with rue being used in spiritual to clear negative energy and restore balance. The burning of dried peels of citrus or other aromatic members of the family serves as a form of incense, believed to carry prayers heavenward and create a bridge to the divine. The freshness and vibrant, evergreen quality of citrus trees also contribute to their symbolism of immortality, resilience, and eternal life in various cultural contexts.

## CONCLUSION

The exploration of ethnobotany of family Rutaceae reveals a profound and intricate embroidery woven between human cultures and the plant kingdom. This journey through traditional knowledge systems underscores that members of the family are far more than botanical curiosities or simple sources of sustenance; they are deeply embedded cultural artifacts, serving as pillars of healing, spiritual practice and social custom across the globe. The enduring relationship between people and these plants is evidence to a deep-seated intuitive and experimental understanding of their properties, long before modern science could articulate the biochemical mechanisms behind their efficacy. The Rutaceae family, therefore, stands as a powerful exemplar of how biodiversity is intrinsically linked to cultural diversity and human well-being. The cultural significance of these plants consistently stems from their most salient sensory characteristics: their vibrant aromatics, their sharp flavours, and their often-evergreen vitality. These properties naturally lent themselves to symbolic interpretation, leading to their roles in purification rituals and as protective talismans against evil spirits. The use of the etrog in Sukkot or citrus in wedding ceremonies highlights how these plants became symbols of purity, fertility and prosperity, their physical perfection mirroring spiritual and communal ideals. This transformation of a natural object into a potent cultural symbol demonstrates the

human capacity to find deep meaning within the natural world. On the other hand, the traditional medicinal applications of Rutaceae species demonstrate remarkably across various cultures. This global consensus points to the genuine bioactivity of the family's characteristic chemical constituents: alkaloids, flavonoids, limonoids and essential oils. In conclusion, the ethnobotany of the Rutaceae family is a rich narrative of interaction and intuition. Thus, the family Rutaceae represents a vital link between nature and human culture, offering medicinal, spiritual and economic benefits. While modern science continues to uncover the biochemical basis of traditional uses, urgent action is needed to conserve both the plants and the knowledge systems surrounding them. By integrating ethnobotanical insights with sustainable practices, the world can ensure that Rutaceae species remain a thriving part of our global heritage.

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