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Review Paper

A Review on *Nepeta cataria* L.: Phytochemistry, Pharmacological Activities, and Therapeutic Prospects

Rishabh Patel, Dr. Shobhit Sirvastava*

Dr. M.C. Saxena College of Pharmacy, Dubagga, Lucknow, Uttar Pradesh 226101, India.

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ABSTRACT

Nepeta cataria L. (catnip), a perennial herb of the Lamiaceae family, is globally recognized for its characteristic effects on domestic cats as well as its traditional medicinal value. This review consolidates botanical, phytochemical, and pharmacological insights on the species, highlighting its wide range of bioactive constituents and therapeutic potential. The plant contains diverse classes of phytochemicals, including monoterpenes (notably nepetalactones), sesquiterpenes, flavonoids, phenolic acids, iridoids, and essential oils. These compounds contribute to a spectrum of pharmacological activities such as insect-repellent, sedative, anxiolytic, anti-inflammatory, antimicrobial, antioxidant, analgesic, and gastrointestinal effects. Nepetalactones exhibit potent insecticidal and repellent properties, often surpassing synthetic agents like DEET, while flavonoids such as apigenin and luteolin are linked to anxiolytic and sedative effects via modulation of GABA_A receptors. Rosmarinic acid and other phenolics further enhance anti-inflammatory, antiviral, and antioxidant activities. Collectively, these findings affirm *N. cataria* as a valuable medicinal herb with applications in integrative medicine, pest management, and natural product research. Future studies should focus on clinical validation, safety profiling, and the development of standardized formulations to harness its therapeutic potential.

INTRODUCTION

Nepeta cataria, commonly known as catnip or catmint, is a perennial herb belonging to the Lamiaceae (mint) family. Native to Europe and Asia, it has been naturalized in North America and other regions due to its widespread cultivation (Grognet, 1990). The plant is characterized by its

heart-shaped, toothed leaves, square stems, and clusters of small, white or lavender flowers. *Nepeta cataria* is renowned for its unique effects on cats, but it also has a long history of medicinal use in humans (Turner, 2005). The primary bioactive compound in *Nepeta cataria* is nepetalactone, an iridoid that binds to feline

*Corresponding Author: Dr. Shobhit Sirvastava

Address: Dr. M.C. Saxena College of Pharmacy, Dubagga, Lucknow, Uttar Pradesh 226101, India.

Email ✉: shobhitpharma85@gmail.com

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olfactory receptors, triggering a temporary behavioral response (Bol et al., 2017). Cats exposed to catnip may exhibit behaviors such as rolling, rubbing, vocalization, and hyperactivity, followed by a period of relaxation. This reaction is hereditary, affecting approximately 50-70% of cats (Ellis & Wells, 2010). Historically, *Nepeta cataria* has been used in traditional medicine as a sedative, digestive aid, and treatment for colds and fevers (Blumenthal et al., 2000).



Figure 1: A depiction of *Nepeta cataria*

When brewed as a tea, it has mild calming effects similar to chamomile. Additionally, it has been employed as an insect repellent due to its high nepetalactone content, which deters mosquitoes and other pests (Schultz et al., 2004). Catnip is a hardy plant that thrives in well-drained soil and full sun. It is drought-resistant and attracts pollinators such as bees, making it beneficial for gardens (Kowalchik & Hylton, 1998). However, its rapid growth can make it invasive if not controlled. Gardeners often grow it as a companion plant to repel certain insects while attracting beneficial ones.

Taxonomy

Nepeta cataria is a widely recognized herb due to its behavioral effects on domestic cats, but it also has historical medicinal uses, including as a mild sedative and digestive aid (Blumenthal et al., 2000). Its hardiness and insect-repellent properties make it valuable in gardens (Kowalchik & Hylton, 1998).

Table 1: Taxonomic Classification of *Nepeta cataria*

Rank	Classification
Kingdom	<i>Plantae</i>
Clade	<i>Tracheophytes</i>
Clade	<i>Angiosperms</i>
Clade	<i>Eudicots</i>
Clade	<i>Asterids</i>
Order	<i>Lamiales</i>
Family	<i>Lamiaceae (mint family)</i>
Genus	<i>Nepeta</i>
Species	<i>Nepeta cataria L.</i>

USDA (2023); Linnaeus (1753)

MORPHOLOGY OF *NEPETA CATARIA*

1. Vegetative Structures

Nepeta cataria exhibits typical morphological characteristics of the Lamiaceae family. The plant grows as a herbaceous perennial, reaching heights of 50-100 cm (20-40 inches) at maturity (USDA, 2023). Its square stems, a diagnostic feature of the mint family, are covered with fine hairs and become woody at the base in mature specimens (Gleason & Cronquist, 1991). The leaves display opposite decussate phyllotaxy, with each leaf measuring 3-7 cm long and 2-5 cm wide. These heart-shaped (cordate) leaves feature crenate margins and a grayish-green upper surface with a paler underside (Tucker & DeBaggio, 2009). The entire plant is covered with glandular trichomes that produce the characteristic aromatic compounds, particularly on the lower leaf surfaces (Werker et al., 1985).

2. Root System and Growth Habit

The plant develops a fibrous root system with rhizomatous growth, allowing for both sexual and vegetative reproduction (Huxley, 1992). This extensive but shallow root system contributes to the plant's drought tolerance while facilitating its spread in favorable conditions. The rhizomes enable the plant to survive winter conditions in



temperate climates, with new growth emerging from these underground structures each spring (Radford et al., 1968).

REPRODUCTIVE STRUCTURES

1. Inflorescence and Flowers

Nepeta cataria produces distinctive flowering structures from late spring through early autumn (June-September in temperate zones) (Polunin, 1969). The inflorescence forms as a thyrse, with flowers arranged in verticillasters (false whorls) at the terminal ends of stems and branches (Mabberley, 2017). Individual flowers feature the characteristic bilabiate (two-lipped) corolla typical of Lamiaceae, measuring 8-12 mm in length. The white to pale purple flowers display darker purple spots and nectar guides visible to pollinators (Judd et al., 2016).

2. Floral Anatomy and Pollination

Each flower contains four didynamous stamens (two long and two short) and a single pistil with a bifid stigma (Spellenberg, 2001). The superior ovary divides into four lobes, developing into nutlets upon maturation. The floral structure promotes cross-pollination by insects, primarily bees, which are attracted to the nectar and ultraviolet patterns on the petals (Werker et al., 1985).

3. Fruits and Seed Dispersal

The fruit develops as a schizocarp that splits into four individual nutlets (mericarps) when mature (Radford et al., 1968). These light brown seeds, measuring 1.5-2 mm long, feature a smooth to slightly reticulated surface. Seed dispersal occurs primarily through gravity and animal-mediated mechanisms, with the small size allowing for wind-assisted distribution over short distances (Spellenberg, 2001).

4. Adaptive Features

The plant's dense covering of glandular trichomes serves multiple functions. These specialized structures produce volatile oils, including the biologically active nepetalactone, which deters herbivores while attracting felines (Bol et al., 2017). The pubescence on leaves and stems provides additional protection against insect predation and reduces water loss through transpiration (Rice, 1984). Furthermore, root exudates may exhibit allelopathic properties, inhibiting the growth of competing plant species in the immediate vicinity (Rice, 1984).

GEOGRAPHICAL DISTRIBUTION OF *NEPETA CATARIA*

1. Native Range and Historical Spread

Nepeta cataria originated in temperate regions of Eurasia, with its natural distribution extending from Southern and Eastern Europe through Western Asia to Central Asia (USDA, 2023). Historical records indicate the plant grew wild across the Mediterranean basin, Caucasus region, and Himalayan foothills before human cultivation facilitated its global dispersal (Grieve, 1931). The species typically thrived in open woodlands, river valleys, and disturbed habitats within these native ranges (Mabberley, 2017).

2. Global Expansion and Naturalization

Through both intentional cultivation and accidental introduction, catnip has established populations across temperate zones worldwide (Polunin, 1969). Following European colonization, it naturalized extensively throughout North America, now occurring from southern Canada to the continental United States (USDA, 2023). Additional introduced populations thrive in New Zealand's North Island and northern South



Island, Japan's Honshu and Hokkaido islands, temperate regions of Chile and Argentina in South America, and South Africa's Western Cape region (Huxley, 1992). This global expansion demonstrates the species' remarkable adaptability to diverse environments.

3. Preferred Growing Conditions

The plant shows particular ecological preferences, flourishing:

At altitudes ranging from sea level to 2,500 meters (USDA, 2023). In temperate climates with annual precipitation between 400-1,200 mm (Polunin, 1969). In well-drained, sandy-loam soils with a pH of 6.1-7.8 (Huxley, 1992). Under full sun to partial shade conditions (Mabberley, 2017)

These adaptable growth requirements contribute significantly to its successful colonization of new territories.

4. Common Habitats

Nepeta cataria frequently colonizes various habitat types including:

- **Ruderal sites** such as roadsides, abandoned fields, and waste areas
- **Riparian zones** along streams and floodplains
- **Forest edges** in deciduous woodlands
- **Agricultural margins** including field boundaries and hedgerows (Polunin, 1969)

The species' ability to thrive in both natural and human-disturbed environments explain its widespread distribution across multiple continents.

PHYTOCHEMISTRY OF *NEPETA CATARIA*

Nepeta cataria, commonly known as catnip or catmint, is a perennial herb belonging to the Lamiaceae (mint) family. Native to Europe and parts of Asia, it has been widely naturalized in North America and other temperate regions. The plant is best known for its behavioral effects on domestic cats, attributed primarily to the monoterpene nepetalactone. However, beyond its feline-attracting properties, *N. cataria* has a rich phytochemical profile that includes a diverse array of secondary metabolites with potential pharmacological significance. This review provides a detailed account of the phytochemical constituents of *N. cataria*, categorized into major chemical classes: monoterpenes, sesquiterpenes, phenolic compounds (including flavonoids and phenolic acids), iridoids, and volatile oils. Each class is discussed with reference to specific compounds, their structural characteristics, and biological relevance.

1. Monoterpenes and Iridoids

The most prominent and well-studied phytochemicals in *N. cataria* are the monoterpenes, particularly the iridoid derivatives nepetalactones. Iridoids are a class of monoterpenoids derived from the cyclization of 10-carbon geraniol, and they are commonly found in plants of the Lamiaceae and Rubiaceae families (Gertsch, 2005). In *N. cataria*, the principal bioactive compounds are cis,trans-nepetalactone and trans,cis-nepetalactone, which are stereoisomeric forms of a bicyclic monoterpene lactone (Baker et al., 2015). These compounds are biosynthesized via the methylerythritol phosphate (MEP) pathway and are primarily localized in the peltate glandular trichomes of the aerial parts, especially the leaves and flowers (Anderson et al., 2010).

Nepetalactones are responsible for the characteristic cat-attractant activity, acting as



agonists at the olfactory receptors of felines, inducing behaviors such as licking, rolling, and hyperactivity (Tucker & Tucker, 1988). Beyond their behavioral effects, nepetalactones have demonstrated insect-repellent properties, particularly against mosquitoes, flies, and cockroaches, with efficacy comparable to DEET in some studies (Bharathi et al., 2010). The mechanism involves modulation of insect olfactory systems, possibly through interaction with octopamine receptors (McLain et al., 2001).

Additional monoterpenes identified in *N. cataria* essential oil include 1,8-cineole (eucalyptol), limonene, α -pinene, β -pinene, and myrcene (Graven et al., 1989). These compounds contribute to the plant's aromatic profile and may synergize with nepetalactones in insect-repellent activity. For instance, 1,8-cineole has known antimicrobial and anti-inflammatory properties (Juergens, 2014), suggesting a broader ecological and pharmacological role for the essential oil constituents.

2. Sesquiterpenes

Although less abundant than monoterpenes, sesquiterpenes are also present in *N. cataria*. These 15-carbon terpenoids arise from the mevalonate (MVA) pathway and contribute to the complexity of the plant's volatile profile. Compounds such as β -caryophyllene, α -humulene, and germacrene-D have been detected in trace amounts in the essential oil (Graven et al., 1989; Radulović et al., 2010). β -Caryophyllene is particularly noteworthy due to its role as a selective agonist of the cannabinoid receptor type 2 (CB2), conferring anti-inflammatory and analgesic effects (Gertsch et al., 2008). Its presence in *N. cataria* may partially explain the traditional use of catnip in folk medicine for pain relief and digestive ailments.

3. Phenolic Compounds: Flavonoids and Phenolic Acids

Phenolic compounds constitute a significant portion of the non-volatile phytochemicals in *N. cataria*. These include flavonoids and phenolic acids, which are known for their antioxidant, anti-inflammatory, and neuroprotective properties (Rice-Evans et al., 1996). High-performance liquid chromatography (HPLC) and mass spectrometry analyses have revealed the presence of several flavonoids in *N. cataria*, including apigenin, luteolin, quercetin, and their glycosylated derivatives such as apigenin-7-O-glucoside and luteolin-7-O-glucoside (Sarikurkcu et al., 2015). Apigenin and luteolin are flavones known for their anxiolytic and sedative effects, mediated through modulation of GABA_A receptors (Budzynska et al., 2013). This pharmacological activity aligns with the traditional use of catnip tea as a mild sedative and remedy for insomnia and anxiety. Quercetin, a flavonol, is a potent antioxidant that scavenges free radicals and inhibits lipid peroxidation (Erlund, 2004), contributing to the plant's overall antioxidant capacity. Phenolic acids such as rosmarinic acid, caffeic acid, chlorogenic acid, and ferulic acid are also abundant in *N. cataria* (Sarikurkcu et al., 2015). Rosmarinic acid, in particular, is a hallmark compound of the Lamiaceae family and is biosynthesized from the condensation of caffeic acid and 3,4-dihydroxyphenyllactic acid. It exhibits anti-inflammatory, antiviral, and hepatoprotective activities (Petersen & Simmonds, 2003). The high concentration of rosmarinic acid in *N. cataria* may underlie its use in traditional medicine for treating respiratory infections and gastrointestinal disturbances.

4. Volatile Oil Composition and Chemotypes



The essential oil of *N. cataria* is highly variable and subject to chemotypic variation influenced by genetic, environmental, and developmental factors. While nepetalactones typically dominate (up to 70–99% of the oil), other chemotypes have been reported with significant levels of 4 α ,7 α ,7 α -nepetalactone, 1-octen-3-ol, or even citral (Radulović et al., 2010). This variability affects the biological activity of the oil, including its insect-repellent and medicinal properties. For example, oils rich in nepetalactone are more effective against mosquitoes, while those with higher oxygenated monoterpenes may exhibit stronger antimicrobial effects (Bharathi et al., 2010).

PHARMACOLOGICAL ACTIVITIES OF *NEPETA CATARIA*

Nepeta cataria, commonly known as catnip or catmint, is a perennial herb in the Lamiaceae family that has been used for centuries in traditional medicine across Europe, North America, and parts of Asia. While it is widely recognized for its psychoactive effects on domestic cats—inducing behaviors such as rolling, rubbing, and hyperactivity—its pharmacological significance in humans and other organisms extends far beyond this peculiar trait. The diverse phytochemical profile of *N. cataria*, rich in monoterpenes (especially nepetalactones), flavonoids, phenolic acids, and essential oils, underpins a broad spectrum of pharmacological activities, including insecticidal, anxiolytic, sedative, anti-inflammatory, antimicrobial, antioxidant, and analgesic effects. This review provides a comprehensive analysis of the pharmacological activities of *Nepeta cataria*, supported by in vitro, in vivo, and clinical evidence, and discusses its potential applications in modern medicine and natural product development.

1. Insect Repellent and Insecticidal Activity

One of the most well-documented and commercially relevant pharmacological properties of *N. cataria* is its potent insect-repellent and insecticidal activity. The primary bioactive constituents responsible for this effect are the iridoid monoterpenes, particularly cis,trans-nepetalactone and trans,cis-nepetalactone, which constitute up to 99% of the essential oil in some chemotypes (Baker et al., 2015). These compounds exhibit strong repellency against a wide range of medically important insects, including *Aedes aegypti* (dengue and Zika vector), *Anopheles stephensi* (malaria vector), *Culex quinquefasciatus* (West Nile virus vector), and *Musca domestica* (housefly) (Bharathi et al., 2010). Studies have demonstrated that nepetalactone is significantly more effective than the synthetic repellent DEET (N,N-diethyl-metaltoluamide) in repelling mosquitoes, with protection lasting over 2 hours at high concentrations (Baker et al., 2015). The mechanism of action involves interaction with the insect olfactory system, particularly through activation of octopamine receptors, which modulate arousal and locomotor activity in arthropods (McLain et al., 2001). This neurobehavioral disruption leads to avoidance behavior, effectively deterring insect bites. In addition to repellency, *N. cataria* essential oil exhibits direct insecticidal effects. Larvicidal activity has been reported against mosquito larvae, with LC₅₀ (lethal concentration for 50% mortality) values ranging from 20 to 60 ppm depending on the species and oil composition (Bharathi et al., 2010). The oil also demonstrates adulticidal effects, particularly against flies and cockroaches, suggesting its potential as a natural alternative to synthetic pesticides. Due to its biodegradability and low mammalian toxicity, *N. cataria* is



increasingly considered a sustainable option for integrated vector management programs.

2. Anxiolytic and Sedative Effects

Nepeta cataria has a long history of use in traditional medicine as a mild sedative and anxiolytic agent. Infusions of the aerial parts are commonly consumed as herbal tea to alleviate anxiety, promote sleep, and relieve restlessness (Hoffmann, 2003). The pharmacological basis for these effects lies in the presence of bioactive flavonoids such as apigenin, luteolin, and quercetin, which are known to interact with the central nervous system. Apigenin, in particular, has been extensively studied for its anxiolytic properties. It acts as a partial agonist at benzodiazepine-binding sites on GABA_A receptors, enhancing the inhibitory effects of gamma-aminobutyric acid (GABA) without the side effects associated with synthetic benzodiazepines, such as dependence and sedation (Budzynska et al., 2013). Animal studies have shown that apigenin reduces anxiety-like behaviors in rodent models, such as the elevated plus maze and open field test, at doses comparable to diazepam but with a more favorable safety profile. In addition to flavonoids, nepetalactones may also contribute to CNS modulation. While their primary action is on feline olfactory receptors, some research suggests that these compounds or their metabolites may have mild sedative effects in mammals through unknown mechanisms, possibly involving transient receptor potential (TRP) channels or modulation of monoaminergic systems (Gertsch, 2005). However, more research is needed to confirm this hypothesis in humans. The combination of flavonoids and terpenoids in *N. cataria* likely produces a synergistic effect, enhancing its overall calming properties. This makes catnip tea a popular natural remedy for mild insomnia and

nervous tension, particularly in integrative and herbal medicine practices.

3. Anti-inflammatory and Analgesic Activities

Chronic inflammation is a key factor in numerous diseases, including arthritis, cardiovascular disorders, and neurodegenerative conditions. *Nepeta cataria* exhibits significant anti-inflammatory activity, primarily attributed to its high content of rosmarinic acid, flavonoids, and sesquiterpenes such as β -caryophyllene. Rosmarinic acid is a potent inhibitor of pro-inflammatory enzymes, including cyclooxygenase (COX) and lipoxygenase (LOX), which are involved in the production of prostaglandins and leukotrienes—key mediators of inflammation (Petersen & Simmonds, 2003). In vitro studies have shown that rosmarinic acid suppresses the expression of inflammatory cytokines such as TNF- α , IL-6, and IL-1 β in activated macrophages (Lim et al., 2013). This activity is further enhanced by the presence of flavonoids like luteolin and quercetin, which also inhibit NF- κ B signaling, a central pathway in inflammation. β -Caryophyllene, a sesquiterpene found in trace amounts in *N. cataria* essential oil, is a selective agonist of the cannabinoid receptor type 2 (CB2), which is expressed primarily in immune cells (Gertsch et al., 2008). Activation of CB2 receptors leads to reduced release of inflammatory mediators and attenuation of immune cell migration, making β -caryophyllene a promising candidate for treating inflammatory and neuropathic pain. In rodent models, β -caryophyllene has demonstrated analgesic effects comparable to conventional NSAIDs but with fewer gastrointestinal side effects. Animal studies using *N. cataria* extracts have confirmed these anti-inflammatory effects. For instance, ethanol extracts of the plant significantly reduced



carrageenan-induced paw edema in rats, with efficacy comparable to indomethacin (Sarikurkcu et al., 2015). These findings support the traditional use of catnip for treating inflammatory conditions such as sore throat, arthritis, and digestive inflammation.

4. Antimicrobial and Antiviral Effects

The essential oil and extract of *N. cataria* exhibit broad-spectrum antimicrobial activity against bacteria, fungi, and viruses. This property is largely due to the combined action of volatile terpenes and phenolic compounds. Nepetalactones, 1,8-cineole, α -pinene, and limonene have all demonstrated antibacterial and antifungal effects in vitro. Studies have shown that *N. cataria* essential oil inhibits the growth of Gram-positive bacteria such as *Staphylococcus aureus* and *Bacillus subtilis*, as well as Gram-negative strains including *Escherichia coli* and *Pseudomonas aeruginosa* (Sienkiewicz et al., 2011). The mechanism likely involves disruption of microbial cell membranes, leading to leakage of cellular contents and cell death. The oil also shows antifungal activity against *Candida albicans* and dermatophytes, suggesting potential use in treating fungal infections. In addition to direct antimicrobial action, the antioxidant properties of *N. cataria* contribute to its protective effects. Oxidative stress plays a critical role in microbial pathogenesis and host tissue damage. The plant's high content of flavonoids and rosmarinic acid scavenges free radicals, reducing oxidative damage and supporting immune function (Sarikurkcu et al., 2015). This dual action—direct antimicrobial and indirect antioxidant—makes *N. cataria* a valuable candidate for developing natural antiseptics and wound-healing formulations. Preliminary evidence also suggests antiviral activity. Rosmarinic acid has been shown to inhibit the replication of several viruses, including herpes

simplex virus (HSV) and influenza virus, by interfering with viral attachment and entry into host cells (Kalus et al., 2009). While specific studies on *N. cataria* extracts are limited, the presence of this compound implies potential antiviral utility.

5. Antioxidant Activity

Oxidative stress, resulting from an imbalance between reactive oxygen species (ROS) and antioxidant defenses, is implicated in aging, cancer, and chronic diseases. *Nepeta cataria* is a rich source of natural antioxidants, primarily due to its high concentration of phenolic compounds. Flavonoids such as quercetin, apigenin, and luteolin are powerful scavengers of free radicals, including superoxide anions, hydroxyl radicals, and peroxynitrite (Rice-Evans et al., 1996). These compounds also chelate transition metals like iron and copper, which catalyze ROS formation. Rosmarinic acid further enhances antioxidant capacity by donating hydrogen atoms and stabilizing free radicals through resonance. In vitro assays, including DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging, FRAP (ferric reducing antioxidant power), and ORAC (oxygen radical absorbance capacity), consistently show that *N. cataria* extracts possess strong antioxidant activity, often comparable to or exceeding that of reference antioxidants like ascorbic acid and trolox (Sarikurkcu et al., 2015). The antioxidant potential is highest in methanol or ethanol extracts, which efficiently solubilize phenolic compounds. These properties suggest that *N. cataria* could be used as a natural preservative in food and cosmetics, or as a dietary supplement to combat oxidative stress-related conditions.

6. Gastrointestinal and Antispasmodic Effects



Traditionally, catnip has been used to treat digestive complaints such as colic, flatulence, indigestion, and diarrhea. These effects are attributed to its antispasmodic and carminative properties. The essential oil, particularly nepetalactones and monoterpenes like 1,8-cineole, acts on smooth muscle in the gastrointestinal tract, reducing spasms and promoting the expulsion of gas. Animal studies have demonstrated that *N. cataria* extracts inhibit acetylcholine-induced contractions in isolated intestinal tissue, indicating a spasmolytic effect (Amos et al., 2007). This activity may involve blockade of calcium channels or modulation of cholinergic transmission. Additionally, the anti-inflammatory and antimicrobial actions of the plant may help alleviate infectious or inflammatory gastrointestinal disorders.

7. Safety and Toxicological Profile

Despite its wide use, *Nepeta cataria* is generally considered safe for human consumption in moderate amounts. The LD₅₀ (lethal dose for 50% of test subjects) of nepetalactone in rodents is relatively high, indicating low acute toxicity (McLain et al., 2001). No significant adverse effects have been reported in humans consuming catnip tea, although excessive intake may cause drowsiness, vomiting, or headache.

SUMMARY

Nepeta cataria is a well-documented medicinal herb native to Eurasia and now widely distributed across temperate regions of the world. Historically employed in traditional medicine for its sedative, digestive, and antipyretic properties, the plant has also gained attention for its unique behavioral effects on felines due to nepetalactones. Morphologically, it possesses square stems, heart-shaped leaves, glandular trichomes, and bilabiate flowers characteristic of the mint family. Its

adaptability to diverse habitats and rapid growth have facilitated its global naturalization.

Phytochemically, *N. cataria* is rich in secondary metabolites. The most notable are monoterpenes, especially nepetalactones, responsible for insect repellent activity and feline attraction. Additional terpenoids, flavonoids (apigenin, luteolin, quercetin), phenolic acids (rosmarinic, caffeic, chlorogenic), and sesquiterpenes (β -caryophyllene) impart broad biological activity. These compounds are concentrated in glandular trichomes and contribute to the plant's ecological adaptability and pharmacological properties.

Pharmacological investigations highlight a wide range of effects. Nepetalactones show superior efficacy compared to DEET against mosquitoes and other vectors. Flavonoids and phenolic acids contribute anxiolytic, sedative, antioxidant, and anti-inflammatory benefits. Sesquiterpenes like β -caryophyllene act via CB2 receptor modulation, offering analgesic potential. Extracts also display antimicrobial, antifungal, and antiviral activity, while gastrointestinal studies confirm antispasmodic and carminative effects. Importantly, safety studies indicate low toxicity, supporting its use in herbal remedies and natural formulations.

CONCLUSION

Nepeta cataria emerges as a multifaceted medicinal herb with both ethnopharmacological relevance and modern therapeutic promise. Its rich phytochemical spectrum underpins diverse pharmacological actions, ranging from insect repellency and antimicrobial activity to anxiolytic and anti-inflammatory effects. While traditional use and preclinical studies support its medicinal potential, further clinical trials and mechanistic studies are essential to validate efficacy and establish standardized therapeutic applications.



Given its ecological adaptability, low toxicity, and broad bioactivity, *N. cataria* represents a valuable candidate for future development in herbal medicine, nutraceuticals, and eco-friendly pest management strategies.

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