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Catnip essential oil: There is more to it than making your cat go crazy

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Abstract

Catnip (*Nepeta cataria*) essential oil shows a wide range of biological activities, not only cat stimulation, but also relaxant, antispasmodic, insect repellent, and allelopathic activities. The essential oil is generally dominated by nepetalactone isomers, but the compositions have shown wide variation depending on phenological cycle and geographical location. Numerous other *Nepeta* species are known and many of those have been characterized in terms of essential oil compositions and biological activities. This review presents an overview of the volatile phytochemistry of catnip (*Nepeta cataria*), its biological activities, and a survey of recent reports on *Nepeta* essential oils.

Keywords: *Nepeta*, nepetalactone, essential oil, bioactivity

1. Introduction

Catnip (*Nepeta cataria*) is a member of the mint family (Lamiaceae). The plant is well known for its behavioral effect on domestic cats (*Felis catus*) [1]. Not only are domestic cats affected, but other members of the cat family (Felidae) are also affected. Lions (*Panthera leo*), leopards (*Panthera pardus*), jaguars (*Panthera onca*), snow leopards (*Panthera uncia*), ocelots (*Leopardus pardalis*), and margays (*Leopardus wiedii*), are particularly sensitive to catnip. Tigers (*Panthera tigris*), cougars (*Puma concolor*), servals (*Leptailurus serval*), and bobcats (*Lynx rufus*) are apparently little affected, however [2].

Catnip has been used as an herbal medicine for many years [3]. Catnip tea and infusions have been used to treat nervous problems. Catnip tea was used as an antispasmodic to treat infantile colic, as a carminative to treat flatulence, and to assist parturition and evacuate the placenta during birth. Catnip juice from the herb was taken to induce menstruation. Catnip poultice has been used to treat toothache, sore breasts of nursing mothers, hemorrhoids, and generally to reduce swelling. Catnip herb has been smoked to relieve respiratory ailments. Catnip had brief popularity in the 1960s as a hallucinogenic drug in place of marijuana or as a filler in marijuana.

2. Catnip Essential Oil

The volatile chemistry of *N. cataria* is well known and is dominated by the iridoid nepetalactones [4]. There are eight possible stereoisomers of nepetalactone (Figure 1), of which six have been found in nature [5], and three are the principal isomers found in *N. cataria*, 4 α ,7 α -nepetalactone, 4 α ,7 α ,7 β -nepetalactone, and 4 α ,7 β ,7 α -nepetalactone. The predominant stereoisomers in *N. cataria* are 4 α ,7 α ,7 α -nepetalactone (up to 90%) [4, 6] and 4 α ,7 α ,7 β -nepetalactone (up to 78%) [4, 7]. The cat attractant is the 4 α ,7 α ,7 α -isomer [8]. This stereoisomer is also the sex pheromone of the cabbage aphid, *Brevicoryne brassicae* [9], the greenbug, *Schizaphis graminum*, the pea aphid, *Acyrtosiphon pisum*, the black bean aphid, *Aphis fabae*, the bird-cherry aphid, *Rhopalosiphum padi*, the peach-potato aphid, *Myzus persicae*, and the potato aphid, *Macrosiphum euphorbiae* [10].

3. Other *Nepeta* Essential Oils

In addition to *N. cataria*, there are numerous other species of *Nepeta*. The Missouri Botanical Garden currently lists 795 taxa in *Nepeta*, which includes many different subspecies, varieties, and cultivars [11]. The phytochemistry of many of these have been reported [4, 12]. A summary of nepetalactone concentrations in recent reports of *Nepeta* essential oil analyses is summarized in Table 1. It is obvious that the chemistry of *N. cataria* as well as different species of *Nepeta* is highly variable and likely depends on environmental factors.

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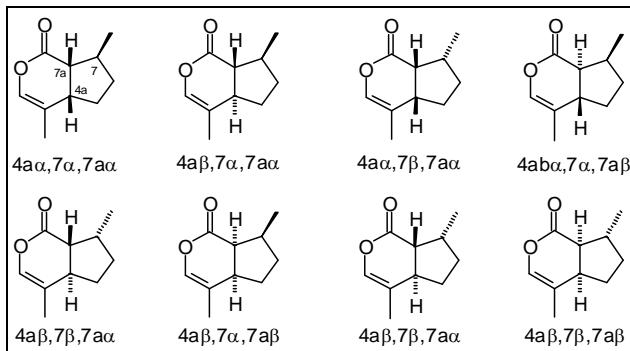


Fig 1: Possible stereoisomers of nepetalactone.

4. Biological Activities of *Nepeta* Essential Oils

4.1 Antimicrobial Activity

A *N. cataria* essential oil sample that was composed of 4aa,7a,7aβ-nepetalactone (70.4%), 4aa,7a,7aa-nepetalactone (6.0%), and 4ao,7β,7aa-nepetalactone (2.5%), was screened for antimicrobial activity against a panel of 24 bacteria and 16 fungi [13]. The oil showed excellent activity against the bacteria *Klebsiella pneumoniae*, *Bacillus macerans*, and *Staphylococcus aureus*, and the fungi *Aspergillus flavus*, *A. veriecolor*, *Fusarium solani*, *F. tabacinum*, *Rhizopus* sp., *Rhizoctonia solani*, and *Trichophyton mentagrophytes*. The essential oil of *N. crispa*, rich in 4aa,7a,7aβ-nepetalactone, showed good antimicrobial activity against *Bacillus subtilis* and *Candida albicans* [14].

Table 1: Nepetalactone stereoisomers in essential oils from different species of *Nepeta*.

Nepeta species	Country of Origin	Ref.	Nepetalactone Stereoisomer					
			4aa,7a,7aa	4aa,7a,7aβ	4aa,7β,7aa	4aa,7β,7aβ	4aβ,7a,7aβ	4aβ,7a,7aa
<i>N. cataria</i>	France	[15]	73.3	0.4	1.1			
<i>N. cataria</i>	Turkey	[13]	6.0	70.4	2.5			
<i>N. cataria</i>	Iran	[16]	31.2	55.0				
<i>N. argolica</i>	Greece	[17]	3.5-10.5	64.5-91.3				
<i>N. clarkei</i>	UK	[18]	0.8					
<i>N. crassifolia</i>	Iran	[19]	92.6	tr			0.6	tr
<i>N. crispa</i>	Iran	[14]	0.1	20.3			1.9	
<i>N. deflersiana</i>	Yemen	[20]	3.0	19.2		4.6		
<i>N. deflersiana</i>	Yemen	[20]	77.7	0.7	0.2			
<i>N. eremophila</i>	Iran	[21]	2.6				73.3	
<i>N. grandiflora</i>	UK	[18]	1.0					
<i>N. meyeri</i>	Iran	[22]	3.4	53.2				
<i>N. nuda</i>	Turkey	[23]	37.6	37.6			2.1	
<i>N. nuda</i>	Tajikistan	[24]	4.7	1.8	21.0	0.9		
<i>N. parnassica</i>	Greece	[4]	1.5	22.0		7.9		
<i>N. parnassica</i>	Greece	[4]	17.3	8.9		2.0		
<i>N. persica</i>	Iran	[25]	26.5	0.5				
<i>N. racemosa</i>	Iran	[26]	24.4	25.6			33.6	
<i>N. sintenisii</i>	Iran	[27]		1.6			23.4	

4.2 Insect Repellent / Insecticidal Activity

Of the stereoisomers present in *N. cataria*, 4aa,7a,7aβ-nepetalactone showed better insect repellent activity toward the German cockroach (*Blattella germanica*) than did the 4aa,7a,7aa-isomer, the essential oil itself, or *N,N*-diethyl-m-toluamide (DEET) [28]. House flies (*Musca domestica*), however, were more responsive to 4ao,7a,7aa-nepetalactone [29]. In addition, mosquitoes (*Culex pipiens*) showed high repellency to surfaces treated with catnip essential oil. 4aa,7a,7aβ-Nepetalactone showed insecticidal activity against *Pogonomyrmex* sp. ants [4]. Catnip oil was found to be superior to DEET as an insect repellent against the stable fly, *Stomoxys calcitrans* [30]. Schultz and co-workers found that catnip oil (55% 4aa,7a,7aa-nepetalactone, 32% 4aa,7a,7aβ-nepetalactone) showed superior six-hour repellent activity against cockroaches (*Periplaneta americana*) and better short-term repellent activity against house flies (*Musca domestica*) than DEET [31].

Catnip oil (~80% “nepetalactone”) was found to exhibit topical repellency to three species of mosquitoes (*Aedes aegypti*, *Anopheles albimanus*, and *Anopheles quadrimaculatus*), but less effective than DEET [32]. In another study, catnip oil (36% 4aa,7a,7aa-nepetalactone, 45% 4aa,7a,7aβ-nepetalactone) showed mosquito-repellent activity against *Aedes albopictus*, *Aedes aegypti*, and *Culex pipiens pallens*, with better six-hour protection than DEET [33]. Catnip oil (composition not reported) showed mosquito repellent

activity against both *Aedes aegypti* and *Anopheles harrisoni* [34]. The essential oil of *N. parnassica*, rich in 4aa,7a,7aβ-nepetalactone, showed notable mosquito repellent activity against *Culex pipiens molestus* [4]. Two different catnip oils (one with 92% 4aa,7a,7aa-nepetalactone and the other with 17.0% 4aa,7a,7aa-nepetalactone and 69.8% 4aa,7a,7aβ-nepetalactone) both showed better mosquito-repellent activity against *Anopheles gambiae* and *Culex quinquefasciatus* than DEET [35]. Interestingly, the catnip oils showed better mosquito-repellent activity than either of the purified stereoisomers alone, indicating synergistic activity between the isomers and possibly other components in the essential oils. Catnip oil has also shown repellent activity against the brown ear tick, *Rhipicephalus appendiculatus*, and the red poultry mite, *Dermanyssus gallinae* [35].

4.3 Other Bioactivities

Catnip oil has shown spasmolytic and myorelaxant activities, which may explain its traditional use in colic, diarrhea, cough, and asthma [36]. The main component of the essential oil of *N. caesarea* from Turkey was 4aa,7a,7aa-nepetalactone (92-95%) [37]. This essential oil showed significant analgesic activity, in addition to marked sedation, which was also blocked by naloxone, indicating involvement of opioid receptors. Moreover, the oil was only active on mechanical, not thermal, analgesic response which suggests selectivity for specific opioid receptor subtypes, excluding μ-opioid

receptors. *N. cataria* essential oil has shown allelopathic (phytotoxic) effects, inhibition of seed germination as well as seedling growth on several plant species (*Hordeum spontaneum*, *Taraxacum officinale*, *Avena fatua*, *Lipidium sativum*, *Nepeta cataria*, and *Ocimum basilicum*)^[16]. Thus, *N. cataria* essential oil can be considered as an allelochemical agent in formulation of natural herbicides in weed control.

5. Conclusions

Catnip (*Nepeta cataria*) essential oil shows a wide range of biological activities, not only cat stimulation, but also relaxant, antispasmodic, insect repellent, and allelopathic activities. The essential oil is generally dominated by nepetalactone isomers, but the compositions have shown wide variation depending on seasonal, environmental, and geographical factors. There are numerous *Nepeta* species known and although many of those have been characterized in terms of essential oil compositions and bioactivities, there are many more to be investigated and additional biological activities to be screened.

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