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A COMPREHENSIVE REVIEW ON PHYTOCHEMICAL CONSTITUENTS OF GENUS *NEPETA*

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ABSTRACT

Genus *Nepeta* (family *Lamiaceae*) is native to Europe, Asia, and Africa and they are commonly known as catmints. The essential oils of *Nepeta* genus are characterized by the presence of one or more of the nepetalactone isomers which are the biochemical markers of this genus. The major compounds present in the essential oils of different *Nepeta* species have been summarized in this review article.

KEYWORDS

Nepeta, Phytochemical and Aromatic.

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INTRODUCTON

Lamiaceae-the 'mint family'-is cosmopolitan with Mediterranean as the chief centre of distribution. The family comprises a total of 180 genera and 3500 species. Harley *et al.* recognize 236 genera and 7200 species[1], and Heywood *et al.* assign 6900 species[2]. In India, the family is represented by 67 genera and 405 species distributed mainly in mountainous regions. The members of the family are characterized by the quadriangular stem, verticillaster inflorescence, bilipped flowers, gynobasic style, deeply 4-lobedovary and aromatic nature. Kashmir Himalaya is located in the north western extreme of the Himalayan biodiversity hotspot and contributes nearly 20% species within

just 2.15 % of the total land area of entire Himalaya[3]. This region is a hub of medicinal and aromatic plants, most of which flourish in the sub-alpine/alpine mountainous region. Lamiaceae is widely used in traditional systems of medicine and horticulture. The genus is native to Europe, Asia, and Africa and they are commonly known as catmints. The essential oils of Nepeta genus are characterized by the presence of one or more of the nepetalactone isomers which are the biochemical markers of this genus. Several species of the genus *Nepeta* have interesting biological activities and are used in traditional system of medicine as laxative to treat dysentery, kidney and liver diseases and teeth troubles; they are also used as diuretic, diaphoretic, vulnerary, antispasmodic, antiasthmatic, tonic, febrifuge and sedative agents[4-7]. Several *Nepeta* species are also reported to reduce serum lipids and anti-inflammatory effects[8,9].

Most *Nepeta* species are rich in essential oils and various biologically active iridoids/monoterpene nepetalactones have been reported in several *Nepeta* species possessing diverse biological activities, viz., feline attractant, canine attractant, insect repellant and arthropod defense[10,11]. Some specific reports on medicinal properties of Labiates include antitumour and anti-inflammatoryactivity[12], antioxidant activity[13], anticancer activity[14] and antibacterial activity[15]. In Kashmir Himalaya, Lamiaceae is the second largest gamopetalous family with 32 genera and 88 species[3].

The Key compounds[16] i.e, one or more of the nepetalactone isomers which are the biochemical markers of this genus, some major compounds present in the essential oils of few species and some major compounds present in few common Himalayan species are summarized in the tables below,

Table No.1: Species which contained nepetalactone as principal constituents

S.No	Species	Principal Compounds	Ref.
1	*N. sintenissii*	4aβ, 7α, 7aα-nepetalactone; 1, 8-cineole; β-elemene/ β-elemol; (Z)-β-farnesene/farnesol; germacrene-D; α-terpineol/4-Terpineol; 4aα, 7α, 7aα-nepetalactone,	17
2	*N. racemosa*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; 4aα, 7α, 7aα-nepetalactone,	18
3	*N. assurgens*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 1, 8-cineole; α-pinene/ β-pinene; O: α-terpineol/4-Terpineol; 4aα, 7α, 7aα-nepetalactone	19
4	*N. cadmea*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aα-nepetalactone,	20
5	*N. caesarea*	4aα, 7α, 7aα-nepetalactone	21, 22
6	*N. cephalotes*	4aα, 7α, 7aα-nepetalactone; 1, 8-cineole; α-pinene/ β-pinene; 4aα, 7α, 7aα-nepetalactone,	23, 24
7	*N. crassifolia*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aα-nepetalactone,	25
8	*N. x faassenii*	4aα, 7α, 7aα-nepetalactone; 4aα, 7β, 7aβ-nepetalactone/4aα, 7β, 7aα-nepetalactone; 1, 8-cineole; germacrene-D; α-pinene/ β-pinene; 4aα, 7α, 7aα-nepetalactone,	26
9	*N. govaniana*	4aα, 7α, 7aα-nepetalactone; β-elemene/ β-elemol; germacrene-D	27
10	*N. mirzayanni*	4aα, 7α, 7aα-nepetalactone; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide; 4aα, 7α, 7aα-nepetalactone	24
11	*N. persica*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aα-nepetalactone	28
12	*N. racemosa*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone	29
13	*N. teydea*	4aα, 7α, 7aα-nepetalactone; α-pinene/ β-pinene; α-terpineol/4-Terpineol	30
14	*N. argolica ssp*	4aα, 7α, 7aβ-nepetalactone; 4aα, 7α, 7aα-nepetalactone,	31
15	*N. atlantica*	4aα, 7α, 7aβ-nepetalactone; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide; (Z)-β-farnesene/farnesol; 4aα, 7α, 7aα-nepetalactone	32
16	*N. cataria*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aα, 7β, 7aβ-nepetalactone/ 4aα, 7β, 7aα-nepetalactone; 1, 8-cineole; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide; limonene/ linalool; 4aα, 7α, 7aα-nepetalactone	32, 33, 34

17	*N. coerulea*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; 4aβ, 7α, 7a β-nepetalactone	35
18	*N. granatensis*	4aα, 7α, 7aβ-nepetalactone; 1, 8-cineole; α-pinene/ β-pinene; 4aα, 7α, 7aα-nepetalactone	32
19	*N. meyeri*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aα, 7α, 7aα-nepetalactone	36
20	*N. nuda*	4aα,7α,7aα-nepetalactone; 4aα,7α,7aβ-nepetalactone; 1, 8-cineole; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide	37, 38
21	*N. nepetella*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone	35
22	*N. racemosa*	4aα, 7α, 7aβ-nepetalactone	39
23	*N. rtanjensis*	4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; germacrene-D; α-pinene/ β-pinene; 4aα, 7α, 7aα-nepetalactone	40, 41
24	*N. septemcrenata*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 1, 8-cineole; β-elemene/ β-elemol; limonene/ linalool; α-terpineol/4-Terpineol; 4aα, 7α, 7aα-nepetalactone	42
25	*N. transcaucasica*	4aα,7α,7aα-nepetalactone; 4aα,7α,7aβ-nepetalactone; germacrene-D; 4aα,7α,7aα-nepetalactone	43
26	*N. tuberose*	4aα, 7α, 7aβ-nepetalactone; 1, 8-cineole; 4aα, 7α, 7aα-nepetalactone,	32
27	*N. bornmuelleri*	4aβ, 7α, 7aα-nepetalactone; 1, 8-cineole; 4aα, 7α, 7aα-nepetalactone,	24
28	*N. eremophila*	4aβ, 7α, 7aα-nepetalactone; 1, 8-cineole; 4aα, 7α, 7aα-nepetalactone,	44
29	*N. persica*	4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; α-pinene/ β-pinene	45
30	*N. saccharata*	4aβ, 7α, 7aα-nepetalactone; germacrene-D; 4aα, 7α, 7aα-nepetalactone	46
31	*N. argolica*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; 4aβ, 7α, 7aβ-nepetalactone	47
32	*N. grandiflora*	4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aβ-nepetalactone	48
33	*N. kotschyi*	4aβ, 7α, 7aβ-nepetalactone; 1, 8-cineole; 4aα, 7α, 7aα-nepetalactone	49
34	*N. crassifolia*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aβ, 7α, 7aα-nepetalactone; 4aα, 7β, 7aβ-nepetalactone/4aα, 7β, 7aα-nepetalactone; 1, 8-cineole	50
35	*N. betonicifolia*	4aα, 7β, 7aβ-nepetalactone/4aα, 7β, 7aα-nepetalactone; 1, 8-cineole; germacrene-D; 4aα, 7α, 7aα-nepetalactone	46
36	*N. crassifolia*	4aα, 7α, 7aα-nepetalactone; 4aα, 7β, 7aβ-nepetalactone/4aα, 7β, 7aα-nepetalactone	34
37	*N. nuda*	4aα, 7β, 7aβ-nepetalactone/4aα, 7β, 7aα-nepetalactone; β-elemene/ β-elemol; germacrene-D	51
38	*N. angustifaliathe*	nepetalactone/ epinepetalactone; 4aα, 7α, 7aα-nepetalactone	52
39	*N. cataria*	nepetalactone/ epinepetalactone; 1, 8-cineole; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide; β-elemene/ β-elemol; (Z)-β-farnesene/farnesol; germacrene-D; limonene/ linalool; α-pinene/ β-pinene; α-terpineol/4-Terpineol; 4aα,7α,7aα-nepetalactone	53, 59
40	*N. mahanensis*	nepetalactone/ epinepetalactone; 1, 8-cineole; germacrene-D; 4aα, 7α, 7aα-nepetalactone	44
41	*N. nepetella*	nepetalactone/ epinepetalactone	54
42	*N. tuberosa*	5, 9-dehydronepetalacone/ (7R)-trans,trans-nepetalactone; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide	55
43	*N. cataria*	5, 9-dehydronepetalacone/ (7R)-trans,trans-nepetalactone; 4aα, 7α, 7aα-nepetalactone	56
44	*N. ellptica*	5, 9-dehydronepetalacone/ (7R)-trans, trans-nepetalactone;	57
45	*N. parnassica*	4aα, 7α, 7aα-nepetalactone; 4aα, 7α, 7aβ-nepetalactone; 4aα, 7β, 7aβ-nepetalactone/ 4aα, 7β, 7aα-nepetalactone; 1, 8-cineole; (E or Z) α or β-caryophyllene/ β-caryophyllene oxide; α-pinene/ β-pinene; α-terpineol/ 4-Terpineol; 4aα, 7α, 7aα-nepetalactone	58
46	*N. mussini*	nepetalactone/ epinepetalactone	59

Table No.2: Major compounds present in the essential oils of few *Nepeta* species

S.No	Species Name	Major compounds with percentage				
1	*N. atlantica*	4aa, 7a, 7a-nepeta1actone (71.4%)	dihydronepetalactone (45) (3.1%)	3-caryophyllene (8.2%)	farnesol (48) (2.5%)	a-curcumene (50) (1.3%)
2	*N. cataria*	4aa, 7a, 7a-nepeta1actone (77.4%)	dihydronepetalactone (5.0%)	terpinene (46) (4.2%)	limonene (4.1%)	Thymol (1.3%)
3	*N. granatensis*	4aa, 7a, 7a-nepeta1actone (39.4%)	eucalyptol (1, 8-cineole) (24.0%)	a-pinene (6.3%)	a-phellandrene (49) (5.8%)	p-cymene (51) (3.8%)
4	*N. tuberose*	4aa, 7a, 7a-nepeta1actone (76.8%)	dihydronepetalactone (5.9%)	menthol (47) (1.6%)	a-pinene (1.3%)	eucalyptol (1, 8-cineole) (1 .2%)

Table No.3: Major compounds present in some common Himalayan *Nepeta* species

S.No	Species Name	Major compounds with percentage
1	*N. clarkei*	a-guaiene (82) (10.0%); germacrene D (13.0%); fl-sesquiphellandrene (22.0%) indodialJ?-monoenol acetate diastereomers (25.3%)
2	*N. discolor*	p-cymene (9.8%); fl-caryophyllene (18.6%); 1, 8-cineole (25.5%)
3	*N. elliptica*	(7R)-trans, trans-nepetalactone (83.4%)
4	*N. erecta*	*isoiridomyrmecin* (66.7%)
5	*N. govaniana*	pregeijerene (20.7%); isoiridomyrmecin (35.2%)
6	*N. leucophylla*	iridodial dienol diacetate (83) (7.8%); dihydroiridodial diacetate (84) (18.2%) indodial J?-monoenol acetate (25.4%)

CONCLUSION

The composition of the essential oil has been varying according the region, soil type and environmental condition from where the plant species have been collected[60,61]. It has been found from the literature that the most of species growing in the Himalayas region have compounds other than nepetalactone as major constituents in their essential oils as compare to the species growing in other part of the world (Iran, Tehran, Serbia, Egypt, Turkey, Brazil, USA etc.), which have both nepetalactone along with its derivatives and other than nepetalactone compounds as the major ingredient of their essential oils. The essential oil isolated from different plant parts viz. stem, leaves, flowers (fresh or dry) collected at different age and vegetative cycle stage have no major effect on the composition of the oil. It has been also found from the literature that the oil of different species of *Nepeta* have been mostly isolated from aerial parts mainly collected during full flowering stage with hydrodistillation using Clevenger type apparatus gives good results. For the sustainable growth and development, a gradual shift from the use of synthetic drugs and agrochemicals to the natural ones have been witnessed as the latter have proven to be non-toxic, cheap and easily available. Active ingredients isolated from genus *Nepeta* has been reported to show wide array of biological activity in medicinal and agriculture field. Depending upon the multiple uses of secondary metabolites obtained from genus *Nepeta*, their structure-activity relationship and activity screening goes unabated. The present review would be supportive in the enhancement of today's research in the development of new biologically potent compounds derived from plants which would find many applications in medicinal and agricultural fields.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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