SPATIAL DISTRIBUTION PATTERNS OF TROPICAL LAMIACEAE AND THEIR RELATIONSHIP WITH MICROHABITAT VARIABLES

MERUGU RAMULU
Research Scholar
Shri JJT University
Rajasthan

DR. DINESH KUMAR SINGH
Guide
Shri JJT University
Rajasthan

ABSTRACT

The study also evaluates anthropogenic pressures affecting these species and proposes recommendations for their conservation and sustainable utilization. Tropical Lamiaceae species demonstrate remarkable ecological plasticity, allowing them to thrive in diverse environmental conditions ranging from humid rainforests and tropical deciduous forests to scrublands and montane ecosystems. These species contribute substantially to ecological stability, biodiversity conservation, ethnobotanical value, and pharmaceutical research. The present study investigates the ecological characteristics, adaptive strategies, habitat associations, and functional roles of tropical Lamiaceae species, with a focus on understanding their distribution patterns, environmental preferences, and interactions within tropical landscapes. Their characteristic morphological traits—square stems, glandular trichomes, and aromatic essential oils—not only help in reducing herbivory and water loss but also contribute to species interactions with pollinators and other organisms. Many genera such as Ocimum, Pogostemon, Leucas, Coleus, Vitex, and Hyptis exhibit strong associations with insect pollinators, especially bees and butterflies, thereby playing an essential role in maintaining pollination networks in tropical regions.

Keywords: *Tropical Lamiaceae, tropical landscapes, ecological plasticity, glandular trichomes, Pogostemon, tropical regions.*

INTRODUCTION

The Lamiaceae family is very abundant in medicinal plants that have beneficial effects on a variety of illnesses. Traditional Moroccan medicine made use of many species in this family to alleviate diabetes. Only three species were studied for their in vivo antidiabetic activity in the in vivo studies: Origanum vulgare, Calamintha officinalis, and Ajuga iva. Streptozotocin (STZ)-induced diabetic rats had a significant antidiabetic effect when given an oral dosage of 20 mg/kg of aqueous extract of Origanum vulgare leaves, which did not alter baseline plasma insulin concentrations. The antidiabetic effects of an aqueous extract from the entire Ajuga iva plant were investigated in rats with and without streptozotocin diabetes. The mild and temperate Holarctic area is home to around 3500-4000 species of plants that belong to the Lamiaceae family. Shrubs and annual or perennial herbs make up the bulk of these plants. The quadrangular stems have opposing and decussately placed leaves. The margins might be whole or split, and the leaves tend to be simple. Axillary cymes or terminal spikes hold the zygomorphic flowers, which have a distinctive bilabiate shape. Both the calyx and the corolla are symmetrical. Typically, there are four stamens and they are didynamous, meaning they are specialized for pollination by insects. In the genus Salvia, there are only two stamens. A gynobasic style and an ovary that is superior to the other carpel nectaries. Four nutlets make up the schizocarp fruit. Many species of Lamiaceae are able to pollinate one another because of their unique flower shapes. The flowering plant family Lamiaceae, often called Labiatae, includes species such as mint, deadnettle, and sage.

LITERATURE REVIEW

Milana Ranimirovic et.al. (2025) There is a 62-name nomenclatural summary of the Stachys recta group provided. We provide nomenclatural remarks for 23 names in the S. recta group that have not been characterized yet, and we recap prior typifications and holotype citations for 10 names. For one name, a second-step typification is suggested. The source material could not be located for 28 names. A neotype was proposed for S. recta and lectotypes are proposed for: Betonica annua var. hirsuta, S. albanica, S. arenariiformis, S. beckeana, S. fragilis f. serpentini, S. labiosa var. sarajevensis, S. linearifolia, S. parolinii, S. petrogena, S.recta subsp. baldaccii, S. r. subsp. b. var. chrysophaea, S.r.sub s p. doerfleri, S. r. subsp. labiosa, S. r. subsp. olympica, S. r. subsp. Rhodo paea, S. r. subsp. subcrenata, S. sendtneri, S. serpentini, S. sideritis, S. steno phylla,S. tetragona, S. zepcensis.

Dr. Jyoti Uikey et al. (2024) A varied collection of plants with great cultural, economic, and ecological significance make up the Lamiaceae family, sometimes called the mint family. All things pertaining to plants in the Lamiaceae family are covered extensively in this study. We investigate the Lamiaceae family of plants by looking at its taxonomy, morphology, ecological relevance, phytochemistry, cultural value, economic importance, and conservation status and dangers. We also emphasize the function of Lamiaceae in ecosystems across the globe and talk about their variety, evolution, and distribution. This study seeks to deepen our comprehension of the Lamiaceae family and its significance in several domains, such as medicine, agriculture, horticulture, and conservation, by combining current literature and research results.

Mei-Lin Qian et.al. (2024) The Leonureae tribe is one of the most physically varied in the Lamiaceae subfamily Lamioideae, with over 80 species distributed among six genera: Leonurus, Lagopsis, Panzerina, Lagochilus, Chaiturus, and Loxocalyx. Due to inadequate sampling and DNA markers, the relationships between and within the genera Leonurus and Lagopsis are still unknown, and prior research has shown that these two taxa are not monophyletic. Here we provide the most extensive phylogenomic analysis of Leonureae to date, using next-generation sequencing data at 127 nuclear loci and whole plastome sequences. Our findings strongly support the idea that Leonureae are monophyletic and may be further subdivided into six main clades. Our results corroborate those of earlier research showing that the hitherto recognized taxa Leonurus and Lagopsis should not be considered monophyletic. Based on morphological evidence and molecular phylogenetic data, we propose a new genus Paraleonurus and six novel combinations.

Nasirkandi, Atefeh Moshari, et al. (2023) Numerous plants of the Lamiaceae family are highly prized for their uses in food, medicine, and cosmetics. We conducted a thorough evaluation of 20 species from the Lamiaceae family—Phlomis herba-venti, P. tuberosa, P. olivieri, P. kurdica, Nepeta sp., N. cataria, N. saccharata, Stachys sp., S. inflata, Scutellaria albida, Marrubium parviflora, Mentha pulegium, Thymus kotschyanus, Lamium album, Salvia officinalis, S. multicaulis, S. macrochlamys, S. candidissima, S. verticillata, and S. nemorosa. The antioxidant capacity, total phenolic content,

total flavonoid content, total tannin content, ascorbic acid content, and polyphenolic components were all measured in the aerial sections of these species using FRAP and DPPH tests, respectively.

Santos, Lizandra et al., (2022) A growing number of people across the globe are turning to the age-old tradition of using medicinal plants to cure a wide range of medical conditions. Dengue, yellow fever, Zika, and chikungunya are some of the so-called neglected illnesses that have impacted and killed millions of people. These diseases are spread by the Aedes aegypti mosquito. In this setting, herbal remedies with insecticidal, larvicidal, and repellant properties emerge as an alternative to naturally occurring chemicals used for pest management. The current study's overarching goal is to compile a literature review of recent efforts pertaining to the Lamiaceae family that could lead to the creation of herbal remedies for the management of diseases caused by the Aedes aegypti mosquito, with a focus on technological advances that show promise as a repellent, insecticide, and larvicide.

Order of the Lamiales: An Introduction

Hutchinson classifies these plants as belonging to the Herbaceae division, subphylum Dicotyledones, and the Angiospermae phylum, specifically order eighty-second. Labiatae is one of four families that make up this order; the others are Myoporaceae, Selaginaceae, Globulariaceae, and this page focuses on the Labiatae. In the tenth order of the Lamiales, of class Dicotyledones, division Gamopetalae and series Bicarpellatae, Bentham and Hooker have positioned the Labiatae with three other families, one of which being Verbenaceae. According to Engler and Prantl, the Labiatae are one of nineteen families in the sixth order of the Tubiflorae, which is part of the Dicotyledoneae class and subclass Sympetalae. The other families included include Convolvulaceae, Verbenaceae, Solanaceae, Scrophulariaceae, Pedaliaceae, Acanthaceae, etc. The plant often has opposite or whorled leaves, a zygomorphic corolla, four or two stamens, an ovary that becomes lobed with a gynobasic style, and ovules that are typically paired. The majority of the plant is herbaceous, and the flowers are either capitula or verticilllasters. Plants of the Lamiaceae family, commonly known as mints, have an extensive and varied phytochemistry that includes many bioactive chemicals with different aromatic, medicinal, and culinary uses.

Plant Taxonomy and Plant Classification: Lamiaceae

Lamiaceae: A System for Botanical Classification The mint family, Lamiaceae, is arranged in botanical taxonomies according to the hierarchical taxonomic system that was developed by botanists to organize and categorize plant species according to their physical traits and evolutionary connections. The botanical taxonomy of the Lamiaceae family is summarized below.

Lamiaceae are members of the Plantae kingdom, which includes all multicellular, photosynthetic creatures such as plants, algae, and even certain fungus.

The Magnoliophyta division, which includes the Lamiaceae family, is comprised of angiosperms, or flowering plants. The fruit-encased flowers and seeds are the defining features of the angiosperm kingdom.

A family of plants known as Magnoliopsida, also called dicots or just

dicots, includes the Lamiaceae. Two cotyledons, or seed leaves, net-veined leaves, and four or five flower parts are hallmarks of dicotyledonous plants.

The Cultural and Economic Value of Lamiaceae Species

The plants belonging to the Lamiaceae family are very important to many different businesses and ways of life across the world. Herbs from the Lamiaceae family, which includes mint, basil, rosemary, and thyme, are highly esteemed in the culinary world for their fragrant qualities and adaptability, which elevate the flavor of innumerable meals in cuisines all over the globe. Traditional medicine systems also make extensive use of Lamiaceae plants due to their high regard for its therapeutic and medicinal qualities. The aromatic and perhaps medicinal properties of essential oils derived from Lamiaceae plants have made them popular in the cosmetics, aromatherapy, and perfumery sectors. Additionally, these plants are very significant in cultural rites and customs, representing wealth, innocence, and safety in different communities. Lamiaceae plants have been used and are significant in both contemporary and traditional settings due to their economic and cultural relevance.

Physical Features of Plants in the Lamiaceae Family

The mint family, or Lamiaceae, is characterized primarily by morphological traits that are used for taxonomy and identification purposes. Many characteristics set Lamiaceae species apart from those of other plant families, which is a taxonomic category in and of itself. One distinguishing feature is the existence of square stems, which is rather noticeable. As a dependable diagnostic indicator, these stems are often seen in immature shoots and are the product of a specific arrangement of vascular bundles. The opposing arrangement of the leaves along the stem is a characteristic feature of Lamiaceae plants. Essential oils provide herbs like mint, basil, and sage their unique aromas and tastes; they are also responsible for the noticeable fragrant quality of the leaf of many Lamiaceae species. Lamiaceae flowers have a bilabiate corolla with two separate lips, and the fruits are usually tiny, dry nutlets that are contained in a persistent calyx. The variety and ecological value of Lamiaceae plants are enhanced by these physical traits when taken as a whole.

RESEARCH METHODOLOGY

Phytochemistry is the subfield that studies the chemical composition of plants and plant-based products. Medicinally active chemical substances are abundant in plants. The term "phyto constituents" or "phytochemicals" describes the bioactive substances found in plants. Naturally occurring substances that aid in plant physiology; they include secondary metabolites such as alkaloids, flavonoids, phenols, triterpenoids, glycosides, and essential oils. In addition to this, humans also eat proteins, carbs, and fats. A comprehensive investigation of any crude medicine should include the research of both the main and secondary metabolites found in plants. There are a number of medicinal uses for the phenolic chemicals found in the Lamiaceae family, which include terpenoids. Plants belonging to the Lamiaceae family are those that have medicinal uses. Due to their shown positive effects on human health in different formulations, those plants have garnered a great deal of interest. They have been studied extensively as potential alternatives to manufactured drugs in the treatment of

several illnesses because to their unique natural antibacterial, antioxidant, antifungal, anticancer, and anti-inflammatory properties. Nevertheless, studying the phytochemical properties of plant material is the first step in identifying the active biological component of any plant. To determine the profile of an extract in terms of its chemical composition, nature, and relationship to antioxidant activity, this research will use qualitative phytochemical testing.

RESULTS AND DISCUSSIONS

An important part of the Lamiaceae family, the genus Ocimum has been around for a long time and is known for its powerful use as culinary herbs to provide a fantastic taste to a wide variety of dishes. One member of this genus, Ocimum americanum L., often known as American basil, has a lot of antioxidant claims made about it. Therefore, the plant's antioxidant characteristics were assessed, and it was shown that the extract obtained with 100 µg/ml ethanol had the greatest DPPH scavenging activity, followed by the extract produced with 75 µg/ml ethanol. The results from the scavenging activity were 85.39 ± 0.54% and 86.67 ± 0.39%, as shown in Table 1.

Table 1: Ocimum americanum L.'s antioxidant activity

Plant Extract µg/ml	Antioxidant activity (%) by DPPH assay				
	PE	CH	AC	ET	WR
25	41.80+0.98	30.89+0.69	14.15+0.28	35.85+0.45	38.81+0.69
50	49.60+0.85	47.09+0.12	34.70+0.97	62.45+1.58	48.18+0.57
75	53.45+1.09	67.30+1.45	52.08+0.65	85.39+0.54	57.25+1.47
100	61.65+0.71	77.11+0.93	57.47+1.34	86.67+0.39	67.34+0.51
Antioxidant activity (%) by ABTS assay					
	PE	**CH**	**AC**	**ET**	**WR**
25	32.24+1.34	33.95+0.62	42.48+0.45	52.52+0.42	52.19+0.90
50	41.67+0.39	47.19+0.25	57.48+0.58	75.81+0.13	71.67+0.24
75	61.29+0.41	60.52+0.42	74.00+0.58	81.33+0.77	81.00+0.35
100	69.14+0.41	71.62+0.50	83.57+0.65	92.19+0.39	91.38+0.51
Antioxidant activity µM (Fe II)/g by FRAP assay					
	PE	**CH**	**AC**	**ET**	**WR**
25	227.17+0.56	224.94+1.47	281.61+2.42	538.28+2.00	398.28+2.42
50	319.39+1.96	332.17+2.5	368.28+2.42	733.83+2.55	467.17+1.67
75	389.94+2.14	391.06+1.4	452.72+2.42	898.83+2.89	564.39+2.00
100	530.50+0.96	451.06+1.11	555.50+2.55	932.17+1.95	703.83+1.92

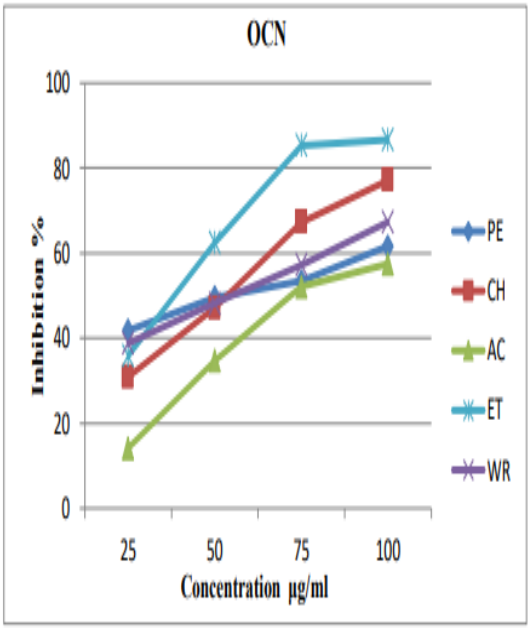
In addition, it is evident from Graph 1 that the extract produced with 25 µg/ml of acetone had the lowest DPPH scavenging activity, measuring 14.15 ± 0.28%. Likewise, according to Table 1, the scavenging activity of the plant species was found to be 92.19+0.39% in the ABTS test

when the extract was prepared using 100 µg/ml ethanol, followed by 91.38+0.51 % when the extract was prepared using 100 µg/ml water.

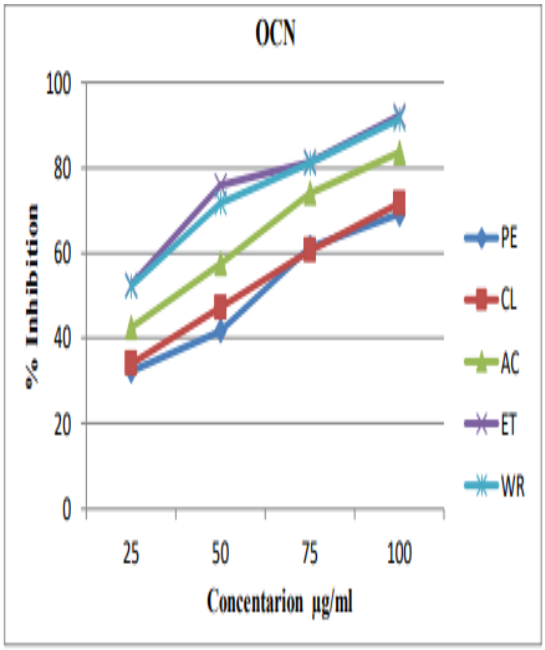
Table 2: IC50 value of Ocimum americanum L.

Assay	IC50 value (ug/ml) of *Ocimum americanum* L.					
	PE	CH	AC	ET	WR	AA
DPPH	56.09	53.61	80.15	37.43	54.69	6.12
ABTS	60.42	44.05	36.78	11.37	15.11	6.31

The extract generated by adding 25 µg/ml of petroleum ether had the lowest scavenging activity by ABTS, measuring 32.24+1.34% (Graph. 2). Once again, with a FRAP value of 932.17+1.9 µM (Fe II)/g and 898.83+2.89 µM (Fe II)/g, respectively, the antioxidants with the highest reducing activity were those whose extracts were produced using 100 µg/ml ethanol and 75 µg/ml ethanol, as shown in Table 1.



Graph 1: Radical scavenging activity (%) of Ocimum americanum L. by DPPH assay



Graph 2: Radical scavenging activity (%) of Ocimum americanum L. by ABTS assay

CONCLUSIONS

Research into the ecology of tropical Lamiaceae species has shown the intricate web of relationships that exists among plant variety, climate, and ecological stability. One of the most interesting and ecologically important groups of blooming plants in tropical and subtropical areas is this family, which is sometimes called the mint family. The key importance of Lamiaceae members in ecosystems and human livelihoods is highlighted by this study's examination of their distribution, adaptive features, reproductive ecology, and function within different habitats. Lamiaceae species, which are native to tropical regions, are very adaptable and may establish themselves in a wide variety of habitats, including wet deciduous woods, dry evergreen forests, grasslands, and disturbed areas. Holiest basil, patchouli, Hyptis suaveolens, Clerodendrum inerme, and Leucas aspera are only a few of the species that can adapt to a wide range of edaphic and climatic circumstances. The

morphological and physiological traits that contribute to their adaptation include square stems, fragrant essential oils, glandular trichomes, and opposite phyllotaxy. These traits help with photosynthetic efficiency, herbivore deterrent, and moisture retention. Both the survival of specific species and the maintenance of ecological harmony in their natural environments are supported by these adaptive methods.

REFERENCES

1. *Milana Ranimirovic et.al (2025), "Nomenclatural notes and typification of the names related to Stachys recta group (Lamiaceae)", phytotaxa ISSN No:1179-3163, Vol. 693, Issue No. 1, Page: 33-54, Doi: 10.11646/ Phytotaxa.693.1.2.*
2. *Dr Jyoti Uikey et.al (2024), "Reviewing of Plant Belonging to Lamiaceae Family" International Journal of Scientific Development and Research (JSDR), ISSN no. 2455-2631, Vol.9 (issue no 3).*
3. *Mei-Lin Qian et.al (2024), "Phylogenomics of the tribe Leonureae reveals a new genus: Paraleonurus (Lamiaceae, Lamioideae)", Turkish Journal of Botany ISSN No:1303-6106, Vol. 48, DOI:10.55730/1300-008X.2825.*
4. *Atefeh Moshari Nasirkandi et.al (2023), "Screening Of 20 Species from Lamiaceae Family Based on Phytochemical Analysis, Antioxidant Activity and HPLC Profiling" Scientific Reports ISSN no 2045-2322 Vol. 13(issue no 1), DOI:10.1038/s41598-023-44337-7.*
5. *Lizandra Santos et.al (2022), "The Potentiality of Plant Species from The Lamiaceae Family for The Development of Herbal Medicine in The Control of Diseases Transmitted by Aedes Aegypti" Pharmacognosy Reviews ISSN no: 0976-2787, Vol 16 (issue no 31), page no 40-44 DOI:10.5530/phrev. 2022. 16.7.*
6. *Tomás Rodríguez-Riaño et.al (2007), "Pollen–Stigma Interference in Two Gynodioecious Species of Lamiaceae with Intermediate Individuals", Annals of Botany ISSN No 1095-8290, Volume 100, Issue 2, Pages 423–431, https: //doi.org/ 10.1093/aob/mcl168.*
7. *Tuncay Dirmenci et.al (2024), "The Lamiaceae Family: Biodiversity and Uses", Records of Agricultural and Food Chemistry, ISSN no: 2792-0763 Issue: 3, http: //doi.org/10.25135/rfac.2024.3rd.3112.*
8. *V. Gobert, S. Moja, M. Colson and P. Taberlet et.al (2002),"Hybridization in the Section Mentha (Lamiaceae) Inferred from AFLP Markers", American Journal of Botany ISSN No:1537-2197, Vol. 89, Issue No. 12, pp. 2017-2023 (7 pages).*
9. *Yan -Wen Zhang et.al (2007), "Nectar Robbing of a Carpenter Bee and Its Effects on The Reproductive Fitness of Glechoma Longituba (Lamiaceae)", Plant Ecology ISSN NOo: 1573-5052, Volume 193, pages 1–13.*
10. *Yasaman Salmaki et.al (2013) "Molecular Phylogeny of Tribe Stachydeae (Lamiaceae Subfamily Lamioideae)", Molecular Phylo genetics and Evolution ISSN No:1095-9513, Volume 69, Issue 3, Pages 535-551, https://doi.org/10. 1016/j.ympev.2013.07.024*