



**International Journal of Biology, Pharmacy  
and Allied Sciences (IJBPAS)**

*'A Bridge Between Laboratory and Reader'*

[www.jibpas.com](http://www.jibpas.com)

---

---

**SWEET BASIL (*OCIMUM BASILICUM* L.): A REVIEW ON ECOLOGY,  
MORPHOLOGICAL DESCRIPTIONS, ETHNOMEDICINAL IM-  
PORTANCE, PHARMACOLOGICAL ANALYSIS AND INDUSTRIAL  
PROSPECTIVE**

**KUMARI N<sup>1</sup>, KHANDURI S<sup>2</sup> AND SINGH M<sup>3\*</sup>**

- 1:** Research Scholar, Department of Botany, School of Basic and Applied Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun (248001) Uttarakhand, India
- 2:** Research Scholar, Department of Botany, School of Basic and Applied Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun (248001) Uttarakhand, India
- 3:** Corresponding Author, Professor, School of Basic and Applied Sciences, Shri Guru Ram Rai University Patel Nagar, Dehradun (248001)

**\*Corresponding Author: Dr. Maneesha Singh: E Mail: [maneeshasingh@sgrru.ac.in](mailto:maneeshasingh@sgrru.ac.in)**

Received 19<sup>th</sup> Nov. 2023; Revised 18<sup>th</sup> Dec. 2023; Accepted 12<sup>th</sup> May 2024; Available online 1<sup>st</sup> Feb. 2025

<https://doi.org/10.31032/IJBPAS/2025/14.2.8742>

**ABSTRACT**

*Ocimum basilicum* L., an annual plant, is widespread in natural habitats across tropical, subtropical, and temperate regions globally. Belonging to the Lamiaceae family, it harbors a diverse array of medicinally significant constituents. Commonly cultivated in households, basil is a prevalent herb known for its versatile therapeutic properties. The predominant chemical constituents responsible for the therapeutic properties of sweet basil include linalool, eugenol, 1,8-cineone, methyl eugenol, and anthocyanin. This comprehensive review aims to offer insights into the ecology, morphology, active chemical components, ethnomedicinal significance, pharmacological analysis, and details of companies engaged in manufacturing basil products worldwide.

In the future, scientists envision the possibility of developing transgenic basil plants to address

---

environmental stress and focus on specific chemical constituents known for their effectiveness in treating various human ailments.

**Keywords:** *Ocimum basilicum* L., Chemical Constituents, Pharmacological Analysis, Ecology, Ethnomedicine

## INTRODUCTION

The Lamiaceae (Labiatae) family, a significant group of angiosperms, occupies a variety of ecosystems and boasts extensive diversity, exhibiting a global distribution [1]. The family's predominant aromatic quality arises from secondary metabolites, including monoterpenes, sesquiterpenes, and phenylpropanoids, found in the majority of its members [2]. The Lamiaceae family is widely distributed in both temperate and tropical regions, with a primary concentration in the Mediterranean area. It encompasses approximately 200 genera and 3,200 species across the globe [3]. The defining traits of the Lamiaceae family include a square stem, opposite and decussate leaves, along with strongly zygomorphic flowers characterized by two distinct lips and numerous gland dots. Plants belonging to this family hold significant value in various industries such as food, cosmetics, flavoring, fragrance, perfumery, pesticides, and pharmaceuticals. Due to their diverse applications, Lamiaceae plants are extensively cultivated and are considered an essential source of functional food [4].

*Ocimum*, a prominent genus within the Lamiaceae family, originates from India, Southern Asia, and the Middle East. With approximately 150-160 species, this genus exhibits widespread distribution in warm regions across the globe. Its cultivation is extensive in Southern, Central, and Eastern Europe, as well as North Africa and the USA, specifically in California. The genus holds paramount economic significance, serving as a vital source of volatile aromatic oils, medicinal compounds, and ornamental plant [1, 4]. These *Ocimum* species thrive in diverse soil and climatic conditions, resulting in variations in their growth habits, physiological appearances, and chemical compositions, including aromatic constituents. The various *Ocimum* species manifest in distinct forms, spanning from herbs to sub-shrubs, showcasing numerous morphological differences such as leaf shape, size, trichome, glands, and other peculiarities. Notably, these species serve as excellent reservoirs of essential oils extensively employed for pharmacological applications, encompassing antimicrobial, antioxidant, antifungal, and anti-inflammatory activities [2].

*Ocimum basilicum* L., a species within the *Ocimum* genus, possesses diverse potent activities attributed to its metabolites. Commonly referred to as sweet or French basil, this particular species is recognized for its versatile attributes [5].

It has a rich history as a traditional remedy for a wide range of conditions, including cancer, convulsions, deafness, epilepsy, gout, impotence, insanity, hiccups, nausea, sore throat, diarrhea, toothaches, and whooping cough [6]. With the highest market demand among various species and chemotypes, *Ocimum basilicum* L. is commercially cultivated in various nations, including India, France, Morocco, and Italy. In the Mediterranean region, infusions of basil are widely employed as a traditional medicine to reduce plasma lipid levels [7, 8]. This exhaustive review delves into the nuanced aspects of sweet basil, encompassing its ecology and morphology. The paper meticulously explores the active chemical constituents of basil, shedding light on their ethno-medicinal significance and pharmacological activities. Additionally, it delves into the traditional therapeutic uses of sweet basil, offering insights into its historical applications. Furthermore, the review provides details on companies engaged in the manufacturing of basil products.

### **Ecology and Morphological Description-**

Basil is well-known for its adaptability to various temperature ranges and geographic locations, rendering it a widely cultivated herb worldwide [9]. The *Ocimum* genus, a member of the Lamiaceae (Labiatae) family, is distributed across tropical and subtropical regions in the continents of America, Africa, and Asia [10]. While commonly cultivated as a garden herb, basil likely originated in Asia and Africa. Historical records suggest that Alexander the Great introduced basil from India to ancient Greece around 356–323 BCE, and it later spread to England in the mid-1500s and the United States in the early 1600s. Presently, numerous nations, such as Egypt, India, Indonesia, Mexico, and the United States, engage in commercial production of basil for market purposes [11]. Sweet basil is a fragrant herb characterized by dense foliage and a diverse range of aromatic constituents; it usually undergoes its entire life cycle among a year [12]. Thriving in a specific agroclimatic setting, temperatures between 7 and 27 °C are preferred by this plant, annual precipitation ranging from 0.6 to 4.3 m, and soil pH levels of 4.3 to 8.2. It is a low-maintenance plant that easily grows both indoors and outdoors. While susceptible to damage from frost and freezing temperatures, this species prospers when exposed to extended periods of daylight, full

sun, and well-drained soil [13].

Basil, is a vertically branched herb reaching heights between 0.6 to 0.9 m. Its stems and branches exhibit a green hue, occasionally tinged with purple, and possess a smooth or slightly hairy texture. The leaves, arranged oppositely, are 2.5-5 cm or more in length, characterized by an ovate shape, pointed tips, and a margin that may be either entirely smooth or somewhat toothed, with an undivided base. The petiole, connecting the leaf to the stem, measures 1.3-2.5 cm. Dot-like oil glands on the leaves release a highly aromatic volatile oil [14]. The inflorescence follows a racemose pattern, with the terminal raceme typically longer than the lateral ones. Stalked bracts, shorter than the calyx, are ovate with pointed tips. The calyx, initially five mm long, enlarges as the fruit develops, featuring a very short stalk. Its lower lip, exhibiting two central teeth, surpasses the rounded upper lip in length. The corolla, ranging from 8-13 mm, presents in shades of white, pink, or purplish, with variations in surface texture from smooth to variously hairy. The slightly protruding stamens' upper filaments are toothed at the base. The ovary is positioned superiorly, consisting of two carpels and four locules, resulting in a four-parted fruit containing four achenes [15].

#### **Ethnomedicinal Importance-**

More than 10% of the total comprises over

50,000 plant species have been harnessed for the creation of pharmaceuticals and healthcare goods [16]. *Ocimum basilicum* L. referred to as the "king of herbs" in Greek, has a historical acknowledgment for its therapeutic attributes and has been employed in both Unani and Ayurvedic medical traditions since ancient times [17].

Ethnobotany, a branch of ethnobiology, investigates the traditional botanical knowledge within various cultures. It delves into the methods of plant utilization, the administration of plant resources, and the significance of plants in cultural, religious, or ritual contexts [18]. In the Bageshwar District of Uttarakhand, India, indigenous and local communities employ the leaves and seeds of *Ocimum basilicum* L. for the treatment of fever, cough, and cold [19]. In the vicinity of Lawachara National Park in Bangladesh, the local community uses *Ocimum basilicum* L. leaves to address high blood pressure, fever, and cough. Similarly, in Lalmohan, Bhola District, Bangladesh, the entire *Ocimum basilicum* L. plant is employed for treating fever and as a carminative [20, 21].

Globally, basil has been widely utilized as an herbal remedy across diverse regions like Asia, Africa, and South America. Traditional healers from various areas have employed different parts of the plant, including leaves,

seeds, inflorescences, fruits, and stems, as well as the whole plant itself. These plant components are utilized in various forms such as infusion, inhalation, paste formulations, powder, and tea, and are also incorporated into food. Traditional healers attribute therapeutic properties to basil, particularly in managing common ailments affecting the digestive, respiratory, urinary, and reproductive systems. Based on their beliefs, some members of the community use this plant for ornamental purposes [21].

#### Advancements in Breeding Approaches and Biotechnological Innovations:

The success of any improvement program relies significantly on the genetic variability, adaptability, and evolution of the species. To cultivate varieties with superior herb and essential yield characteristics, the genetic enhancement of *Ocimum* species through diverse breeding methods is essential. The CSIR-Central Institute of Medicinal and Aromatic Plants in India has successfully developed several varieties, including Khushmohak and CIM Saumya, utilizing various breeding techniques [22]. At the Central Institute for Medicinal and Aromatic Plants, Lucknow,

successfully breed CIM Saumya, a variety of Indian basil (*Ocimum basilicum* L.) characterized by its early maturation, brief growth period, and notable production of essential oil, particularly enriched with methyl chavicol and linalool [22]. The creation of new essential oils for the world market is contributed to by the production of hybrids through the crossing of cultivars [23].

The diversification and speciation of flowering plants, coupled with variations in the nuclear DNA amount of the complete chromosome set or holoploid nuclear DNA content, as well as alterations in chromosome number and structure, were documented [23].

#### Varieties:

*Ocimum basilicum* L. stands out as the sole economically cultivated species in India. Numerous institutions have introduced different varieties, including RRL-011, Vikarsudha, Kusumohak, and Cim-Saumya. Internationally recognized varieties of *Ocimum basilicum* L. have been developed through diverse breeding techniques, including crossing and selection [22]. These varieties cover a spectrum of chemotypes detailed illustrate in **Tables 1 and 2**.

**Table 1: Varieties, origin of plant germplasm, chemical variants of basil and its genetics improvement approaches**

S. No.	Varieties	Origin of the Plant germplasm	Chemical Variants	Genetic improvement approaches
1.	Blue spice	Czech Republic	Bisabolene	Asexual reproduction
2.	Cinnamon	Poland, Wroclaw	Linalool and methyl cinnamate	Selection
3.	Compact	Maine, USA	Linalool	Asexual reproduction
4.	Dbasbloom	Israel	Linalool	Asexual reproduction
5.	Dark lady	Wolsier, Germany	Linalool	Asexual reproduction

6.	Fino Verde	Maine, USA	Linalool	Asexual reproduction
7.	Genovese	Slovenia	Linalool	Selection
8.	Holandjanin	Istria	Linalool	Asexual reproduction
9.	Lattuga	USA	Linalool	Selection
10.	Osmin	California	Linalool	Selection
11.	Purple opal	Czech Republic	Linalool	Selection
12.	Purple Ruffles	Germany	Linalool	Crossing
13.	Siam queen	USA	Methyl chavicol	Cross selection

Table 2: Released varieties from CSIR-CIMAP of *Ocimum basilicum* L. with their quality and breeding techniques

Varieties	Common name	Herb yield (ql/ha)	Oil content (%)	Oil yield (kg/ha)	Main essential oil constituents						Breeding techniques	Reference
					Eugenol	Metyl eugenol	Methyl chavicol	Linalool	Methyl cin-namate	Citric content		
CIM Snigdha	French basil	221	0.9	190	-	-	9.1	1.95	78.7	-	Developed through half-sib selection	[22]
CIM Saumya	Indian basil	290	0.68	197.2	-	-	62.54	24.61	-	-	Developed through half-sib selection	[22]
CIM Shurabhi	Sweet basil	200	0.75	166	-	-	0.44	75.71	-	-	Developed through intensive breeding	[22]
CIM Sharada	French basil	280	0.7	190	-	-	89.75	0.067	-	-	Developed through intensive breeding	[22]
Khushmohak	Sweet basil	391	0.4	134	-	-	37	45	-	-	Developed through selection in seed raised progeny of the introduced strain from Argentina	[22]
Vikarsudha	French basil	335	0.5	167.5	0.62	-	78	0.16	-	-	Developed through intra-specific hybridization between exotic basil from Australia (EC-331886)-CSIRO No. L6323 and local adaptive landrace, Baddhun local	[22]

### Active Chemical Constituents of *Ocimum basilicum* L.:

Basil immensely contains more than 20 compounds such as linalool, methyl eugenol, estragole etc., which has been analyzed by GC-MS technique [24]. Various varieties of basil differ in fragrance due to presence of different combination of essential oil were found in all

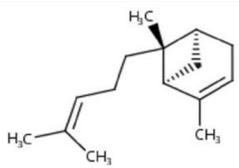
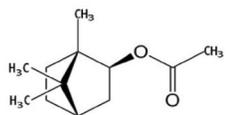
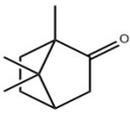
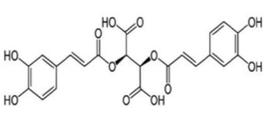
over the world. Essential oil composition of basil was eucalyptol (1.79%), linalool (12.63%),  $\alpha$ -terpineol (0.95%), eugenol (19.22%),  $\beta$ -elemene (2.68%),  $\alpha$ -bergamotene (3.96%),  $\alpha$ -guaiene (2.33%), germacrene D (8.55%), cubenol (1.78%), tau-cadinol (15.13%), camphor (0.70%), bornil acetate

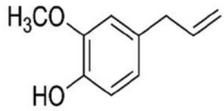
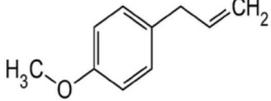
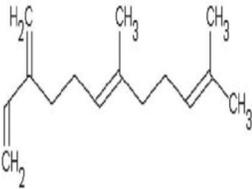
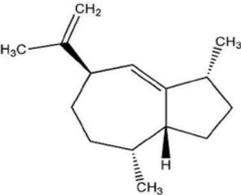
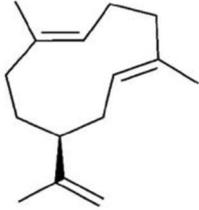
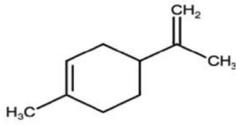
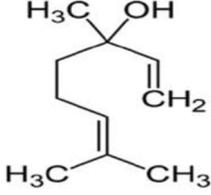
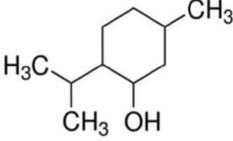
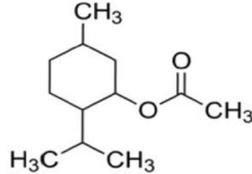
(1.97%),  $\beta$ -cariophyllene (0.61%),  $\alpha$ -cariophyllene (1.67%), elixen (2.59%),  $\beta$ -cadinene (0.80%),  $\alpha$ -copaene (0.33%), methyl eugenol (0.76%),  $\beta$ -farnesene (0.58%), epibicyclosesquiphelandrene (0.76%), tau muralol (0.96%),  $\alpha$ -bisabolol (0.35%),  $\delta$ -gurjunene (5.49%) and  $\delta$ -cadinene (5.04%) [25].

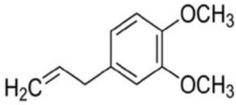
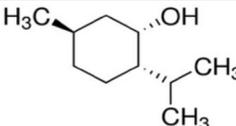
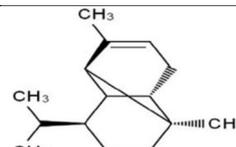
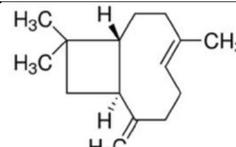
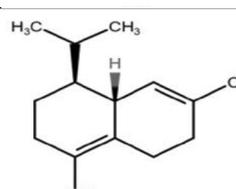
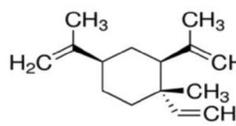
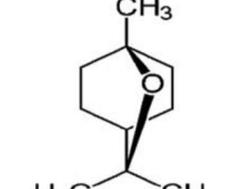
Five distinct oil profiles have been distinguished for sweet basil, categorized according to the components present in its essential oil: (i) linalool; (ii) methyl chavicol; (iii) a combination of both linalool and methyl chavicol; (iv) a combination of both linalool and eugenol; and (v) an enriched profile featuring both methyl chavicol and methyl eugenol [26, 27]. Basil possesses the capacity to synthesize and transform phenyl propenes, key components that significantly influence the taste of herbs,

while simultaneously acting as either attractions for cultivators or deterrents for herbivores. The specific aroma and taste of various basil varieties are primarily dictated by their chemical composition, with major components including linalool, methyl chavicol, 1,8-cineole, and methyl present in varying quantities. The repellent effects of the essential oil obtained from *Ocimum basilicum* L. against *Nephotettix virescens* have been recorded [28] and *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus* [29] while acting as an anti feedant in *Helicoverpa armigera* [30,31]. The active constituents, molecular structure with different extraction analysis method and applications of basil listed in **Table 3**.

**Table 3: Chemical constituents, molecular structure, chemical group, extraction analysis method, biological activities and applications of *Ocimum basilicum* L.**

Chemical Constituents	Molecular Structure	Chemical Group	Extraction analysis Method	Biochemical activity and Applications	References
A2-bergamotene		Sesquiterpene	Cold maceration	Abiotic Stresses release. Used as flavouring and flavour agent	[32, 33]
Bornyl acetate		Acetate ester	Microwave assisted Extraction	Anti-inflammatory, Analgesic, used as air fresheners, cleaners and care products.	[34, 35]
Camphor		Terpenoid Liquid	liquid extraction	Antipruritic, Counter-irritant. Used to treat toenail fungus, insect bites.	[36, 37]
Chicoric acid		Phenylpropanoid	Solvent microwave Extraction	Antioxidant, immunostimulatory, treatment of diabetes, epilepsy, hemorrhoids.	[38, 39]

<b>Eugenol</b>		<b>Phenylpropanoid</b>	<b>Steam Distillation</b>	<b>Antioxidant activity, antidiabetic, antistress activity, antiseptic and used in perfumes, mosquito repellent</b>	<b>[40]</b>
<b>Estragole</b>		<b>Phenylpropene</b>	<b>Hydro distillation</b>	<b>Neuronal excitability, used in cosmetic products, cleaning, fragrance.</b>	<b>[41, 42]</b>
<b>Farnesene</b>		<b>Sesquiterpene</b>	<b>Steam Distillation</b>	<b>Antioxidant, anti-insecticidal, used as sedative and attractive scent.</b>	<b>[43, 44]</b>
<b>Guaiene</b>		<b>Sesquiterpene</b>	<b>Steam distillation</b>	<b>Antithrombotic, anti-depressant, used in flavouring industries.</b>	<b>[45, 46]</b>
<b>Germacrene</b>		<b>Sesquiterpene</b>	<b>Solvent extraction</b>	<b>Anti-inflammatory, analgesic, used to treat fevers, perfume industry.</b>	<b>[47, 48]</b>
<b>Limonene</b>		<b>Monoterpene</b>	<b>Solvent at high pressure high temperature extraction</b>	<b>Motor relaxant, Anti-inflammatory and used as flavouring agent, ointments</b>	<b>[49, 50]</b>
<b>Linalool</b>		<b>Monoterpene alcohol</b>	<b>Solvent free microwave extraction and conventional hydro-distillation</b>	<b>Anticancer, Anti proliferative, Anti-inflammatory, Anti-microbial and used as fragrances in food additives, cosmetics.</b>	<b>[51]</b>
<b>Menthol</b>		<b>Alcohol</b>	<b>Soxhlets solvent extraction</b>	<b>Local anesthetic, used in minor irritation, pain, sore mouth.</b>	<b>[52, 53]</b>
<b>Menthyl acetate</b>		<b>Monoterpene</b>	<b>Solid-phase micro extraction</b>	<b>Antioxidant, antibacterial, used as flavouring agent an odour.</b>	<b>[54, 55]</b>

Methyl eugenol		Phenylpropene	Hydro distillation	Anticonvulsant and Anesthetic and used in non-alcoholic beverages, processed food	[56]
Neo isomenthol Menthane		Monoterpenoid	Steam distillation	Nasal sensation. Used as flavouring agent and pharmaceutical products.	[57, 58]
$\alpha$ -copaene		Sesquiterpene	Supercritical fluid extraction	Cytotoxic, antioxidant. Used as Flavor additives.	[59]
$\beta$ -caryophyllene		Sesquiterpene	Supercritical fluid extraction	Antibiotic, antioxidant, carcinogenic. Used an insect attractant, a fragrance.	[60]
$\delta$ -cadinene		Bicyclic sesquiterpene	Headspace solid-phase Micro extraction	Antioxidant, antimicrobial, used as flavouring industries, cosmetics.	[61, 62]
$\beta$ -elemene		Sesquiterpenoid	Hydro and glycol distillation	Antineoplastic, Anti-cancer and used as enhance effect of chemotherapy, cell apoptosis.	[63]
1,8-cineole		Monoterpenoid	Hydro distillation	Antiulcer, Wound healing Activity, Anti-cancerous and used as personal care products, flavouring	[64, 65]

## Pharmacological importance

### 1) Immunomodulatory Activity-

Wistar albino rats were administered varying amounts of basil, encompassing both low and high doses amount of extract. Antibody titre was calculated using the SRBC titre technique. Increased RBC, WBC, hemoglobin, and antibody titre values were observed. Basil

demonstrated a rise in body weight concerning the control animals when assessing the immunomodulatory effect [66]. *Ocimum basilicum* L. plant extracts show that the herb has immunomodulatory effects at the cellular level, including platelet antiaggregant properties and counter HIV1 reverse transcriptase inhibitory activity [67, 68].

## 2) *Antioxidant Activity-*

The antioxidant activity of methanolic extracts of *O. gratissimum* and *O. basilicum* was investigated using standard techniques. Comparing *O. basilicum* to *O. gratissimum*, *O. basilicum* displayed incredibly low DPPH activity. Concentration was an important factor in the percentage of radical scavenging activity [69]. At doses of 50, 100, 250, and 500 in g/mL, the antioxidant activity of acetone and ethanol extracts of *A. indica* and *O. basilicum* was investigated. The effects of antioxidants were concentration-dependent. By using ferric thiocyanate (FTC), an ethanol extract of *O. basilicum* at a concentration of 500 g/mL demonstrated 75.87%, antioxidant activity closely resembling that of the reference compound, 500 g/mL -tocopherol (82.14%) [70].

## 3) *Larvicidal Activity-*

By combining *O. basilicum's* petroleum ether leaf extract with the synthetic nicotinoid insecticide imidacloprid in various ratios against the *Anopheles stephensi* malaria vector, larvicidal activity of the plant was discovered. In comparison to 1:2 and 1:4, a binary mixture of a 1:1 ratio was the most efficient against mosquito larvae. With LC50 values of 12.351 and 5.290 ppm, respectively, this effective ratio was safe for aquatic mosquito predators *Anisops bouvieri* and Cyclops after 24 hours of exposure. Individual components

were not quite as efficient as the tested combination [71]. *O. basilicum*, *Vetiveria zizanioides*, and the chemical Spinosad were all found to have larvicidal and repulsive effects on the Anopheles mosquito, which is known to be a malaria carrier. Synthetic pesticides pose numerous risks to the environment and to people. Consequently, the recommendation is for microbial insecticides due to their safety for both humans and other animals. The 85% mortality rate *Anopheles stephensi* Liston, the malarial vector, was significantly repelled by the aforementioned plants. This percentage encourages the use of plant extracts as bio-insecticides [71].

## 4) *Antifungal Activity-*

Numerous organisms, primarily various types of fungi, are responsible for a large number of infections of the skin, hair, nails, and subcutaneous tissues in both humans and animals (Amer et al., 2006). These organisms were known as dermatophytes, and the disorders associated with the Crusades were known as dermatophytoses [72]. The utilization of synthetic antifungal drugs is limited in the treatment of humans and animals due to their high toxicity [73]. In a few different nations throughout the world, antifungal medicines derived from plants and their natural products are free to be used in veterinary practices or for human therapy. The majority of plant-

based antifungal medicines are reportedly safe for both human and animal consumption [73]. The findings of the study revealed that, in comparison to standard antiseptics, the minimum inhibitory concentration (MIC) of solvent extracts derived from the aerial parts and roots, basil oil, and isolated phytochemical compounds was notably higher. This suggests that elevated concentrations are required to effectively inhibit the growth of various test organisms, as indicated by the experimental results [74, 75]. Furthermore, it was demonstrated that the extracted phytochemical compounds from leaves of the plant and their ethanol extracts exhibited higher levels of antifungal activity than the root extracts, indicating that the antifungal agents were most likely polar in nature [76]. The essential oils significantly showed antifungal activity against numerous plant pathogenic fungi [74].

**5) Antimutagenic Activity-** Linalool, 1,8-cineole, and -myrcene are undiluted chemicals that have been demonstrated to have antimutagenic properties in *Salmonella typhimurium* TA 100, TA 98, and TA 102 when used with or without microsomal rat liver fraction (S9 mix). The Ames test was then analyzed using *S. typhimurium* TA 100 because no activity was seen in any of the tested strains. Chemical mutagens such as 4-

nitroquinoline-N-oxide (4NQO), 2-nitropropane (2-NP), and benzo (a) pyrene (B (a) P) as well as UVC rays were used to cause mutagenesis. All basil derivatives decreased UV-induced mutations; the highest levels of inhibition were between 64 and 77%. The 4NQO inhibitory potential (52–67%) was comparable to UV. Essential oil and 1, 8-cineole both demonstrated moderate inhibition of 2-NP-induced mutagenesis, whereas the latter also shown moderate inhibition of B (a)P-induced mutagenesis [77].

#### **6) Antitoxic Activity-**

Deltamethrin caused a number of histopathological changes in the kidneys of albino rats, including the degeneration of epithelial lining cells, dilating and constricting of renal blood vessels, the infiltration of inflammatory leucocytic cells into the intertubular spaces, and an increase in urea and serum creatinine. The concentration of malondialdehyde (MDA) significantly rose while superoxide dismutase (SOD) and catalase (CAT) in renal tissue became more or less inactive. Then, basil aqueous extract and deltamethrin were administered to the mice. It resulted in the treatment of histopathological diseases. Creatinine and urea levels returned to normal, MDA levels decreased, and the activities of CAT and SOD were seen to increase [78].

#### **7) Anticonvulsant-**

Strong anticonvulsant action is primarily attributed because of the existence of eugenol in the hydro distilled aqueous leaf extract of *Ocimum basilicum* [79]. Many scientists are interested in screening natural products for these uses and studying their chemical and pharmacological aspects, which could potentially extend further, in list to develop new anti-convulsant compounds that have advantages over existing synthetic drugs. The fascination of numerous scientists has been piqued by recent research on essential oils and their fundamental phytochemical constituents. Many researchers have delved into the exploration of basil oil and its associated phytochemical components extracted specifically from the leaves and seeds of *Ocimum basilicum* L., in pursuit of this objective [80].

#### Traditional and therapeutic uses-

Basil exhibits utility in various ailments related to the heart, blood, biliousness, and imbalances of kapha and vata, as well as conditions like leucoderma. The juice of basil serves to alleviate joint pain, enhance the luster of eyes, and proves beneficial for tooth-

aches and earaches. Additionally, when combined with camphor, it is effective in treating epistaxis [81]. The juice of plant is dropped into ears to cure dullness of hearing [81, 82]. The plant infusion is administered for the treatment of headaches and gouty joints, and it serves as a gargle to address foul breath. Basil is recognized for its efficacy in alleviating headaches, facilitating digestion, and acting as a gentle laxative. Additionally, it is noted for its reported ability to repel flies and snakes [83]. Demonstrating a spectrum of benefits, the plant's oil is notably effective in relieving mental fatigue, addressing colds, spasm, and rhinitis. Additionally, it serves a dual purpose by acting as a first aid treatment for both wasp stings and snakebites [84]. The oil content has anti-cancerous property [85].

#### Companies manufacturing basil products-

Products made from basil are utilized in commerce all over the world because of its nutritional and therapeutic benefits. Numerous producers create basil-based goods due to its many uses. Asian countries are the locations of the majority of basil product manufacturing enterprises listed in **Table 4**.

**Table 4: Various Companies and Plant-Based Products Across Different Locations**

S. No.	COMPANY NAME	COUNTRY	PRODUCTS	SOURCES
1.	Haridass Aggarwal & sons	India	Leaves for flavoring.	<a href="http://www.indiamart.com/haridas-agarwal-sons/">www.indiamart.com/haridas-agarwal-sons/</a>
2.	Natural Healthy concepts	India	Basil oils.	<a href="http://www.naturalhealthyconcepts.com/">www.naturalhealthyconcepts.com/</a>
3.	Silver line Chemicals	India.	Basil essential oils	<a href="http://www.silverlinechemicals.com/">www.silverlinechemicals.com/</a>
4.	Global Merchants	India	Basil oil.	<a href="http://www.global-merchants.in/">www.global-merchants.in/</a>

5.	Right Future International	India	Leaves for flavoring Purpose	www.rightfutureinternational.co.in/
6.	Frontier Natural Products Co-op.	US	Basil leaf for flavors.	www.frontiercoop.com/
7.	Zhongbei Northland Bio-chem industry Co. Ltd.	China	Basil oils for tonic purpose	http://daxinganling-lily.en.china.cn/
8.	Dujardin Foods Nv	Belgium	Basil oils	www.dujardin-foods.com/

## CONCLUSION

In recent times, there has been a growing interest in the traditional medical system as a valuable resource for tackling the increasing prevalence of chronic, degenerative, environmental, lifestyle, and stress-related disorders. *Ocimum basilicum* (L.) has been historically employed as a holistic remedy for a spectrum of illnesses. The extensive and varied range of its therapeutic effects is believed to arise from the synergistic interactions among its phytochemical components, an effect that cannot be fully replicated with individual extracts or constituents. The discussion encompasses information on basil product manufacturers, cautioning about potential adverse effects when consumed concurrently with prescribed medications. Future research prospects involve the development of transgenic basil plants to mitigate environmental stress and target specific chemical constituents for combating human diseases. This comprehensive exploration of basil's nuances, including its highs and lows, serves as a valuable resource for researchers aiming to innovate and create new basil-based products. Ac-

knowledging the significance of basil, the directive is to utilize and safeguard this vital natural resource.

**Acknowledgement-** Authors are grateful to Prof. (Dr.) Arun Kumar Dean, School of Basic and Applied Sciences, Shri Guru Ram Rai University, Patel Nagar, Dehradun for his kind support and suggestions.

## REFERENCES-

- [1] Dechamps, C and Simon, JE, Terpenoid essential oil metabolism in basil (*Ocimum basilicum* L.). Journal of Essential Oil Research. 18, 2006, 618-621.
- [2] Nahak, G, Mishra, RC and Sahu, RK, Taxonomic distribution, medicinal properties and drug development potentiality of *Ocimum* (Tulsi). Drug Invention Today, 3(6), 2011, 95-113.
- [3] Nakagawa, H, Induced Plant Mutations in the Genomics Era. Food and Agriculture Organization of the United Nations, Rome, 2009, 48-54.
- [4] Singh, MP and Panda, H, Medicinal Herbs with Their Formulations. Daya

- Publishing House, Delhi, 2005, 607-610.
- [5] Simon, JE, Quin, J and Murray, RG, Basil: A source of essential oil. In: Janick, J. and J.E. Simon (eds.). Advances in new crops. Timber Press, Portland, OR. 1990, 484-489.
- [6] Olga Makri and Spiridon Kintzios, *Ocimum* sp. (Basil): Botany, Cultivation, Pharmaceutical Properties, and Biotechnology. Journal of Herbs, Spices & Medicinal Plants, 13(3):2008,123-150.
- [7] Malekpoor, F, Pirbalouti, AG, Salimi, A, Effect of foliar application of chitosan on morphological and physiological characteristics of basil under reduced irrigation. Research on Crops, 17: 2016, 354–359.
- [8] Blank, AF, Carvalho Filho, JLS, Santos Neto A L, Alves PB, Blank, MFA, Mann, RS, Mendonca, MD, Morphologic & Agronomic Characterization of basil accessions, Horticultura Brasileira.22, 2004, 113–116.
- [9] Barickman TC, Olorunwa OJ, Sehgal A, Walne CH, Reddy KR, Gao W, Interactive impacts of temperature and elevated CO<sub>2</sub> on basil (*Ocimum basilicum* L.) root and shoot morphology and growth. Horticulturae, 7, 2021,112.
- [10] O’Leary N, Taxonomic revision of *Ocimum* (lamiaceae) in Argentina. J. Torrey Bot. Soc 144, 2017, 74–87.
- [11] Chang, X, Alderson, PG, Wright, CJ, Variation in the essential oils in different leaves of Basil (*O. basilicum* L.) at day time. The Open Horticulture Journal, 2: 2009, 13-16.
- [12] Nazarian H, Amouzgar D, Sedghianzadeh H, Effects of different concentrations of cadmium on growth and morphological changes in basil (*Ocimum basilicum* L.). Pak. J. Bot 48, 2016, 945–952.
- [13] Lal RK, Gupta P, Chanotiya CS, Sarkar S, Traditional plant breeding in *Ocimum*. In *The Ocimum Genome*; Shasany, A.K., Kole, C., Eds.; Springer: Cham, Switzerland, 2018, 89–98.
- [14] Kumar A, Shukla AK, Shasany AK, Sundaresan V, Systematic position, phylogeny, and taxonomic revision of Indian *Ocimum*. In *The Ocimum Genome*; Shasany, A.K., Kole, C., Eds.; Springer: Cham, Switzerland. 2018. 61–72.
- [15] Paton A, Harley MR, Harley MM, *Ocimum*: An overview of classification and relationships. In *Basil*:

- The Genus Ocimum*; Hiltunen, R., Holm, Y., Eds.; CRC Press: London, UK, 1999, 1–38.
- [16] Chen, S.L, Yu, H, Luo H.M, Wu Q, Li, C F, Steinmetz, A, Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *Chinese. Medicine.* 11, 2016, 37.
- [17] Nadeem HR, Akhtar S, Ismail T, Qamar M, Sestili P, Saeed W, Azeem M, Esatbeyoglu T, Antioxidant effect of *Ocimum basilicum* essential oil and its effect on cooking qualities of supplemented chicken nuggets. *Antioxidants.* 11, 2022, 1882.
- [18] Abbasi AM, Shah MH, Khan MA, Ethnobotany and ethnomedicine. In *Wild Edible Vegetables of Lesser Himalayas.* Springer International Publishing. Berlin/Heidelberg, Germany. 2015, 19–29.
- [19] Ojha SN, Tiwari D, Anand A, Sundriyal RC, Ethnomedicinal knowledge of a Marginal Hill community of Central Himalaya: Diversity, usage pattern, and conservation concerns. *J. Ethnobiol. Ethnomed.* 16, 2020, 29.
- [20] Uddin MZ, Arefin MK, Alam MF, Kibria MG, Podder SL, Hassan MA, Knowledge of ethnomedicinal plants and informant consensus in and around Lawachara National Park. *J. Asiat. Soc. Bangladesh Science,* 43, 2017, 101–123.
- [21] Sohel MDD, Kawsar MDH, Sumon MDHU, Sultana T, Ethnomedicinal studies of Lal Mohan Thana in Bhola District, Bangladesh. *Altern. Integr. Med,* 5, 2016, 317–327.
- [22] Lal RK, Khanuja SPS, Agnihotri AK, Shasany AK, Naqvi AA, Dwivedi S, Misra HO, Dhawan OP, Kalara A, Singh A, Bahl JR, Singh S, Patra DD, Agarwal S, Darokar MP, Gupta ML, Chandra R, An early, short duration, high essential oil, methyl chavicol, and linalool yielding variety of Indian Basil (*Ocimum basilicum*) ‘CIM- Saumya’. *Journal of Medicine and Aromatic Plant Science,* 26, 2004, 77–78.
- [23] Murray, BG, De Lange, PJ, Fergusson, AR. 2005. Nuclear DNA variation, chromosome numbers and polyploidy in the endemic and indigenous grass flora of New Zealand. *Ann Botany,* 96(7), 2005, 1293–1305.
- [24] Radulovic NS, Blagojevic PD, Miltojevic AB.  $\alpha$ -Linalool marker

- compound of forged/synthetic sweet basil (*Ocimum basilicum* L.) essential oils. *Journal of the Science of Food and Agriculture*. 93, 2013, 3292–303.
- [25] Zamfirache MM, Padurariu C, Burzo I, Olteanu Z, Boz I, Lamban C, Research Regarding the Chemical Composition of the Volatile Oil of Some Taxa Belonging to the Genus *Ocimum*, *Biology vegetala Journal*. 2011, 31-34.
- [26] Grayer, RG, Kite, GC, Goldstone, FJ, Bryan, SE, Paton, A, Putievsky, E, Intraspecific taxonomy and essential oil chemotypes in basil, *Ocimum basilicum*. *Phytochemistry*, 43: 1996, 1033-1039.
- [27] Pandey, A K, Singh P, Tripathi, NN, Chemistry and bioactivities of essential oils of some *Ocimum* species. *Asian Pacific Journal of Tropical Biomedicine*. 4(9): 2014,682-694.
- [28] Chittihunsa, T, Samngamnim, N, Studies on the effects of some crude plant extracts to the mortality and feeding behavior of *Nephotettix virescens*. In: Oates CG (ed.). *The 37th Kasetsart University Annual Conference*, Bangkok, Thailand. Text and Journal Publication Co, Ltd, 1999. 70–77.
- [29] Prajapati, V, Tripathi, AK, Aggarwal, KK, Khanuja, SPS, Insecticidal, repellent and oviposition-deterrent activity of selected essential oils against *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus*. *Bioresource Technology*, 96, 2005, 1749–1757.
- [30] Balakrishnan Purushothaman, Ramalingam Prasanna Srinivasan, Purushothaman Suganthi, Balu Ranganathan, Jolius Gimbun and Kumaran Shanmugam A, Comprehensive Review on *Ocimum basilicum*. *Journal of Natural Remedies*, 2018, 18(3): 71-85.
- [31] Rao, MS, Pratibh, G, Korwar, GR, Evaluation of aromatic oils against *Helicoverpa armigera*. *Ann. Plant Prot. Sci*, 2000, 8, 236–238.
- [32] Jadhav NM, Thergaonkar RS, Deodhar MA. Extraction of essential oil from flowers of *Mesua ferrea* linn. Gcms analysis and incorporation in cosmetic product. *International Journal of Pharmaceutical Sciences and Research*. 7(12), 2016, 5106–10.

- [33] Palmer-Young EC, Veit D, Gershenzon J, Schuman MC, The Sesquiterpenes (E)- $\beta$ -Farnesene and (E)- $\alpha$ -Bergamotene quench ozone but fail to protect the wild Tobacco nicotiana attenuate from ozone, UVB, and Drought Stresses. PLoS ONE. 2015, 10(6): e0127296.
- [34] Fan S, Chang J, Zong Y, Hu G, Jia J, GC-MS analysis of the composition of the essential oil from *Dendranthema indicum* Var. *Aromaticum* using three extraction methods and two columns. Molecules. 23(3), 2018, 576.
- [35] Wu X, Xiao F, Zhang Z, Li X, Xu Z, Research on the analgesic effect and mechanism of bornyl acetate in volatile oil from *Amomum villosum*. Zhong Yao Cai. 2005, 28(6), 505-7.
- [36] Nozala MJ, Bernala JL, Jimenez JJ, Gonzalez MJ, Higes M, Extraction of thymol, eucalyptol, menthol, and camphor residues from honey and beeswax: Determination by gas chromatography with flame ionization detection. Journal of Chromatography A. 954(1-2): 2002, 207–15.
- [37] Zuccarini P, Camphor: risks and benefits of a widely used natural product. Journal of Applied Sciences and Environmental Management. 13(2), 2009, 69–74.
- [38] Lekar AV, Borisenko SN, Filonova OV, Vetrova EV, Maksimenko EV, Borisenko NI, Minkin VI, Extraction of caftaric and cichoric acids from *Echinacea purpurea* L. in subcritical water. Russian Journal of Physical Chemistry B. 7(8), 2013, 968–75.
- [39] Kuban-Jankowska A, Sahu KK, Gorska M, Tuszynski JA, Wozniak M, Chicoric acid binds to two sites and decreases the activity of the YopH bacterial virulence factor. Oncotarget. 7(3), 2016, 2229–38.
- [40] Khalil A, Antimicrobial activity of ethanolic extracts of *Ocimum basilicum* leaf from Saudi Arabia. Biotechnology. 12, 2013, 61–4.
- [41] Andrade TCB, Lima SG, Freitas RM, Rocha MS, Islam T, Silva TG, Isolation, characterization and evaluation of antimicrobial and cytotoxic activity of estragole, obtained from the essential oil of *Croton zehntneri* (euphorbiaceae). Anais da Academia Brasileira de Ciencias. 87(1), 2015, 173–82.

- [42] Silva-Alves KS, Ferreira-da-Silva FW, Peixoto-Neves D, Viana-Cardoso KV, Moreira-Junior L, Oquendo MB, Estragole blocks neuronal excitability by direct inhibition of Na<sup>+</sup> channels. *Brazilian Journal of Medical and Biological Research*, 46(12), 2013, 1056–63
- [43] Green CP, Osborne P. Rapid methods for obtaining essential oil from hops. *Journal of the Institute of Brewing*, 99, 1993, 335–9.
- [44] Sun Y, Qiao H, Ling Y, Yang S, Rui C, Pelosi P, Yang X, New Analogues of (E)- $\beta$ -Farnesene with insecticidal activity and binding affinity to aphid odorant binding proteins. *Journal of Agricultural and Food Chemistry*, 2003.
- [45] Gakuubi MM, Steam distillation extraction and chemical composition of essential oils of *Toddalia asiatica* L. and *Eucalyptus camaldulensis* Dehnh. *Journal of Pharmacognosy and Phytochemistry*. 5(2), 2016, 99–104.
- [46] Swamy MK, Sinniah UR, A comprehensive review on the phytochemical constituents and pharmacological activities of *Pogostemon cablin* Benth.: An aromatic medicinal plant of industrial importance *Molecules*. 2015, 20: 8521–47.
- [47] Noge K, Becerra JX. Germacrene D, A common sesquiterpene in the Genus *Bursera* (Burseraceae). *Molecules*. 2009, 14:5289–97.
- [48] Del-Vechio-Vieira G, Vieira de Sousa O, Miranda MA, Senna-Valle L, Coelho Kaplan MA, Analgesic and anti-inflammatory properties of essential oil from *Ageratum fastigiatum*. *Brazilian Archives of Biology and Technology*. 2009, 52(5): 1115–21
- [49] Lopresto CG, Petrillo F, Casazza AA, Aliakbarian B, Perego P, Calabro V, A non-conventional method to extract D-limonene from waste lemon peels and comparison with traditional Soxhlet extraction. *Separation and Purification Technology*. 2014,137: 13–20
- [50] Vale TG, Furtado EC, Santos JG, Viana GS. Central effects of citral, myrcene and limonene, constituents of essential oil chemotypes from *Lippia alba* (Mill). *Phytomedicine*. 2002, 9(8): 709–14.

- [51] Galhiane MS, Rissato SR, Chierice GO, Almeida MV, Silva LC. Influence of different extraction methods on the yield and linalool content of the extracts of *Eugenia uniflora* L. *Talanta*. 2006, 70(2): 286–92
- [52] Alvi MN, Ahmad S, Rehman K, Short communication preparation of menthol crystals from mint (*Mentha arvensis*). *International Journal of Agriculture and Biology*. 2001, 3(4): 527–8
- [53] Galeotti N, Ghelardini C, Cesare Mannelli LD, Mazzanti G, Baghiroli L, Bartolini A, Local anaesthetic activity of (+)- and (±)-Menthol. *Planta Medica*. 2001, 67: 174–6.
- [54] Rohloff J. Monoterpene composition of essential oil from peppermint (*Mentha piperita* L.) with regard to leaf position using solid phase micro-extraction and Gas Chromatography/Mass Spectrometry Analysis, *Journal of Agricultural and Food Chemistry*. 1999, 47 (9): 3782–6.
- [55] Muftah RS, Shushni Asma Belkheir AM, Antibacterial and antioxidant activities of *Mentha piperita* L, *Arabian Journal of Chemistry*. 8(3), 2015, 322–8.
- [56] Ding J, Huang C, Peng Z, Xie Y, Deng S, Nie YZ, Xu TL, Ge WH, Li WG, Li F, Electrophysiological characterization of methyleugenol: a novel agonist of GABA (A) receptors. *ACS Chemical Neuroscience*, 5(9), 2014, 803–11.
- [57] Manuale DL, Betti C, Juan C, Yori JM, Synthesis of liquid menthol by hydrogenation of dementholized peppermint oil over Ni catalysts, *Quimica Nova*. 33(6), 2010, 1231–4.
- [58] Eccles R, Griffiths DH, Newton CG, Tolley NS. The effects of menthol isomers on nasal sensation of air-flow. *Clinical Otolaryngology*. 13(1), 1988, 25–9.
- [59] Turkez H, Celik K, Togar B, Effects of copaene, a tricyclic sesquiterpene, on human lymphocytes cells in vitro. *Cytotechnology*, 66(2014), 2013, 597–603
- [60] Quispe-Condori S, Foglio MA, Rosa PTV, Meirelesa MAM, Obtaining  $\beta$ -caryophyllene from *Cordia verbena*-cea de Candolle by supercritical fluid extraction. *The Journal of Supercritical Fluids*. 46(1), 2008, 27–32.
- [61] Nekoei M, Mohammad hosseini M, Chemical composition of the essential oils and volatiles of *Salvia*

- leriifolia by three different extraction methods prior to Gas Chromatographic-Mass Spectrometric determination: Comparison of HD with SFME and HS-SPME, *Journal of Essential Oil-Bearing Plants*, 20(2), 2017, 410–25.
- [62] Scura MC, Pintoa FGS, Pandini JA, Costa WF, Leite CW, Temponi LG, Antimicrobial and antioxidant activity of essential oil and different plant extracts of *Psidium cattleianum* Sabine. *Brazilian Journal of Biology*. 76(1), 2016, 101–8.
- [63] Quentin Li Q, Wang G, Huang F, Banda M, Reed E, Antineoplastic effect of  $\beta$ -elemene on prostate cancer cells and other types of solid tumour cells. *Journal of Pharmacy and Pharmacology*, 62(8), 2010, 1018–27
- [64] Rocha Caldas GF, Silva Oliveira AR, Araujo AV, Lopes Lafayette SS, Albuquerque GS, Silva-Neto JC, Gastroprotective Mechanisms of the Monoterpene 1,8-Cineole (Eucalyptol). *PLoS ONE*. 10(8), 2015, 134558.
- [65] Wu H, Hendrawinata W, Yu Y, Gao X, Li Y, Bartle J, Grayling P, Effect of Hydro distillation on 1,8-Cineole Extraction from Mallee leaf and the fuel properties of spent biomass. *Industrial & Engineering Chemistry Research*, 50(19), 2011, 11280–7
- [66] Jeba CR, Vaidyanathan R, Rameshkumar G, Efficacy of *Ocimum basilicum* for Immunomodulatory Activity in Wistar Albino Rats, *International Journal of Pharmacy and Pharmaceutical Sciences* 3(4), 2011, 199-203.
- [67] Okazaki K, Nakayama S, Kawazoe K, Takaishi Y, Anti-aggregant effects on human platelets of culinary herbs, *Phytotherapy Research*, 12: 2011, 603–5.
- [68] Yamasaki K, Nakano M, Kawahata T, Mori H, Otake T, Ueba N, Oishi I, Inami R, Yamane M, Nakamura M, Anti-HIV-1 activity of herbs in Labiatae, *Biological and Pharmaceutical Bulletin*. 21, 1998, 829–33.
- [69] James O, Eniola JO, Nnacheta PO, Comparative Evaluation of Antioxidant Capacity and Cytotoxicity of Two Nigerian Species, *Int. J. Chem. Sci.* 6(4), 2008, 1742-1751.
- [70] Durga RK, Karthikumar S, Jegatheesan K. Isolation of Potential Antibacterial and Antioxidant Compounds from *Acalyphha indica* and *Ocimum basilicum*, *Journal of Medicinal*

- Plants Research 3(10), 2009, 703-706.
- [71] Aarthi N, Murugan K, Larvicidal and repellent activity of *Vetiveria zizanioides* L, *Ocimum basilicum* Linn and the microbial pesticide spinosad against malarial vector, *Anopheles stephensi* Liston (Insecta: Diptera: Culicidae), Journal of Biopesticides 3(1 Special Issue) 199 - 204 ,2010, 199.
- [72] Valeria FM, Preve L and, Tullio V, Fungi responsible for skin mycoses in Turin (Italy). Mycoses 39, 1996, 141-50.
- [73] Araujo CR, Miranda KC, Fernandes OFL, Soares AJ, Silva MRR, 'In vitro' susceptibility testing of dermatophytes isolated in Goiania, Brazil, against five antifungal agents by broth microdilution method, Revista Institute of Medicine tropical Sao Paulo,51,2009, 9-12.
- [74] Ji-Wen Z, Sheng-Kun L, Wen-Jun W, The Main Chemical composition and in vitro antifungal activity of the essential oils of *Ocimum basilicum* L.var. *pilosum* (Willd) Benth. Molecules 14, 2009, 273-8.
- [75] Bokhari FM, Antifungal activity of some medicinal plants used in Jeddah, Saudi Arabia. Mycopath 7, 2009, 51-7.
- [76] Martin KW, Ernst, Herbal medicines for treatment of fungal infections, a systematic review of controlled clinical trials, Mycoses, 47, 2006, 87-92.
- [77] Stajkovii O, Bjedov BT, Culafic MD, Gacic VB, Simic Vukcevic KJ, Antimutagenic Properties of Basil (*Ocimum basilicum* L.) in *Salmonella typhimurium* TA 100, Food Technol. Biotechnology 45(2), 2007,213-217.
- [78] Sakr AS, Al-Amoudi MW, Effect of leave extract of *Ocimum basilicum* on deltamethrin induced nephrotoxicity and oxidative stress in albino rats, Journal of Applied Pharmaceutical Science. 62(05), 2012, 22-27.
- [79] Freire MM, Marques OM, Costa M. Effects of seasonal variation on the central nervous system activity of *Ocimum gratissimum* L. essential oil. Journal of Ethnopharmacology 105, 2006, 161–6.
- [80] Almeida OS, Silva AHB, Silva AB, Amaral CLF, Study of floral biology and reproductive mechanisms of *Ocimum officinalis* L. aimed at

- breeding, Acta. Science 26, 2004, 343-348.
- [81] Khare, CP, Indian Medicinal Plants, An Illustrated Dictionary, New Delhi; Springer India (P) Limited, 2007, 442-444.
- [82] Nadkarni, KM, The Indian Plants and Drugs. New Delhi. Shrishti Book Distributors, 2005, 263.
- [83] Anonymous, The Wealth of India. Vol. IV. New Delhi: National Institute of Science Communication and Information Resources, 2003, 216-218.
- [84] Ismail, M, Central properties and chemical composition of *Ocimum basilicum* essential oil. Pharmaceutical Biology. 44(8), 2006, 619–626.
- [85] Rabani, M, Jafarian, A, Hasanzadeh, F, Hashemi, S, Hagherabadi, A, Sabet, S, Evaluation of anti-epileptic effect of conjugated form of valproic acid and phenytoin in mice. J Shahrekord Univ Med Sci, 6(2), 2004, 22-30.