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ETHANOMEDICINAL, PHYTOCHEMICAL AND PHARMACOLOGICAL INVESTIGATION OF *OCIMUM TENUIFLORUM* LINN.

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ABSTRACT: *Ocimum tenuiflorum* Linn. commonly known as holy basil, tulsi is an aromatic perennial plant in the family Lamiaceae. It is native to the Indian subcontinent and cultivated plant throughout the Southeast Asian tropics, where the leaves, seeds and stem of tulsi are used for valuable source of culinary and traditional medicinal uses. Indian material medica describes the use of the plants in a variety of ailments such as immunostimulatory effect, gastric antiulcer activity, diabetes mellitus, hyperlipidemia, wound healing effects, protective effect, chemopreventive activity, and blood pressure, etc. The present review aims to summarize up to date information on the ethnomedicinal, phytochemical and pharmacological activity. Until now, highly complex natural molecules have identified including fixed oils, essential oils, triterpenes, flavonoids, flavonoid glycosides, polysaccharides, phenolic glycoside, lignans, and norlignans. In addition to solvent extracts, these individual active compounds have been suggested for ethano-pharmacological activities. Although the results are promising *in-vitro* and *in-vivo* preclinical studies, clinical studies are insufficient; therefore, further investigation of each active compound need to be done to validate its therapeutic effects and to ensure its toxicity, safety, and efficacy.

INTRODUCTION: *Ocimum sanctum* Linn. (Sanskrit: Tulasi; Family: Lamiaceae), popularly called holy basil or *Ocimum tenuifolium* is widely distributed almost covering entire India. Many therapeutic activities have been attributed to the Tulsi plant, not only in Ayurveda and Siddha but also in Unani, Greek, and Roman System of Medicine for various ailments.

Herbal extracts are included in Ayurvedic remedies for the common cold, stomach disorders, headache, and heart disease, inflammation, malaria, and diverse forms of poisoning.

It is an erect, much divided subordinate shrub, 34-62 cm height, with simple opposite green or purple leaves; leaf: dark green to green in color, opposite arrangement, stipule, absent, petiole and are ovate, up to 5 cm long, usually somewhat toothed; margin: serrated, fluorescence: raceme type, floral bracts: caudiform in shape, flowers: vertical, 5-7 mm in length, calyx; greenish in colour, 5 in number, corolla; bilabiate in shape and covered with scattered hair, white petals, stamen: 4,



filament length is 1 mm, filament color is white; ovary; absent, style: single style, color is white, fruit: none seed; plant is prolific producer of seed; seed is very small, white in color, stem is covered with minute hairs **Fig. 1**.

Scientific Classification:

Kingdom	: Plantae
(Unranked)	: Angiosperms
(Unranked)	: Eudicots
(Unranked)	: Asterids
Division	: Magnoliophyta
Order	: Lamiales
Family	: Lamiaceae
Genus	: <i>Ocimum</i>
Species	: <i>teinufolium</i>

Phytochemical Review: Several nutrients and bioactive molecules have been found in *O. sanctum*. The quantity of these phytoconstituents depends on the nature of soil, climate, processing, harvesting and storage techniques. The various chemical constituents reported in *O. sanctum* are listed in **Table 1**.



FIG. 1: OCIMUM SANCTUM LINN.

TABLE 1: THE REPORTED CHEMICAL CONSTITUENTS OF *O. SANCTUM* LINN.

Plant Part	Category of Constituents	Name of the Constituent	References
Leaves	Flavonoid glycosides	Ocimumosides A and B, ocimarin and apigenin, apigenin-7- β -D-glucopyranoside, apigenin-7-O- β -D-glucuronic acid, luteolin, luteolin-7-O- β -D-glucuronic acid,	1
Seed	Fixed oil	palmitic acid, stearic, oleic, linoleic and linolenic	2
Leaves	Polysaccharide	Mucopolysaccharide, hyaluronic acid	3
Leaves	Volatile oil	Eugenol, methyl eugenol and caryophyllene	4
Seed	Phenolic acid	Rosmarinic acid	5
Leaves	Neolignan	-allyl-3',8-dimethoxy-flavan-3,4'-diol, 6-allyl-3-(4-allyl-2-methoxyphenoxy)-3', 8-dimethoxyflavan-4'-ol, 5-allyl-3-(4-allyl-2-methoxyphenoxy)-2-(4-hydroxy-3-methoxyphenyl)-7-methoxy-2,3-dihydrobenzofuran, 2-bis (4-allyl-2-methoxyphenyl)-2-(4-hydroxy-3-methoxyphenyl)-7-methoxy-2,3-dihydrobenzofuran, 2-bis (4-allyl-2-methoxyphenoxy)-3-(4-hydroxy-3-methoxyphenyl)-3-methoxypropane, 2-bis (4-allyl-2-methoxyphenoxy)-3-(4-hydroxy-3-methoxyphenyl)-3-methoxypropane, 11-(4-hydroxy-3-methoxyphenyl)-1,2,3-tris (-allyl-2-methoxyphenoxy) propane, 1-allyl-4-(5-allyl-2-hydroxy-3-methoxyphenoxy)-3-(4-allyl-2-methoxyphenoxy)-5-methoxybenzene, 3-(5-allyl-2-hydroxy-3-methoxyphenyl)-1-(4-allyl-2-hydroxy-3-methoxyphenyl)-1-(4-hydroxy-3-methoxyphenyl)-prop-1-ene	6
Leaves / aerial parts	Phenolic compounds	Aesculetin -glucuronide, triacontanol ferulate, vicenin-2-, circineol, gallic acid, galuteolin, isorientin, isovitexin, circineol, luteolin, molludistin, orientin, procatechuic acid, stigmasterol, ursolic acid, vallinin, viceni, vitexin, vallinin acid	7, 8, 9
Whole plant	Vitamin and mineral contents	Vitamin C, vitamin A, vitamin E, calcium, phosphorus, chromium, copper, carotene, zinc, iron, nickel	7, 10
Leaves	Essential oil	Aromadendrene oxide, borneol, caryophyllene oxide, bornyl acetate,	8, 11, 12

Seeds	Fixed oil	benzaldehyde, veridifloro, cubenol, cardinene, d-limonene, eicosane, eucalyptol, eugenol, methyl eugenol, farnesene, farnesol, furaldehyde, germacrene, heptanol, humulene, limonene, cis- α -Terpineol, n-butyl benzoate, ocimene, oleic acid, sabinene, selinene, α -camphene, α -pinene, camphor, α -myrcene, β -pinene, α -Thujene, β -Guaiene, β -gurjunene, methyl chavicol, linalool, circimaritin, phytol, isothymusin, apigenin, rosameric acid, octane, cadinene, borneol	7, 13
		Stearic acid, linoleic acid, oleic acid, palmitric acid, linolenic acid, sitosterol, linodilinolin, dilinoleno-linolins, hexoureic acid	

Ethanopharmacological Review: As per the available literature, the plant is found to be hepatoprotective, immunomodulatory, anti-cancer, anti-diabetic, anti-ulcer and as an antibacterial

agent. Some of the reported pharmacological activities of *O. sanctum* are mentioned with scientific evidence in **Table 2**.

TABLE 2: THE REPORTED PHARMACOLOGICAL ACTIVITY OF *OCIMUM SANCTUM* LINN.

Plant Part	Type of Extract	Model of Study	Activity	References
Leaves	Aqueous	<i>In-vivo</i>	Hyperlipidemic	14
Leaves	Alcoholic	<i>In-vivo</i>	Antioxidant	15
Leaves	Hexane	<i>In-vitro</i>	Sexual disease	16
Leaves	Aqueous, alcoholic	Toxicity studies	Wound healing, antioxidant	17
Leaves	Alcoholic	<i>In-vivo</i>	Cardiac	18
Leaves	Ethanollic	<i>In-vivo</i>	CNS	19
Leaves	Ethanollic	<i>In-vitro</i>	Diabetic Mellitus	20
Leaves	Ethanollic	<i>In-vivo</i>	Anti-ulcerogenic	21
Leaves	Alcoholic	<i>In-vivo</i>	Antinociceptive	22
Seed	P. ether	Cell line	Immunomodulatory	23
Seed	-	<i>In vitro</i>	Chemopreventive	24
Leaves, stem, root, flower	Ethanollic	<i>In-vitro</i>	Antiplasmodial activity	25
Leaves	Ethanollic	<i>In-vitro</i>	Human monocyte (THP-1) cell activation	26
Whole plant	Methanollic	<i>In-vitro</i>	Influenza virus (H1N1)	27
Seed	Essential oil	<i>In-vitro</i>	Induce apoptosis in <i>Candida albicans</i>	28
Leaf	Aqueous	<i>In-vivo</i>	Antiplasmodial activity	29
Whole plant	Essential oil	<i>Ex-vivo</i> and <i>in- vivo</i>	Antibacterial and anti-inflammatory	30
Whole plant	Essential oil	<i>In-vitro</i>	Antimicrobial and antioxidant activity	31
Whole plant	Essential oil & Ethanollic	<i>In-vivo</i>	Anti-inflammatory, gastrointestinal and hepatoprotective effects	32
Whole plant	Hydroalcoholic	<i>In-vivo</i>	Neuroprotective activity	33
Whole plant	Ethanollic	<i>In-vivo</i>	Anti-aging, anti-stress and ROS scavenging activity	34
Whole plant	Ethanollic	<i>In-vivo</i>	Anticancer	35
-	-	<i>In-vivo</i>	Chemopreventive activity	36
Leaf	Ethanollic	<i>In-vivo</i>	Human pancreatic cancer cell	37
Whole plant	Ethanollic	<i>In-vivo</i>	Mutagenic potential	38
Whole plant	Ethanollic	<i>In-vivo</i>	Stress-induced anxiety	39
Whole plants	Ethanollic	<i>In-vivo</i>	Stress-induced central monoaminergic and oxidative changes in rats	40
Whole plants	Ethanollic	<i>In-vivo</i>	Fatigue stress	41
Leaves	Ethanollic	<i>In-vitro</i>	Typhoid fever	42
Whole	Ethanollic	<i>In-vivo</i>	Cerebral ischemia/ reperfusion	43
Whole	Methanollic	<i>In-vivo</i>	Anti-dengue activity	44
Whole	Aqueous	<i>In-vivo</i>	Ameliorative activity	45
Leaves	Ethanollic	<i>In-vivo</i>	Lipid lowering and antioxidant activity	46
Whole	Ethanollic	<i>Ex-vivo</i>	Larvicidal activity	47
Whole	Ethanollic	<i>Ex-vivo</i>	Antifungal activity	48
Leaf	Alcoholic and aqueous	<i>In-vivo</i>	Cognitive disorders	49
Aerial parts	Hydroalcoholic extracts	<i>In-vivo</i>	Anti-diabetic activity	50

Whole plant	Aqueous	<i>In-vivo</i>	Anti-diabetic activity	51
Leaves	Alcoholic	<i>In-vivo</i>	Hepatoprotective activity	52
Leaves	Hydroalcoholic	<i>In vivo</i>	Antioxidant activity	15
Leaf	Aqueous	<i>In-vitro</i>	Thrombolytic activity	53
Leaf	Alcoholic	<i>In vivo</i>	Effect on sperm count and reproductive hormones	54
Leaves	Hydroalcoholic	<i>In-vivo</i>	Antimelanoma and radioprotective activity	55
Seed	Fixed oil	<i>In-vivo</i>	Anti-hyperlipidemic and cardioprotective activity	56
Leaves	Ethanollic	<i>In-vivo</i>	Anxiety and depression	57
Leaves	Aqueous	<i>In-vivo</i>	Anxiety and depression	58
Leaves	Powder	<i>In-vivo</i>	Reversal of cadmium-induced oxidative stress	59
Leaf	Essential oil	<i>Ex-vivo</i>	Antifungal activity	28
Leaves	Aqueous	<i>Ex-vivo</i>	Wound healing activity	60
Leaves	Ethanollic	<i>In-vivo</i>	Effect on homocysteine levels and lipid profile	61
Leaves	Ethanollic	<i>In-vivo</i>	Effect on macrophage function and oxidative stress	62
Leaves	Essential oil	<i>Ex-vivo</i>	Anti-candidal activity	63
Leaves	Essential oil	<i>In-vivo</i>	Respiratory tract infection	64
Leaves	Ethanollic	<i>In-vivo</i>	Cardioprotective activity	65
Leaves	Aqueous	<i>In-vivo</i>	H ₂ O ₂ induced cytotoxicity changes in human lens epithelial cells	66
Leaves	Ethyl acetate	<i>In-vivo</i>	Leishmanicidal activity	6
Seed	Essential oil	<i>In-vivo</i>	Immune response	67
Leaves	Ethanollic	<i>In-vivo</i>	Arsenic induced toxicity	68
Leaves	Ethanollic	<i>In-vivo</i>	Anti-fertility activity	69
Leaves	Aqueous	<i>Ex-vivo</i>	Nematicidal	70
Leaves	Aqueous	<i>In vivo</i>	Humoral immune response	71
Leaves	Alcoholic	<i>In vivo</i>	Modulatory activity	72
Leaves	Water or hydroalcoholic	<i>In-vivo</i>	Radioprotective activity	73
Leaves	Alcoholic	<i>In-vivo</i>	Anti-diabetic activity	74
Leaves	Alcoholic	<i>In-vivo</i>	Radioprotection	75
Leaves	Alcoholic	<i>In-vivo</i>	Regulation of thyroid function	76
Leaves	Alcoholic	<i>In-vivo</i>	Anti-inflammatory	2
Leaves	Volatile	<i>In-vivo</i>	Anthelmintic activity	77
Leaves	Alcoholic	<i>In-vitro</i>	Radioprotective, anticarcinogenic and antioxidant properties	78
Seed	Oils	<i>In-vivo</i>	Chemopreventive activity	24
Whole	Ethanollic	<i>In-vivo</i>	Radiation protection of human lymphocyte chromosomes	79
Whole	Ethanollic	<i>In-vivo</i>	Anti-atherogenic activity	80
Leaves	Aqueous	<i>In-vivo</i>	Cardioprotective activity	81
Leaves	Alcoholic	<i>In-vivo</i>	Antinociceptive action	22
Leaves	Ethanollic	<i>In vivo</i>	Anti-diabetic activity	82
Seed	Oils	<i>In-vivo</i>	Immunomodulatory	23
Leaves	Aqueous	<i>In vivo</i>	Anti-diabetic activity	20
Leaves	Ethanollic	<i>In-vivo</i>	Cardioprotective activity	21
Leaves	Fixed oils	<i>In-vivo</i>	Hypertensive activity	83
Leaves	Ethanollic	<i>In-vivo</i>	Myocardial necrosis	84
Leaves	Ethanollic	<i>In-vivo</i>	Oral cancer	85
Leaves	Ethanollic	<i>In vivo</i>	Acute noise stress	19
Whole	Ethanollic	<i>In-vivo</i>	Hypoglycemic activity	86
leaves	Water and aqueous	<i>In-vivo and in-vitro</i>	Inhibition of lipid peroxidation	87
Leaves	Methanollic	<i>In-vivo</i>	Antioxidant and hepatoprotective activity	11
Whole	Ethanollic	<i>Ex-vivo</i>	Nitric oxide scavenging activity	88
Leaves, stem	Ethanollic, chloroform	<i>In-vivo</i>	Anticonvulsant activity	89
Leaves	Ethanollic extract	<i>In-vivo</i>	Hepatoprotective activity	90
Whole	Ethanollic	<i>In-vitro</i>	Lens aldose reductase inhibitor	91
Whole	Ethanollic	<i>In-vitro</i>	Modulates selenite exposed management of rat lens opacification and cataractogenic changes and	92

Whole	Aqueous	<i>In-vivo</i>	Protective activity	93
Leaves	Aqueous	<i>In-vivo</i>	Protective effect against Cr/Hg induced genetic damage	94
Seed	Oils	<i>In-vivo</i>	Anti-diabetic, anti-hypercholesterolemia and antioxidant effect	95
Leaves	Ethanollic	<i>In-vivo</i>	stimulate insulin from clonal pancreatic beta cells and perfused pancreas isolated islets	96
Leaves	Ethanollic	<i>In-vivo</i>	Anti-diabetic activity	20
Leaves	Ethanollic	<i>In-vivo</i>	Hypoglycemic and antioxidant	97
Leaves	Ethanollic	<i>In-vivo</i>	Anti-ulcerogenic and ulcer-healing properties	21
Leaves	Aqueous	<i>In-vivo</i>	Ameliorating 131 iodine-induced damage to the salivary glands	93
Leaves	Ethanollic	<i>In-vivo</i>	Anti-tussive activity	98
Leaves	Methanollic	<i>In-vivo</i>	Gastric mucosal offensive and defensive factors	99
Leaves	Aqueous	<i>In-vivo</i>	Immunotherapeutic potential	100
Leaves	Ethanollic	<i>In-vivo</i>	Anti-stressor activity	101
Leaves	Ethanollic	<i>In-vivo</i>	Inhibit DMBA induced genotoxicity and oxidative stress	102
Leaves	Ethanollic	<i>In-vivo</i>	Anti-stress activity	1
Leaves	Ethanollic	<i>In-vitro</i>	Modulatory activity	103
Leaves	Ethanollic	<i>In-vitro</i>	Anti-metastatic activity	104
Leaves	Ethanollic	<i>In-vivo</i>	Anxiety disorder	105
Leaves	Ethanollic	<i>In-vivo</i>	Ameliorative effect	106
Leaves	Aqueous	<i>In-vivo</i>	Pretension of insulin resistances	107
Leaves	Hydroalcoholic	<i>In-vivo</i>	Peptic ulcer	108
Leaves	Ethanollic	<i>In-vivo</i>	Anti-diabetogenic properties	109
Whole	Aqueous	<i>In-vivo</i>	Wound healing activity	3
Whole	Hydroalcoholic	<i>In-vivo</i>	Cardiac changes in rats	18

CONCLUSION: Holy basil has been widely used for curing various ailments due to great pharmacological and phytochemical moieties, therefore, a review of the plant has been summarized up-to-date information on the ethnomedicinal, phytochemical and pharmacological activity.

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