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A review on *Tulasi (Ocimum sanctum Linn.)*

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ABSTRACT

Ocimum sanctum Linn is one of the important medicinal plant; known as holy basil. It is commonly available and cultivated across the India and it is having many therapeutic usages. And it is widely used in *Ayurveda* for the treatment of various disorders. It is extensively used as antioxidant, immune-modulatory, antipyretic, anticancer, chemo-preventive, radio-protective, anti-hypertensive and cardio protective and antimicrobial activity etc. The present article provides all necessary information regarding its classical literature and research updates on Phytoconstituents and pharmacological activities.

Keywords: *Ayurveda, Tulasi, Ocimum sanctum Linn.*

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INTRODUCTION

Tulasi is widely used in Indian system of medicine; Known as holy basil and it is also called as *Vishnupriya* means the one that pleases Lord Vishnu. It is commonly available and cultivated across the India and botanically called *Ocimum sanctum, Tulasi* belongs to plant family Lamiaceae and it is one of the popular home remedy for Swasa (Asthma) and Kasa (Cough).

Bhrhat trayi not used the term *Tulasi* to indicate it. Its synonym *Surasa* is mainly used by them in their work while *Charaka* quoted *Apetaraksasi* as the synonym and included under the name *surasa* in the *Swasahara* group.[1] *Susruta* described two kinds *Surasa dwi* in the context of *Surasadi gana.*[2]

Tulasi is found Throughout India ascending up to 1800 m in the Himalayas, commonly cultivated in gardens and courtyards. It is a Perennial herb with a typical aromatic smell, which grows up to 30 – 60 cm high, much branched. Stems and branches usually purplish, Sub quadrangular, sometimes woody below, Clothed with soft spreading hairs. Stem: Erect, branched, quadrangular, slightly woody, solid, branches covered with soft hairs. **Leaves:** 2.5 by 1.6 – 3.2 cm, Elliptic –oblong, obtuse or acute, entire or serrate, pubescent on both sides, minutely gland – dotted, base obtuse or acute, petioles 1.3 – 2.5 cm long, slender, hairy

Inflorescence: Verticillaster. **Flowers:** Racemes 15 – 20 cm long in close whorls, bract nearly 3 mm long and almost as broad as long, broadly ovate with a long slender acuminate, ciliate, pedicels longer than the flowering calyx, slender, pubescent. **Fruit**: Nutlets 1.25 mm long, broadly ellipsoid, nearly smooth, yellow with black markings.[3, 4]

The present review attempts to compile information from regarding *Tulasi* including synonyms, classification, properties, actions and formulations from *bhrihatrayee* (classicaltexts), *nighantu* (lexicons) *sangrahagranthas* (compendia), text related to *prayoga* (therapeutic use) and ethno medical books in systematic manner.

GANA VARGEEKARANA

Tulasi has been categorized under various *Gana* or *varga* (groups) in the classical *Sahmita's* and *Nighantu's* (lexicons) of Ayurveda

Table 1: Showing *Gana vargeekarana* of *Tulasi* in *Samhita's* and *Nighantu's*.[1,2,5,6,7,8,9,10,11,12,13,14,15,16]

SAMHITA AND *NIGHANTU*	*VARGA/GANA*
Charaka Samhita	*Shwasahara gana*
Susruta Samhita	*Surasadi gana*
Astanga Hridaya	*Surasadi gana* and *Kaphaghna gana*
Astanga Sangraha	*Shwasahara gana* and *Surasadi gana*
Bhavaprakasha Nighantu	*Pushpa varga*
Raja Nighantu	*Karaviryadi varga*
Dhanwantari nighnatu	*Karaviryadi varga*
Madanapaala nighantu	*Karpuradi varga*
Kaiyadeva Nighantu	*Oushadi varga*
Shodala nighantu	*Karaviryadi varga*
Priya Nighantu	*Shatapushpadi varga*
Haritakyadi nighantu	*Pushpa varga*
Saligrama nighantu	*Pushpa varga*
Nighantu adarsha	*Tulsyadi varga*

SYNONYMS

Synonyms are the different alternative names defined for particulars in various parts. These synonyms are having specific meaning which gives an idea about the Mythological information Morphological features, Pharmacological properties, Traditional use and Ethno botanical use.

Table 2: Showing various synonyms of *Tulasi (Ocimum sanctum* Linn.*)*

PARYAYA	**BN**[7]	**DN**[9]	**RN**[8]	**KN**[11]	**MPN**[10]	**SN**[12]	**PN**[13]	**Sh.N**[15]	**NA**[16]
Tulasi	+	+	+	+	+	+	+		+
Surasa	+	+	+	+	+	+	+		+
Gramya	+	+		+		+	+		
Sulabha	+								
Bahumanjari	+	+			+	+			+
Apetarakshasi	+	+	+			+			+
Gowri	+	+	+	+	+	+			
Bhutaghi	+	+	+	+	+	+	+		
Devadundubhi	+	+		+		+	+		+
Surabhi		+	+	+		+			
Thivra			+						
Pavani			+						
Vishnuvallabha			+						
Surejya			+						
Kayastha			+	+					
Suradundubhi			+						
Bahupatri			+						
Manjari			+	+					
Haripriya			+						
Shyama			+						
Tridashamanjari			+						
Putapatri			+						
Putapriya				+					
Shrimanjari				+					
Burimanjari				+					
Nagamata				+					
Sumanjari				+					
Butapati				+					
Rajasi				+					
Dalasagrasi				+					
Grasa				+					
Pavitra								+	
Suravallari								+	
Patrapuspa								+	
Sugandha								+	
Andharohini								+	
Mala						+			
Swadugandhachhada				+					
Bhuteshta				+					
Chakraprni				+					
Sakrapatni				+					

Vishnuhita						+			
Vishnupriya						+			
Shrestamata						+			
Vaishnavi								+	
Vrindha								+	+
Amrutha								+	

BN-*Bhavaprakasha Nighantu*, **DN**-*Dhanwantarinighantu*, **RN**-*Raja Nighantu*, **KN**-*Kaiyyadevanighantu*, **MPN**- *Madanapalanighantu* , **SN**-*Shodalanighantu* **, PN**-*Priyanighantu*, **Sh.N –** *Shaligrama Nighnatu,* **NA**-*Nighantuadarsha.*

VERNACULAR NAMES

Vernacular names are different names of the drug in different languages and hence helpful in identifying the drug in the other parts of world.

Table 3: Showing the Vernacular names of *Tulasi*[17]

LANGUAGES	VERNACULAR NAMES
Hindi	Kalatulasi, Tulasi
Kannada	Vishnu tulasi, Kari tulasi, Sri tulasi, Tulashi-gida
English	Holy Basil
Malayalam	Tulasi, Trttavu karuttarttavu, Niella tirtua, Krishna - tulasi,Shiva tulasi
Telugu	Tulasi, Gaggera - chettu
Tamil	Tulaci.Karuttulaci
Bengali	Tulasi, Krishna tulasi
Gujarati	Tulasi, Talasi
Punjab	Bantulsi, Tulsi
Marathi	Tulasa, Tulasi
Konkani	Tulsi

VARITIES

Classical *Nighantu's* of Ayurveda refer to different types/varieties of *Tulasi* based on the color of leaves.

Table 4: Showing Varieties of *Tulasi*

VARITIES	BN[7]	RN[8]	KN[11]	PN[13]	Sh.N[15]	NA[16]	HN[14]
Shweta tulasi	+	+	+	+	+	+	+
Krishna tulasi	+	+	+	+	+	+	+
Karpura tulasi			+				
Ram tulasi						+	

BN-*Bhavaprakasha Nighantu*, **RN**-*Raja Nighantu*, **KN**-*Kaiyyadevanighantu*, **PN**-*Priyanighantu*, **Sh.N –** *Shaligrama Nighnatu,* **NA**-*Nighantuadarsha.***HN -** *Haritakyadi Nighantu*

Table 5: Showing Varieties of *Ocimum sanctum* Linn.[18]

S N	LATI N NAME	SANSKRIT ANME	ENGLISH NAME
1	*Ocimum sanctum*	*Tulasi*	Holy basil
2	*Ocimum basillicum*	*Barbari*	Sweet basil
3	*Ocimum gratissimum*	*Phanijjaka*	Shrubby basil
4	*Ocimum americanum*	*Sweta tulasi*	Common basil/American basil
5	*Ocimum Kilimandcharicum*	*Karpura tulasi*	Camphor basil
6	*Ocimum minimum*	*Marubaka*	Bush basil
7	*Ocimum pilosum*	*Kharapushpa*	Green basil

RASA PANCHAKA

In Ayurveda, the actions of any herb are analyzed based on the five basic principles, *Rasa* (taste), *Guna*(properties), *Virya* (potency), *Vipaka*(aftertaste), *Prabhava*(specialaction).

Table (06) shows the opinion on the pharmacological properties as stated in different lexicons.

Table 6: Showing *Guna karma of Tulasi (Ocimum sanctum* Linn.)

GUNA		BN[7]	RN[8]	DN[9]	KN[11]	PN[13]	Sh.N[15]	NA[16]
Rasa	*Katu*	+	+		+	+	+	+
	Tikta	+	+		+	+	+	+
	Kasaya				+			
Guna	*Laghu*			+				
	Tikshna				+			
	Ushna	+					+	
	Ruksha			+	+			
Virya	*Ushna*		+	+	+	+		+
Vipaka	*Katu*				+			+
Doshagnata	*Vatakaphahara*	+	+		+	+	+	+
	Kaphahara			+				

BN-*Bhavaprakasha Nighantu*, **RN**-*Raja Nighantu*, **DN**-*Dhanwantarinighantu* **,KN**-*Kaiyyadevanighantu*, **PN**-*Priyanighantu*, **Sh.N –** *Shaligrama Nighnatu* **,NA**-*Nighantuadarsha.*

KARMA (ACTIONS) AND *ROGAGNATA* (INDICATIONS)

The action of any herb is analyzed on the basis of its effect on the *Dosha* (Humors) of the body. It has been stated that *Tulasi* has *Vatakapha* action, i.e. it mitigates *Vata* and *kapha dosha*.

Table 7: Shows Tulasi pharmacological actions as listed in different lexicons.

Table 7: Showing *Karma* and *Rogaganta* of *Tulasi* (*Ocimun sanctum Linn*.)

KARMA* AND *ROGHAGNATA	BN[7]	RN[8]	DN[9]	MPN[10]	KN[11]	SN[12]	PN[13]	Sh.N[15]	N.A[16]
Agnidipani	+		+	+	+	+	+	+	
Kushtajit	+			+	+			+	
Krcchrasrajit	+			+				+	
Parshwarukjit	+			+	+	+		+	
Pittakrut	+			+	+		+	+	
Hridya	+			+	+	+		+	
Dahakrut	+			+	+			+	
Krimidoshanihanti		+	+		+				
Ruchikrut		+	+						
Jantubhutakrumihara		+							
Shwasahara					+	+	+		
Kasahara	+			+	+	+	+		
Hikkahara	+			+	+	+			
Krumisudana	+			+					
Pratishyayaghna	+			+					
Vranyashodana	+			+					
Jwaraghna							+		
Chardighna					+				
Mutrakrcchra					+				
Ashmari					+				
Netraroga					+				
Vishaghna					+				
Putigandha						+			

BN-*Bhavaprakasha Nighantu*, **RN**-*Raja Nighantu*, **DN**-*Dhanwantarinighantu*, **MPN**- *Madanapalanighantu* , **KN**-*Kaiyyadevanighantu*, **SN**-*Shodalanighantu* **, PN**-*Priyanighantu*, **Sh.N –** *Shaligrama Nighnatu,* **NA**-*Nighantuadarsha.*

CLASSICAL THERAPEUTIC USES: [19]

1) ***Kasa*:** The juice of black *Tulasi* mixed with honey is useful in cough caused by *Kapha*.
2) ***Kushta*:** *Mula swarasa* should be taken daily in the early morning.
3) ***Sheetapitta*:** Applictaion of *Tulasi* juice is the best remedy.
4) ***Vishamajwara:*** Leaves juice mixed with *Maricha* powder should be taken.
5) ***Karnashula,Vranaprakshalana,Krmidamsa* and *carmaroga***: Leaves juice is useful.
6) ***Mutrakrcchra:*** Seeds are useful.
7) ***Krimi***: The drugs of *surasadi gana* separately should be taken with honey.
8) ***Visha***: In case of poison located in head, one should take as snuff, the roots of *Bandhuka, Bhargi* and black *tulasi*
9) ***Karnashula:*** Oil cooked with *surasadi* drugs should be filled in the ear. It removes pain.
10) ***Pakshmashata***: *Pushpakasisa* is powdered and impregnated with *Tulasi* juice in a copper vessel for ten days used as collyrium.
11) **Conjuctivites**:Juice of *tulasi* mixed with honey should be used as collyrium.

12) ***Vrana***: Sprinkling with the juice of *surasadi* drugs or paste of garlic destroys the maggots in wound.

13) **Indigestion**: Water boiled with the root of *Shweta tulasi* and *sunthi* removes indigestion immediately.

14) ***Makkalla* (Post-partum pain):** Intake of the juice of *tulasi* mixed with old jaggery and wine -scum removes pain.

15) **Pediatric disorders**: *Lavanga,tulasi* leaves and *tankana* all pounded together should be given to the child, it alleviates *jwara, kasa, shwasa* and abdominal disorders.

FORMULATIONS

Table 8: Showing list of formulations containing *Tulasi* as a major ingredient.[20,21,22,23,24,25,26,27]

SI.NO	*Yogas*	Dosage form	Indications
1	*Anu taila*	*Taila*	*Urdhwajatru roga*
2	*Marichyaadi taila*	*Taila*	*Apatantraka*
3	*Nili nishadi taila*	*Taila*	*Kapala vyadhi*
4	*Nirgundi taila*	*Taila*	*Karna roga*
5	*Tulasiswarasadi taila*	*Taila*	*Pinasa, nasa daurgandhya*
6	*Vrana ropana taila*	*Taila*	*Swasa, kasa,jwara*
7	*Vyagree taila*	*Taila*	*Putinasa, sita jwara*
8	*Agurvadya taila*	*Taila*	*Sitajwara*
9	*Manasamitra vati*	*Vati*	*Manasika vyadhi's*
10	*Bilvadi gutika*	*Vati*	*Sarpa, luta visha*
11	*Surasaadigana kwatha*	*Kwatha*	*Bala graha, krimi*
12	*Ksudraadi kwatha*	*Kwatha*	*Jihvaka*
13	*Swasahara kashaya churna*	*Churna*	*Swasa*
14	*Kustadi lepa*	*Lepa*	*Kusta, visarpa*
15	*Dadhika grita*	*Grita*	*Apasmara,unmade*
16	*Dasamoola grita*	*Grita*	*Grahini, kasa*
17	*Hingusauvarcaladya ghrita*	*Ghrita*	*Vatagulma*
18	*Kandvadou lepa*	*Lepa*	*Charma roga*
19	*Nimbaadi lepa*	*Lepa*	*Kusta, visarpa*
20	*Jwarankusha rasa*	*Rasa*	*Ekadoshaja jwara*
21	*Cintamani rasa*	*Rasa*	*Sannipata jwara.swasa, kasa*
22	*Jwarankusha rasa*	*Rasa*	*Sarva jwara*
23	*Vishma jwara rasa*	*Rasa*	*Vishama jwara*
24	*Muktaadi mahanjana*	*Anjana*	*Netra roga*
25	*Amavata rasayoga*	*Rasa*	*Amavata*
26	*Sitakesari rasa*	*Rasa*	*Seeta jwara*
27	*Sannipata bhairava rasa*	*Rasa*	*Sannipata jwara*
28	*Vasanta kusumakara rasa*	*Rasa*	*Amashaya gata roga*
29	*Sannipata bhairava rasa*	*Rasa*	*Sannipata jwara, kandu*
30	*Tribhuvanakeerti rasa*	*Rasa*	*Vatakaphajajwara*
31	*Tulasi arka*	*Arka*	*Shawsa,Kasa*

PROPAGATION AND CULTIVATION: [28]

The plant grows in a variety of soil and climatic conditions. Well drained soil, humid weather, long days and high temperature are favorable for good growth of the plant and high yield of essential oil.

Plants are propagated by seeds. Direct planting and fresh seeds are preferred. Plants are spaced at a distance of 50cm ×50 cm. A fertilizer dose comprising of 80 kg N and P_2O_5 is optimum for a hectare. While preparing land 25 tonnes of FYM is to be incorporated with soil. For higher yield of essential oil, leaves and tender shoots are to be harvested at full bloom stage. It can be propagated through tissue culture technique by inoculating axillary buds on MS medium supplemented with 1 mg/BAP. The shoots thus obtained, are rooted on half strength MS medium supplemented with 1 mg/1 NAA

SUBSTITUTE AND ADULTERANTS: [28]

The leaves of other species of *Ocimum* are often adulterated with genuine drug.

DISCUSSION

Tulasi has been attributed with *Katu,Tikta* and *kashaya rasa*, *Ushna virya, Katu vipaka* and it has *Laghu, Tikshna, Ushna* and *Ruksha guna*. It pacifies *kapha,vatadoshas. Tulasi* is being used as an ingredient in many formulations and it used both internally and externally.

Tulasi has been investigated for antioxidant, immune-modulatory, antipyretic, anticancer, chemo-preventive, radio-protective, antihypertensive, cardio protective, antimicrobial, anti-inflammatory, analgesic, memory enhancer, hepato-protective, anti-fertility, anti-diabetic, antiulcer, anti-arthritic, adaptogenic /antistress and anti-cataract activities.

ANTIOXIDANT ACTIVITY

Antioxidant activity of the flavonoids (orientin and vicenin) in vivo was expressed in a significant reduction in the radiation induced lipid peroxidation in mouse liver.[29] OS extract has significant ability to scavenge highly reactive free radicals28. The phenolic compounds, viz., cirsilineol,

cirsimaritin, isothymusin, apigenin and rosmarinic acid, and appreciable quantities of eugenol (a major component of the volatile oil) from OS extract of fresh leaves and stems possessed good antioxidant activity.[30]

IMMUNOMODULATORY ACTIVITY

Steam distilled extract from the fresh leaves of OS showed modification in the humoral immune response in albino rats which could be attributed to such mechanisms as antibody production, release of mediators of hypersensitivity reactions and tissues responses to these mediators in the target organs.[31] OS seed oil appears to modulate both humoral and cell-mediated immune responsiveness and GAB ergic pathways may mediate these immunomodulatory effects.[32]

ANTIPYRETIC ACTIVITY

The antipyretic activity of OS fixed oil was evaluated by testing it against typhoid paratyphoid A/B vaccine-induced pyrexia in rats. The oil on ip administration considerably reduced the febrile response indicating its antipyretic activity. At a dose of 3 ml/kg, the antipyretic activity of the oil was comparable to aspirin. Further, the fixed oil possessed prostaglandin inhibitory activity and the same could explain its antipyretic activity.[33]

ANTICANCER ACTIVITY

The alcoholic extract (AlE) of leaves of OS has a modulatory influence on carcinogen metabolizing enzymes such as cytochrome P 450, cytochrome b5, aryl hydrocarbon hydroxylase and glutathione S-transferase (GST), which are important in detoxification of carcinogens and mutagens.[34] The anticancer activity of OS has been reported against human fibrosarcoma cells culture, wherein AlE of this drug induced cytotoxicity @50 □g/ml and above. Morphologically, the cells showed shrunken cytoplasm and condensed nuclei. The DNA was found to be fragmented on observation in agarose gel electrophorosis.[35]

CHEMOPREVENTIVE ACTIVITY

The chemopreventive effect of OS leaf extract is probably through the induction of hepatic/extra hepatic GST in mice. Elevated levels of reduced GSH in liver, lung and Stomach tissues in OS extract supplemented mice were also found.[36] Significant antiproliferative and chemo preventive activities were observed in mice with high concentration of OS seed oil.[37] The potential chemopreventive activity of seed oil has been partly attributed to its antioxidant activity.[38]

RADIOPROTECTIVE ACTIVITY

The radio protective effect of OS was firstly reported in the year 1995.[39]Two isolated flavonoids, viz., orientin and vicenin from OS leaves showed better radio protective effect as compared with synthetic radio protectors. They have shown significant protection to the human lymphocytes against the clastogenic effect of radiation at low, nontoxic concentrations.[40] The combination of OS leaf extract with WR-2721 (asynthetic radio protector) resulting in higher bone marrow cell protection and reduction in the toxicity of WR-2721 at higher doses, suggested that the combination would have promising radioprotection in humans.[41]

ANTIHYPERTENSIVE AND CARDIO PROTECTIVE ACTIVITIES

The transient cerebral ischemia and long term cerebral hypoperfusion (causing cellular oedema, gliosis and perivascular inflammatory infiltrate) have been prevented by OS.[42]The OS fixed oil administered intravenously produced hypotensive effect in anaesthetized dog, which seems to be due to its peripheral vasodilatory action. Essential fatty acids like linoleic and linolenic acids, contained in the OS oil produce series 1 and 3 (PGE1 and PGE3) prostglandins and inhibit the formation of series 2 prostglandins (PGE2).[43]The long term feeding of OS offers significant protection against isoproterenol-induced myocardial necrosis in Wistar rats through enhancement of endogenous antioxidant.[44]

ANTIMICROBIAL ACTIVITY

AqE of OS showed growth inhibition for Klesbiella, E. coli, Proteus and Staphylococcus aureus; while AlE of OS showed growth inhibition for Vibrio cholerae.[45] The AlE of OS was also found to be active against multidrug-resistant strains of S. aureus that are also resistant to common beta lactam antibiotics.[46] Similarly, OS was found to be active against resistant Neisseria gonorrhea strains.[47] OS fixed oil showed good antibacterial activity against Bacillus pumilus, Pseudomonas aeruginosa and S. aureus. Higher content of linolenic acid in OS fixed oil could contribute towards its antibacterial activity.[48]

ANTI-INFLAMMATORY ACTIVITY

Methanolic extract (500 mg/kg) and aqueous suspension of OS showed analgesic, antipyretic and anti-inflammatory effects in acute (carrageenan-induced pedal oedema) and chronic (croton oil induced granuloma and exudate formation) inflammations in rats.[49] The fixed oil and linolenic acid possess significant anti-inflammatory activity against PGE2, leukotriene and arachidonic acid induced paw oedema in rats by virtue of their capacity to block both the cyclooxygenase and lipoxygenase pathways of arachidonic acid metabolism.[50]

ANALGESIC ACTIVITY

The OS oil was found to be devoid of analgesic activity in experimental pain models (tail flick, tail clip and tail immersion methods). However, it was effective against acetic acid induced writhing method in mice in a dose dependent manner. The writhing inhibiting activity of the oil is suggested to be peripherally mediated due to combined inhibitory effects of prostaglandins, histamine and acetylcholine.[51]

MEMORY ENHANCER ACTIVITY

The AlE of dried whole plant of OS ameliorated the amnesic effect of scopolamine (0.4 mg/kg) and aging-induced memory deficits in mice. Passive avoidance paradigm served as the exteroceptive behavioural model. OS extract increased step-down latency (SDL) and acetylcholinesterase inhibition significantly. Hence, OS can be employed in the treatment of cognitive disorders such as dementia and Alzheimer's disease. [52]

HEPATOPROTECTIVE ACTIVITY

Oral administration of hydro-ethanolic extract of OS leaves @ 200 mg/kg in male Wistar albino rats gave protection against liver injury induced by paracetamol.[53] The cold water extract (3g/100 g, orally for 6 days) of OS was found to be effective against carbon tetrachloride (0.2 ml/100 g, subcutaneously) induced liver damage in albino rats.[54]

ANTIFERTILITY ACTIVITY

Benzene extract of fresh OS leaves in male rats showed decreased total sperm count, sperm motility and weight of testis.[55] The long term feeding (up to 3 months) of OS leaves (200 and 400 mg/kg) to adult male and female albino rats

along with normal diet decreased sperm count, sperm motility and weight of male reproductive organs.[56]

ANTIDIABETIC ACTIVITY

Oral administration of OS extract led to marked lowering of blood sugar in normal glucose fed hyperglycemic and streptozotocin-induced diabetic rats.[57] A randomized, placebo-controlled, cross over single blind human trial indicated a significant decrease in fasting and postprandial blood glucose levels by 17.6% and 7.3%, respectively. Urine glucose levels showed a similar trend. [58]Further, OS has aldose reductase activity, which may help in reducing the complications of diabetes such as cataract, retinopathy, and etc.[59]

ANTIULCER ACTIVITY

The fixed oil of OS administered intraperitoneally elicited significant antiulcer activity against aspirin, indomethacin, alcohol (ethanol 50%), histamine, reserpine, serotonin or stress-induced ulcers in rats.[33] The fixed oil significantly possessed antiulcer activity due to its lipoxygenase inhibitory, histamine antagonistic and antisecretory effects.[60]

ANTIARTHRITIC ACTIVITY

The anti-arthritic activity of OS fixed oil was evaluated against formaldehyde-induced arthritis in rats. The fixed oil significantly reduced the diameter of inflamed paw. On intra-peritoneal administration of the fixed oil daily for 10 days, there was marked improvement in the arthritic conditions in rats. The anti-arthritic effect at 3 ml/kg dose was comparable to aspirin @ 100 mg/kg, ip41. The fixed oil inhibited carrageenan and inflammatory mediators (e.g., serotonin, histamine, bradykinin and PGE2) induced inflammation. It is natural that the oil could inhibit any inflammatory response involving these mediators. The result suggests potentially useful anti-arthritic activity of the inflammation models; including adjuvant as well as turpentine oil induced joint oedema in rats.[61]

ADAPTOGENIC ACTIVITY/ANTISTRESS ACTIVITY

The immune-stimulant capacity of OS may be responsible for the adaptogenic action of plant.[62]The AlE of OS whole plant increased the physical endurance (survival time) of swimming mice, prevented stress induced ulcers and milk induced leucocytosis, respectively in rats and mice, indicating induction of non-specifically increased resistance against a variety of stress induced biological changes by OS in animals.[63]

ANTICATARACT ACTIVITY

The AqE of fresh leaves of OS delayed the process of cataractogenesis in experimental models of cataract (galactosemic cataract in rats by 30% galactose and naphthalene cataract in rabbits by 1 g/kg naphthalene). OS 1 and 2 g/kg delayed the onset as well as subsequent maturation of cataract significantly in both the models.[64]

CONCLUSION

The present review indicates the importance of Tulasi as one of the important medicinal plant described for its pharmacological actions and indications in the Ayurvedic lexicons and it is widely used in treating various types of jwara (fever), tamaka swasa (bronchial asthma), kasa (cough) and hikka (hiccough). The various researches have proved many of its activities mentioned in Ayurvedic classics and demonstrate its effective use in various diseases.

REFERENCES

1) Trikamji Yadvaji Acharya, Agnivesha Charaka Samhita Chakrapani Commentary, Sutrasasthan, Chapter 4, Shadvirechana shatasreetiya adyaya , Verse no. 37, Varanasi, Chaukhambha Surbharati Prakashana, Reprint 2011,p 34

2) Trikamji Yadvaji Acharya, Sushruta Samhita Nibandhadangarha commentary of Dalhanacharya, Sutrasthan, Chapter 38, Dravyasangrahaniya adhyaya ,Verse no.18-19, Chaukhambha orientalia,Varanasi, Reprint 2009,p-165

3) P.C.Sharma, M.BYelne, T.J.Dennis, Data base on medicinal plants used in Ayurveda, Vol 2, Delhi, CCRAS, Reprint 2005, p 500

4) Kirtikar Basu, Indian Medicinal Plants ,second edition, International Book Distributors, Dehradun,Vol 3, Reprint,1987,p 1965-6

5) Professor K.R.Srikantha Murthy, Vagbhata's Astanga Hridaya, Shodhanadigana sangraha adhyaya, Chapter 15, Vol 1, Verse 30-31,Varanasi, Krishnadas Academy, Second edition 1994, p 204

6) Professor K.R.Srikantha Murthy, Mahakasaya sangraha adhyaya, Chapter 15, Astanga Samgraha, Vol 1, Verse 34,Varanasi, Choukhambha orientalia , Second edition 1994, p 306

7) Professor K.C.Chunekar, Bhavaprakasha nighantu, Varanasi, Chaukhambha Bharati Academy, Reprint 2013,Verse 62,p 496

8) Narahari Pandit, Raja Nighantu, Karaveeradi varga, Varanasi, Choukhambha orientalia, First edition 2012, Verse 148, p 528

9) Dr S.D.Kamat, Dhanwantari Nighantu, Karaveera varga, Delhi, Chaukhambha Sanskrit Pratistan, 2002, p 301

10) JLN Shastry, Madanapaala Nighantu, First edition,2010, Varanasi, Chaukhambha orientalia,Vol 1,p 462

11) Priyavat Sharma, Kaiyadeva nighantu, First edition,1979,Varanasi, Choukhambha orientalia, p 633

12) Shodala with Gyanendra Pandey commentary, Shodala nighnatu, Karaveeradi varga, Varanasi, Choukhambha Krishnadas Academy, 2009,p-96.

13) P.V.Sharma, Priya nighantu, Shatapushpadi varga, Varanasi, Choukhambha Surbharathi Prathistan, First edition 1983, Verse 148, p 104.

14) P. Shivsharmaji, Haritakyadi nighantu, Bombay,Khemraj sri Krishnadas Prakashana,1900, p 160-61

15) Lal Saligram Vaishya, Saligrama nighantu, Bombay, Khemraj Srikrishnadas Prakashan,1995

16) Vaidya Bapalal, Nighantu Adarsha, Uttaraardha, Tulsyadi varga, 1st ed, Chaukambha Bharati Academy, Varanasi, 1985, p 266-270.

17) P.C.Sharma, M.BYelne, T.J.Dennis, Data base on medicinal plants used in Ayurveda, Vol 2, Delhi, CCRAS, Reprint 2005, p 500

18) Dr Prakash L.Hegde, Dr Harini A, A Text Book of Dravyaguna Vignana, Vol 2, Varanasi, Choukhambha Publications, 2014, p 828

19) Sharma PV, Classical use of Medicinal Plants, Chaukhamba Vishwabharati Varanasi, Reprint 2004, p 168-69

20) Vaidyar KVK, PillaiGS: Sahasrayogam, 21st ed.Vidyarambham Publishers, Alappuzha:1996.

21) Bhavamishra, Bhavaprakasha Dwitiya bagha uttarardha Edited with Vidyothini Hindi Commentary by Pandit sri Brahmasankara Misra, Chaukhambha Sanskrit Samsthana,Varanasi, 1st Edition; 1913.

22) Acharya Sharangadhara, Adhamalla, Pandit Kashirama. Sharangadhara Samhita, Dipika Gudhartha Dipika. 5thed.Varanasi; Chaukhambha Orientalia: 2002.

23) Shri Das Govind. Bhaishajya ratnavali, Mishra BS, Shastri AD, Shastri RD,(editors)19thed, ChukhmbhaPrakashan, Varanasi, 2008.

24) Sri Vaidya Shodala,Gadanigraha Hindi commentary by Triphati sri Indravdeva, Edited by Pandey GS, Chaukhambha Sanskrit Sansthan,Varanasi,Reprint;2011.

25) Trikamji Yadvaji Acharya, Agnivesha Charaka Samhita Chakrapani Commentary, Chikitssasthan, Varanasi, Chaukhambha Surbharati Prakashana, Reprint 2011.

26) Professor K.R.Srikantha Murthy, Vagbhata's Astanga Hridaya, Varanasi, Krishnadas Academy, Second edition 1994.

27) Ravana, Indradev Tripathy. Arkaprakasha. 2nd ed. Varanasi: Chowkamba Sanskrit Series; 2006.

28) P.C.Sharma, M.BYelne, T.J.Dennis, Data base on medicinal plants used in Ayurveda, Vol 2, Delhi, CCRAS, Reprint 2005, p 503.

29) Uma Devi P, Gonasoundari A, Vrinda B, Srinivasan KK, Unnikrishanan MK. Radiation protection by the Ocimum sanctum flavonoids orientin and vicenin: Mechanism of action. Radiat Res 154(4): 2000,455- 460.

30) Nair AGR, Gunasegaran R, Joshi BS. Chemical investigation of certain south Indian plants. Indian J Chem 21B:1982,979.

31) Mediratta PK, Dewan V, Bhattacharya SK, Gupta VS, Maiti S, Sen P. Effect of Ocimum sanctum Linn. on humoral immune responses. Indian J Med Res 87:1998,384.

32) Mukherjee R, Das PK, Ram GC. Immunotherapeutic potential of Ocimum sanctum Linn. bovine subclinical mastitis. Rev Vet Sci 79(1):2005,37-43.9

33) Singh S, Taneja M, Majumdar DK. Biological activities of Ocimum sanctum L.fixed oil- An overview. Indian J Exp Biol 45:2007,403-412.

34) Pandey Govind, Madhuri S. Medicinal plants: Better remedy for neoplasm. Indian Drug 43(11):2006,869- 874.

35) Kathiresan K, Guanasekan P, Rammurthy N, Govidswami S. Anticancer activity of Ocimum sanctum. Pharmaceutical Biology 37(4):1999,285- 290.

36) Prashar R, Kumar A. Chemopreventive action of Ocimum sanctum on 2, 12-dimethylbenz(a) anthracene (DMBA) induced papillomagenesis in the skin of mice. Int J Pharmacog 33:1995, 181.

37) Prakash J, Gupta SK, Singh N, Kochupillai V, Gupta YK. Antiproliferative and chemopreventive activity of Ocimum sanctum Linn. Int J Med Biol Environ 27:1999,165.

38) Prakash J, Gupta SK. Chemopreventive activity of Ocimum sanctum seed oil. J Ethnopharmacol 72(1- 2):2000, 29-34.

39) Uma Devi P, Gonasoundari A. Radioprotective effect of leaf extract of Indian Medicinal Plant Ocimum sanctum. Indian J Exp Biol 33:1995,205.

40) Uma Devi P, Gonasoundari A, Vrinda B, Srinivasan KK, Unnikrishanan MK. Radiation protection by the Ocimum sanctum flavonoids orientin and vicenin: Mechanism of action. Radiat Res 154(4): 2000,455- 460.

41) Gonasoundari A, Uma Devi P, Rao BSS. Enhancement of bone marrow radioprotection and reduction of WR-2721 toxicity by Ocimum sanctum. Mutat Res 397:1998,303.

42) Kelm MA, Nair MG, Strasburg GM, DeWitt DL. Antioxidant and cyclooxygenase inhibitory phenolic compounds from Ocimum sanctum Linn. Phytomedicine. 7(1):2000,7-13.

43) Singh S, Rehan HMS, Majumdar DK. Effect of Ocimum sanctum fixed oil on blood pressure, blood clotting time and pentobarbitone-induced sleeping time. J Ethnopharmacol 78:2001,139.

44) Sood S, Narang D, Dinda DK, Maulik SK. Oral administration of Ocimum sanctum Linn. augments cardiac endogenous antioxidant and prevents isoproterenol-induced myocardial necrosis in rats. J Pharm Pharmacol 57(1):2005,127-133.

45) Geeta Vasudevan DM, Kedlaya R, Deepa S, Ballal M. Activity of Ocimum sanctum (the traditional meditional plant) against the enteric pathogens. Indian J Med Sci 55(8):2001,434-438.

46) Auil F, Khan MS, Owais M, Ahmad I. Effect of certain bioactive plant extracts on clinical isolates of betalactamase producing methicillin resistant Staphylococcus aureus. J Basic Microbiol 45(2):2005,106-114.

47) Shoken P, Ray K, Bala M, Tandon V. Preliminary studies on Ocimum sanctum, Drynaria quericifolia and Annona squamosa against Neisseria gonorrhoeae. Sex Transm Dis 32(2):2005,106-111.

48) Singh S, Malhotra M, Majumdar DK. Antibacterial activity of Ocimum sanctum L. fixed oil. Indian J Exp Biol 43:2005,835.

49) Godhwani S, Godhwani JL, Vyas DS. Ocimum sanctum: an experimental study evaluating its antiinflammatory, analgesic and antipyretic activity in animals. J Ethnopharmacol 21(2):1987,153-163.

50) Singh S, Majumdar DK. Evaluation of antiinflammatory activity of fatty acids of Ocimum sanctum fixed oil. Indian J Exp Biol 35:1997,380-383.

51) Singh S, Majumdar DK. Analgesic activity of Ocimum sanctum and its possible mechanism of action. Int J Pharmacog 33:1995,188.

52) Joshi H, Parle M. Cholinergic basis of memory improving effect of Ocimum tenuiflorum Linn. Indian J Pharm Sci 68(3):2006,364-365.

53) Chattopadhyay RR, Sarkar SK, Ganguly S, Medda C, Basu TK. Hepatoprotective activity of O. sanctum leaf extract against paracetamol induced hepatic damage in rats. Indian J Pharmacol. 24:1992,163.

54) Seethalakshmi B, Narasappa AP, Kenchaveerappa S. Protective effect of Ocimum sanctum in experimental liver injury in albino rats. Indian J Pharmacol, 14:1982,63.

55) Seth SD, Johri N, Sundaram KR. Antispermatogenic effect of Ocimum sanctum. Indian J Exp Biol 19:1981,975.

56) Khanna S, Gupta SR, Grover JK. Effect of long term feeding of Tulsi (Ocimum sanctum) on reproductive performance of adult albino rats. Indian J Exp Biol 24:1986,302.

57) Chattopadhyay RR. Hypoglycemic effect of Ocimum sanctum leaf extract in normal and streptozotocininduced diabetic rats. Indian J Exp Biol 31:1993,891-893.

58) Agrawal P, Rai V, Singh RB. Randomized placebo controlled, single blind trial of holy basil leaves in patients with noninsulin dependent diabetes mellitus. Int J Cli Pharmacol Ther 34:1996,406.

59) Halder N, Joshi N, Gupta SK. Lens aldose reductase inhibiting potential of some indigenous plants. J Ethnopharmacol 86(1):2003,113-116.

60) Singh S, Majumdar DK. Evaluation of the gastric antiulcer activitry of fixed oil- Ocimum sanctum (Holy basil). J Ethnopharmacol 65:1999,13-19.

61) Singh S, Majumdar DK. Effect of fixed oil of Ocimum sanctum against experimentally induced arthritis and Volume 5, Issue 1, November – December 2010; joint edema in laboratory animals. Int J Pharmacog 34:1996,218.

62) Godhwani S, Godhwani JL, Vyas DS. Ocimum sanctum: A preliminary study evaluating its immunoregulatory profile in albino rats. J Ethnopharmacol 24:1988,193- 198.

63) Bhargava KP, Singh N. Antistress activity of Ocimum sanctum Linn. Indian J Med Res 73: 1981,443.

64) Gupta SK, Prakash J, Srivastava S. Validation of traditional claim of Tulsi, Ocimum sanctum Linn. as a medicinal plant. Indian J Exp Biol 40:2002,765-773.