International Journal of Phytomedicine 5 (2013) 125-130
http://www.arjournals.org/index.php/ijpm/index

Review Article

ISSN: 0975-0185

The queen of herb with potent therapeutic constituent in various disease states: A reappraisal

Harun-Al-Rashid[1*], Anindya Banerjee[2], Nigam Jyoti Maiti[3]

***Corresponding author:**

Harun-Al-Rashid

[1] Pharmacognosy and Phytotherapy Research Laboratory, Department of Pharmaceutical Sciences, Utkal University, Bhubaneswar-751004, Odisha, India
[2] Gupta College of Technological Sciences, Asansol-3, West Bengal, India
[3] IMT Pharmacy College, Puri-752002, Odisha, India .

Abstract

Ocimum sanctum Linn has been used extensively for its medicinal value in India and China. In traditional system of medicine, different parts (leave, stem, flower, root, seed and even whole plant) of *O. sanctum* L. (Tulsi in Hindi and Vasub in Arabic), a small herb seen throughout in India. *O. sanctum* have been recommended for the treatment of bronchitis, bronchial asthma, malaria, diarrhea, dysentery, skin disease, arthritis, painful eye disease, chronic fever, insect bite etc. It has also been suggested to possess antifertility, anticancer, antidiabetic, antifungal, antimicrobial, hepatoprotective, cardio-protective, antiemetic, antispasmodic, adoptogenic and diaphoretic activity. Current scientific research revealed that *O. sanctum* exhibit significant anticancer activity by enhancing antioxidant potential of gastric mucosa thereby reducing mucosal damage and reduces stress; enhances stermina and endurance ;boosts the immune system, reduces inflammation; lessens aging factors; supports the heart, lungs and liver.

Keywords: Tulsi, NF-κB, TNF- , antioxidant, anticancer, anthelmentic.

Introduction

Ocimum Sanctum Linn (also known as O.T., Tulsi) has been used for thousands of years in Ayurvedic medicine for its diverse healing properties. Tulsi "The Queen of Herbs", the legendary "incomparable one", is one of the holiest of cherished of the many sacred basil and is famous for its religious and spiritual sanctity [1]. There has been an increasing interest in the study of medicinal plants as natural products as different part of the World [2]. As discovered by various researchers, even close members of same genus (Ocimum) do not possess the same chemical constituents as well as biological activities due to certain Geographical variation and climatic changes [3]. The plant is considered to be an adoptogenic for balancing different processes in the body and helpful for adopting to stress etc. Due to its strong aroma and astringent taste, it is regarded in Ayurvedic as a kind of "elixir of life" and believes to promote longevity [4,5]

Botanical Sources

Among the other plants it is known for medicinal value, the plants of genus Ocimum belonging to the family Labiatae are very important for their therapeutic potentials. *O. sanctum* L. (Tulsi), *O. gratissimum* (ram Tulsi) , *O. canum* (Dulal Tulsi), *O. bascilium* (Ban Tulsi), *O. kilimandschricum, O. americunum, O. camphora* and *Ocimum micranthum* are examples of known important species of genus Ocimum that grow in different parts of World and are known to have medicinal properties [6-8].

Geographical Sources

It is herbaceous, much branched, annual plant found throughout India. The plant is commonly cultivated in garden and also grown near temples. It is propagated by seeds. Tulsi, now-a-days cultivated commercially for its credential significant medicinal value because of the presence of some active constituent, viz., volatile oil [9].

Phytoconstituents

Tulsi leaves contain 0.7% volatile oil comprising about 71% eugenol, 20% methyleugenol, 30% carvacrol and caryophylline. Caffeine or other stimulants are absent in Holy basil. *O. sanctum* (fresh leaves and stems) extract yielded some phenolic compounds (antioxidants) such as cirsilineol cirsimaritin, isothymusin, apigenin, and rosmarinic acid appreciable quantities of euginol [10]. Two flavonoids viz., orientin and vicerin from aqueous leaf extract of *O. sanctum* have been isolated [11]. Seed contain good drying properties [12,13]. There can be many chemo types of various members Ocimum family. Also chemical composition changes throughout the seasons and are affected by

different soil, growing, harvesting, processing and storage conditions[14].

Traditional Uses

Tulsi is known as a general tonic and vitalizer " The elixir of life" and it has been traditionally used for the treatment of various disorders, in throat, lungs, heart, blood, liver, kidney and the disorder in digestive, metabolic, reproductive and nervous systems. Tulsi is generally used for the treatment of coughs, cold, flu, head and ear aches, rheumatism, arthritis, malaria, fever, allergies and various types of skin diseases and also reduce the toxicity of various poisons, including insect and reptile bites. On the other hand it is also used as insect repellent like mosquito in the rural and urban areas. In Panchmari, Madhya pradesh 'Gondi' is a Tribe those who are habituated with the use of Tulsi as an anti-tussive and anti coughing agent [15,16].

Nutritional Value

O. sanctum contains vitamin C, A and minerals like calcium, zinc and iron, as well as chlorophyll and many other phytonutrients. Also enhances the efficient digestion, absorption and use of nutrition from food herb. Protein: 30 kcal, 4.2 g; Fat: 0.5 g; carbohydrate 2.3 g; Calcium: 25 mg; Phosphorus 287 mg; iron: 15.1 mg and Edible portion 25 mg vitamin C Per 100 g [17]. It also contains traces of maleic, citric and tartaric acid [18].

Pharmacological Activity

Antidiabetic activity

Pharmacoepistemiology resembles that db/db mouse and NOD mouse are the animal models for diabetic activity, they are actually mutated for the leptin receptor which provokes them for hungriness and PPAR-γ is the saliva secretary precursor which posses them to eat and die quickly due to diabetes and obesity. On the other hand, Diabetic retinopathy is also a clinical complication of NIDDM. Here due to pathogenic angiogenesis VEGF, bFGF and IGF stricken the vitreous humor and shrinks the venous passage thus due to the obligatory pressure and less isotonicity, venous bleeding takes place as well as it causes unilateral and bilateral vision problem, even often it causes blindness. The leaves of *O. sanctum* protrude hypoglycemic effect in all those experimental animal models [19-22]. A study conducted with Tulsi and neem has suggested that this combination is better for antidiabetic activity [23]. *O. sanctum* has aldose reductase activity, which may help in reducing complications of diabetes such as cataract; retinopathy etc [24]. Preparation of decoction with various parts of plants lowers the blood sugar level [25].

Antifertility activity

Nitric oxide (NO) is the progener of penile region, actually eNOs and iNOs use to accumulate in the cavernosal region of the penis and it decreases penile erection and decrease the ejection power of seminal fluid because of the benzene content of this queen herb. An uninterrupted gavages of the extract decreases sperm count, seminal fluid in male and menarche, estrous cycle in the female knockout mice. It is also conceded with relapse of pregnancy, Oligoammanorrhea, Oligohydramnios thus causes Intra Uterine Growth Retardation (IUGR) by the process of revascularization where amniotic fluid index (AFI) remain <5cm. So, it can also be explicitly said that this one is probably a detrimental effect of *O. sanctum*. Antifertility has been seen due to presence of ursolic acid [26]. Tulsi leaves have antiandrogenic properties also [27,28].

Anticancer activity

Cancer is the most pandemic and epidemic disease in the present scenario worldwide [29-32]. The metastasis procedure use to proliferate uninterrupted cell growth by signaling cascade mechanism. Ethanolic extract of *O. sanctum* mediate a significant radiation in tumor cell size and an increase in life span of nude mice having sarcoma -180 solid tumors which probably stop the mutation of the suspected gene [33]. In case of non small cell lung cancer (NSCLC), uterine tumor and prostate cancer, it is having a significant role. Also due to the presence of benzopyrene and 3-methyldimethylaminoazobenzene, it is having an important role against neoplasia. It is also found to be having a putative role against breast cancer by inhibiting caspase 3, 6 and 8 [34]. Leaf extracts of *O. sanctum* block or suppresses metabolic activation of the carcinogenic agent [35]. Topical application of Tulsi in pappiloma worts by pappiloma virus having a significant clinical implication. Ursolic and oleolic acid possesses anticancer property. Even Ocimum has the ability to protect the DNA of the body from dangerous radiation [36].

Radio protective activity

In the years 1995 the radio protective effect of *O. sanctum* was first reported [37]. Two isolated flavonoids viz., orientin and vicerin from *O. sanctum* leaves showed better radio protective effect in comparison to synthetic radio protectors. They have shown significant protection to the human lymphocytes against the clastogenic effect of radiation at low, non toxic concentrations [38].

Antioxidant activity

The antioxidant activity of *O. sanctum* has been reported by many investigators [29-32]. Antioxidant activity of the flavonoids (orientin and vicerin) *in-vivo* in rodent expressed a significant reduction in the radiation induced by lipid per-oxidation in the mouse liver [39]. The antioxidant properties of flavonoids and relation to membrane protection have been observed. *O. sanctum* extract has a credential free radical scavenging activity [40]. The phenolic compounds viz., circilineol, cirsimaritin, isothymustin, agigenin and rosmarinic acid and appreciable quantities of euginol (a major volatile oil) from *O. sanctum* extract of fresh leaves and stems possesses good antioxidant activity. It usually stops the aging of skin and also enhances the tonicity of skin. On the other hand *O. sanctum* by it's antioxidant property stop or increase latency period of various disease state simultaneously like NIDDM, baldness etc [41].

Antihypertensive and cardio protective activity

O. sanctum have been used for prevention of transient cerebral ischemia and long term cerebral hypo perfusion causing cerebral oedema, gliosis and per vascular inflammatory infiltrate [41]. Oral feeding of hydro alcoholic extract of *O. sanctum* L.(100mg/kg) to male Wister rats subjected to chronic resistant stress (6h/day for 21 days) significantly prevent chronic resistance stress induced by rise in plasma cAMP level, myocardial superoxide dismutase and catalase activity in the myocardium [42].

Antibacterial, antiviral and antifungal activity

Bacteria and viruses are surrounded by 50 lipopolysaccarides layer which use to help them penetrate in the various targeted region inside body, *Bacillus pumillus* use to penetrate in the stratum cornium layer and block the sebaceous gland and exfoliate pimples. Again fungi are consisted of 1-2 layers of lipopolysaccarides which are plausibly not so detrimental than antibacterial or antiviral. *O. sanctum* fixed oil showed good antibacterial activity against *Bacillus pumillus*, *Pseudomonas auriginosa* and *S. aurious*. Higher content of linolenic acid in *O. sanctum* fixed oil could contribute towards its antibacterial activity [43]. Tulsi leaves have been reported to show strong antifungal activity against the aspergillums species [44]. *In-vitro* antifungal activity was also observed against Candida species by *O. gratissimum* L. [45]. *O. basilium* act as a strong antiviral agent against DNA viruses (herpes virus (HVE), adenoviruses (ADV) and hepatitis B virus) and RNA viruses e.g., coxsackievirus B^1 (CUB^1) and enteroviruses71 (EV71) [46].

Hepatoprotective activity

In case of ulcer the mascularis mucosa layer gets damaged and leaks hydrochloric acid and causes gastric ulcer, among the seven animal screening model of ulcer in two animal models Tulsi has been found to be having potential healing effect at a time. Hydro ethanolic extract of *O. sanctum* leaves (200mg/kg BW) in male Wister albino rats' gives protection against liver injury induced by paracetamol after the administration of oral route [47]. Again in stress induced cold immersion ulcer model *O. sanctum* has been given 3g/100g for 6 days against Carbon Tetrachloride (CCL_4) 0.2ml/100g sub cutaneously and it also gave a positive result [48]. In the present study *O. sanctum* was evaluated for its antiulcer activity against ethanol induced gastric ulceration in Wister albino rats [49].

Adoptogenic and anti-stress activity

Tulsi leaves are regarded as an 'adoptogen' or anti-stress agent. Recent studies show that the leaves afford significant protection against stress [50]. The immunostimulant capacity of *O. sanctum* may be responsible for adoptogenic action of plant [51]. A study conducted with rabbits has suggested that Tulsi decrease oxidative stress [52].

Analgesic activity

The analgesic activity of leaf extract of *O. sanctum* L. (50,100mg/kg,ip ; 50,100,200 mg/kg,po) was tested in mice using glacial acetic acid induced writhers, *O. sanctum* L.(50,100 mg/kg ip) also increase the tail withdrawal frequency in mice [53].

Antipyretic, anti-inflammatory activity

The antipyretic activity of *O. sanctum* fixed oil was evaluated by testing it against typhoid, paratyphoid A/B vaccine induced pyrexin in rats. The oil on i.p. administration considerably reduces the febrile response indicating its antipyretic activity [54]. Compound isolated from *O. sanctum* extract civsilineol, civsimavatine, isothymusine, Aspigenin, Rosavinic acid and eugenols were observed for their anti-inflammatory activity or cyclo-oxygenase inhibitory activity [55].

Anthelmintic activity

Essential oil of *O. sanctum* L. has anthelmintic activity which was evaluated by caenorhabditis elegance model. Euginol exhibit an ED_{50} of 62.10 µg/ ml and being the predominant component of the essential oil, it was suggested to have putative anthelmintic principle [56].

Immunomodulatory activity

Aqueous extract of *O. sanctum* L. leaf in bovine subclinical mastitis (SCM) was investigated after intrammamary infusion of aqueous extract of *O. sanctum* L. treatment reduces the total bacterial count and increase neutrophil and total bacterial counts with enhanced phagocyte activity and phagocytic index [57].

Antiarthritic activity

Arthritis use to occur due to NF-κB and also due TNF- which is having necrotic effect on bones. The fixed oil inhibits carrageen and inflammatory mediators (e.g. Serotonin, histamine, bradykinin and PGE_2) induced inflammation on screening model of rodents. It is natural that the oil could inhibit any inflammatory response involving these mediators. The result suggests potentially useful antiarthritic adjuvant as well as turpentine oil induced joint edema in rats [58].

Anti-coagulant activity

Anti platelet action stands with the clotting factor XIII and also it resembles with the blockage of the arachidonic acid along with PGE_2 and PGF_{2A}.The *O. sanctum* fixed oil (3ml/kg, i.p.) prolonged blood clotting time and the response was comparable to that obtained with aspirin(100mg/kg) [59]. *Shetty et al* suggested that the wound healing effect and vividly it has shown that anti clotting effect of Dexamethasone competitively inhibited by the ethanolic extract of this queen of Herbs [60].

Antilipidemic activity

Administration of *O. sanctum* L. seed oil (0.8 gm/kg body weight/day) for four weeks, in cholesterol feed (100mg/kg body weight/day) rabbits significantly decreases serum cholesterol,

triglycerides and LDL+VLDL cholesterol as compared to retreated cholesterol-feed group suggesting the hypo-cholesterolemic activity of *O. sanctum L.* [61]. Aqueous extract of *O. basilium* reduce the level of total cholesterol, triglycerides and LDL cholesterol in acute hyper-lipidaemia induced by trillionWR-1339 in rats [62].

Side Effect or Interaction

All the medicine synthetic, herbal are having some kind of side effect or suspected adverse drug reaction. Tulsi, being the queen of herb also having some kind of narrow side effect. The side effect stands for antifertility. In Pattanayak P., *et. al.*, has been shown that two animal model of antifertility suggested a significant result. So it is better not to take Tulsi in pregnant and lactating mother [63-65].

Discussion

The Queen of herbs is having various kind of therapeutic activity in both the animal and human in various aspects of diseased and co-morbid condition. The main focus of the activity will be to perturbed and attribute the efficacy, safety and curability in cancer and other deadly diseases which are having narrow therapeutic effect of the other drugs. In case of Diabetic retinopathy patho angiogenic procedure can be stopped by inhibiting Interleukin and Matrix Metalloproteinase enzyme. Even neovascularisation process can also be stop or block in Diabetic Retinopathy by using Tulsi. But still something is needed to find out to eradicate cancer.

Conclusion

Tulsi is the most sacred and holistic plant worldwide. There are various species of Ocimum available, and they all have contributed a tremendous positive role in various diseases. Likely and unlikely it is well documented for its multi therapeutic role from a last couple of years. This Queen of herbs is also having role in catalepsy which is actually a co-morbid condition of Parkinsonism and epilepsy. Even some studies are also showing that iatrogenic effect of haloperidol in Schizophrenia is curable by the use of this herb. Although this herb needs no acknowledgment in the field of Science for its contribution but still some orphan disease and rare diseases are on the verge of healing by this sacred herb.

References

[1]. Warrier PK. In: ongman O, editor. Indian Medical Plants. New Delhi, CBS publication, 1995. P-168.

[2]. Indian J physiol pharmacol 2005; 49(2) Therapeutic Uses of O. sanctum Linn (Tulsi) 13 (Edited and published by S, Cipla Ltd., Bombay Central, Bombay), *Ocimum sanctum*: The Indian home remedy. In: Current Medical Scene, March-April 1992

[3]. Gazzaneo, Ir. Paira de licena, RF. and Paulino de Albuquerque.: J Ethnobiol. Ethnomed. 1:9 (2005).

[4]. Singh NK, Sehgal CB. Micropropagation of "Holly basil"(*Ocimum sanctum* Linn.) from young inflorescence of nature plants. Plants Growth Regul. 1999; 29(5):161-166.

[5]. Sen P. Therapeutic Potential of Tulsi: From experience to facts. Drugs News View 1993;1:15-21

[6]. Gupta SK, Prokash J, Srivastav S. Validation of traditional claim of Tulsi, *Ocimum sanctum* Linn as a medicinal Plant. Indian J Exp Biol 2002; 40;765-73

[7]. Chopra RN, Nayer SI, Chopra IC. Glossary of Indian Medicinal plant. New Delhi CSIR;1956

[8]. Kokate CK, Purohit AP, Gokhale SB. Pharmacognosy 2009: P-11.53

[9]. Yanpallewar SU, Rai S,Kumar M, Acharya SB. Evaluation of antioxidant and neuroprotective effect of *Ocimum sanctum* on transient cerebral ischemia and long term cerebral hypoperfusion. Bhamacol Biochem Behar 2004;79(1): 155-164.

[10]. Gupta SK, Prokash J, Srivastav S. Validation of traditional claim of Tulsi, Ocimum sanctum Linn as a medicinal Plant. Indian J Exp Biol 2002; 40;765-73

[11]. Shah CS, Qadry JS. A Test Book of Pharmacognosy 1998: P-216

[12]. Kokate C.K., Purohit A.P., Gokhale S.B. Pharmacognosy 2009: P-11.53

[13]. Maimes Report of Holy basil. Ocimum sanctum-Tulsi: version 1-November 2004-www.holy-basil.com.

[14]. Eliningaya J. Kweka1, Hassan M. Nkya, Lucile Lyaruu, Epiphania E. Kimaro, Beda J. Mwang'onde,Aneth M. Mahande. Efficacy of Ocimum kilimandscharicum plant extracts after four years of storage against Anopheles gambiaess. Journal of Cell and Animal Biology 2009; 3:171-174

[15]. Raja R. and Ratnam Prasad. Chemo types of Ocimum: Exploring the Potential of Pathway Engineering http://203.190.147.122/ocimum/pptPDF/raja_2.pdf

[16]. Karthikeyan, P, Gunasekaran, N. Ramamurthy and S. Gobindasamy: Anticancer activity of *Ocimum sanctum* Summary Pharmaceutical Biology 1999; 37(4):285-290.

[17]. Kath RK, Gupta RK. Antioxidant activity of hydroalcoholic leaf extract of *Ocimum sanctum* in animal models of peptic ulcer. Indian J Physiol Pharmacol 2006; 50 (4): 391–396

[18]. Kochhar A, Sharma N, Sachdeva R. Effect of Supplementation of Tulsi (*Ocimum sanctum*) and Neem (Azadirachta indica) Leaf Powder on Diabetic Symptoms, Anthropometric Parameters and Blood Pressure of Non Insulin Dependent Male Diabetics. Ethno-Med 2009; 3(1): 5-9

[19]. Sharma M, Pandey G. Ethnomedicinal plants for prevention and treatment of tumours 2009; 3 (1):2-5.

[20]. Misra P, Pal NL, Guru P K, Katiyar JC, Tandon JS. Antimalarial Activity of Traditional Plants against Erythrocytic Stages of Plasmodium berghei. Pharmaceutical Biol. 1991; 29(1): 19-23.

[21]. Mandan S, Das D N, Kamala D, Ray K, Roy G, Chaudhari SB, Sahana. *Ocimum sanctum* Linn – A study on gastric ulceration and gastric secretion in rats. Indian J Physiol Pharmacol 1993; 37: 91–92

[22]. Nair VD, Jaleel CA, Gopi R, Gomathinayagam M, Panneerselvam R. Antioxidant potential of *Ocimum sanctum* under growth regulator treatments. EurAsia J BioSci 2009; 3: 1-9.

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

[24]. Misra P, Pal NL, Guru P K, Katiyar J C and Tandon J S. Antimalarial Activity of Traditional Plants against Erythrocytic Stages of Plasmodium berghei. Pharmaceutical Biol. 1991;29(1): 19-23.

[25]. Ahmed M, Ahamed RN, Aladakatti RH, Ghosesawar MG. Reversible anti-fertility effect of benzene extract of *Ocimum sanctum* leaves on sperm parameters and fructose content in rats. J Basic Clin Physiol Pharmacol. 2002; 13(1):51-9.

[26]. Pratibha D. NadigLaxmi S. Study of anti-tussive activity of *Ocimum sanctum* Linn in guinea pigs. Indian J Physiol Pharmacol 2005; 49 (2): 243–245.

[27]. Seth SD, Johri N, Sundaram KR. Antispermatogenic effect of *Ocimum sanctum.* Indian J Exp Biol1981; 19:975.

[28]. Madhuri S. Studies on oestrogen induced uterine and ovarian carcinogenesis and effect of ProImmu in rats. PhD thesis, Rani Durgavati Vishwa Vidyalaya, Jabalpur, MP, India: 2008.

[29]. Madhuri S, Pandey G. Effect of ProImmu, a herbal drug on estrogen caused uterine and ovarian of tumor promotion in mice by eugenol. Indian J Physiol Pharmacol 1994;38:306.

[30]. Pandey G. An overview on certain anticancer natural products. J Pharm Res 2(12):2009;1799-1803.

[31]. Pandey G, Sharma M. Autochthonous herbal products in the treatment of cancer. Phytomedica 2006;7:99-104.

[32]. Nakamura CV, Ishida K, Faccin LC, Filho BPD, Cortez DAG, Rozental S, de Souza W, Ueda-Nakamura T. In vitro activity of essential oil from *Ocimum gratissimum* L. against four Candida species. Research in Microbiology 2004;155(7): 579-586.

[33]. (Edited and published by S, Cipla Ltd., Bombay Central, Bombay), *Ocimum sanctum*. The Indian home remedy. In: Current Medical Scene 1992.

[34]. Prashar R, Kumar A, Hewer A, Cole KJ, Davis W, Phillips DH. Inhibition by an extract of *Ocimum sanctum* of 7, 12-dimethylbenz(a)anthracene in rat hepatocytes in vitro. Cancer Lett. 1998; 128(2):155-160.

[35]. Panda S, Kar A. Ocimum sanctum leaf extract in the regulation of thyroid function in the male mouse. Pharmacol Res 1998;38(2):107–110.

[36]. Uma Devi P, Gonasoundari A. Radioprotective effect of leaf extract of Indian Medicinal Plant *Ocimum sanctum.* Indian J Exp Biol. 2005; 33:205.

[37]. 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 2000;154(4):455-460.

[38]. Saija A, Scalese M, Lanza M, Marzillo D, Bonina F, Castelli F. Flavonoids as antioxidant agents: Importance of their interaction with biomembrane. Free Rad Biol Med1995;19:481.

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

[40]. Nair AGR, Gunasegaran R, Joshi BS. Chemical investigation of certain south Indian plants. Indian J Chem. 1982; 21B:979.

[41]. Sood S, Narang D, Thomas MK, Gupta YK, Maulik SK. Effect of *Ocimum sanctum* Linn. On cardiac changes in rats subjected to chronic restraint stress. J Ethnopharmacol 2006; 108:423-7.

[42]. Singh S, Malhotra M, Majumdar DK. Antibacterial activity of *Ocimum sanctum* L. fixed oil. Indian J Exp Biol. 2005; 43:835.

[43]. Joglekar GV, Chaudhary NY & Aiman R. Effect of indigenous plant extracts on glucose-absorption in mice. Indian Journal of Physiology and Pharmacology 1959; 3: 76

[44]. Jyoti S, Satendra S, Sushma S, Anjana T, Shashi S. Antistressor activity of *Ocimum sanctum* (Tulsi) against experimentally induced oxidative stress in rabbits. Methods Find Exp Clin Pharmacol. 2007; 29(6):411-6.

[45]. Chiang LC, Ng LT, Cheng PW, Chiang W & Lin C. Antiviral activities of extracts and selected pure constituents of *Ocimum basilicum*. Clinical and Experimental Pharmacology and Physiology 2005; 32(10): 811-816.

[46]. Seethalakshmi B, Narasappa AP, Kenchaveerappa S. Protective effect of *Ocimum sanctum* in experimental liver injury in albino rats. Indian J Pharmacol. 1982;14:63.

[47]. 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. 1992; 24:163.

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

[49]. Reghunandana R *et al.* Effect of *Ocimum sanctum* Linn (Tulsi) extract on testicular function. Indian J Medical Research 1995;49(4):83–87.

[50]. Godhwani S, Godhwani JL, Vyas DS. *Ocimum sanctum*: A preliminary study evaluating its immunoregulatory profile in albino rats. J Ethnopharmacol. 1988;24:193-198.

[51]. Rastogi S. Ayurveda for comprehensive healthcare. Indian J. Med. Ethics 2009; 6(2):101-102.

[52]. Khanna N, Bhatia J. Antinociceptive action of *Ocimum sanctum* (Tulsi) in mice: Possible mechanisms involved. J Ethnopharmacol 2003; 88:293-6.

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

[54]. Kelm MA, Nair MG, Stasburg GM, DeWitt DL. Antioxidant and cyclooxygenase inhibitory phenolic compounds from *Ocimum sanctum* Linn. Phytomedicine 2000; 7:7-13.

[55]. Asha MK, Prashanth D, Murali B, Padmaja R, Amit A. Anthelmintic activity of essential oil of *Ocimum sanctum* and eugenol. Fitoterapia 2001; 72:669-70.

[56]. Mukherjee R, Dash P K, Ram G C. Immunotherapeutic potential of *Ocimum sanctum* (L) in bovine subclinical mastitis. Res Vet Sci 2005; 79:37-43.

[57]. Singh S, Majumdar DK. Effect of fixed oil of *Ocimum sanctum* against experimentally induced arthritis and joint edema in laboratory animals. Int J Pharmacog. 1996; 34:218.

[58]. 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. 2001; 78:139.

[59]. Shetty S, Udupa S, Udupa L, Somayaji N. Wound healing activity of Ocimum sanctum Linn with supportive role of antioxidant enzymes. Indian J Physiol Pharmacol 2006; 50:163-8.

[60]. Trevisan MT, Vasconcelos Silva MG, Pfundstein B, Spiegelhalder B, Owen RW. Characterization of the volatile pattern and antioxidant capacity of essential oils from different species of the genus Ocimum. J Agric Food Chem 2006; 54:4378-82.

[61]. Pandey BP and Anita. In: Economic Botany (Published by Chand and Company Ltd., Ramnagar, New Delhi), p. 294. 1990.

[62]. Seth SD, Johri N, Sundaram KR. Antispermatogenic effect of *Ocimum sanctum*. Indian J Exp Biol 1981; 19:975-6.

[63]. Kasinathan S, Ramakrishnan S, Basu SL. Antifertility effect of *Ocimum sanctum* L. Indian J Exp Biol 1972;10:23-5.

[64]. Brinker F. Herb Contraindications and Drug Interactions. New York, Eclectic Medical Publications; 1998. p.33.