



IJPPR

INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH  
An official Publication of Human Journals

ISSN 2349-7203



Human Journals

Review Article

October 2015 Vol.:4, Issue:3

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## A Systemic Review on Phytochemistry and Pharmacological Activities of *Capsicum annuum*

 **IJPPR**  
INTERNATIONAL JOURNAL OF PHARMACY & PHARMACEUTICAL RESEARCH  
An official Publication of Human Journals

 **HUMAN**

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**Submission:** 29 September 2015  
**Accepted:** 3 October 2015  
**Published:** 25 October 2015



HUMAN JOURNALS

[www.ijppr.humanjournals.com](http://www.ijppr.humanjournals.com)

**Keywords:** *Capsicum annuum*, capsaicin, pharmacological properties

### ABSTRACT

*Capsicum annuum* Linn. belonging to the family of Solanaceae is an extremely valuable medicinal herb, distributed throughout India. The aim of present review is to form a short compilation of the phytochemical composition and pharmacological properties of this multipurpose fruit. It is used in various indigenous systems such as Siddha, Ayurveda, Unani and Allopathy to treat different ailments such as dyspepsia, flatulence, constipation, arthritis, menstrual cramps, gangrene, catarrhal affliction as in colds, cough, asthma and urinary catarrh. *Capsicum annuum* contains capsaicin and capsaicinoids apart from Vitamin C as its main phytoconstituents. Many research studies have been conducted to prove the plant's potential as being analgesic, antiangiogenic, antiparasitic, antiplatelet, anti-arthritic, antioxidant, antiviral, antifungal, antineoplastic, hypoglycemic, gastroprotective, and larvicidal effects. The present review highlights some of the pharmacological properties and uses of this plant.

## INTRODUCTION

Nature always stands as a golden mark to exemplify the outstanding phenomena of symbiosis. Natural products from plant, animal and minerals have been the basis of the treatment of human disease. About 500 plants with medicinal use are mentioned in ancient literature and around 800 plants have been used in indigenous systems of medicine. India is a vast repository of medicinal plants that are used in traditional medical treatments <sup>[1]</sup>. *Capsicum annuum* Linn. belonging to the family of Solanaceae is cultivated in almost all the tropical countries. In ayurvedic medicine, *C. annuum* is classified as follows: <sup>[2]</sup>

- *Gunna* (properties) – *ruksh* (dry), *laghu* (light) and *tikshan* (sharp)
- *Rasa dhatu* (taste) – *katu* (pungent)
- *Virya* (potency) – *ushan* (hot)

The present review opens the door for exploration of *Capsicum annuum*, its phytochemistry, pharmacology and medical applications apart from its therapeutic effectiveness and safety.

## TAXONOMY: <sup>[3]</sup>

- Domain: Eukaryotes
- Kingdom: Plantae
- kingdom: Viridiaeplantae
- phylum: Tracheophyta
- Subphylum: Euphyllophytina
- Infraphylum: Radiatopses
- Class: Magnoliopsida
- Subclass: Lamiidae
- Superorder: Solananae
- Order: Solanales
- Family: Solanaceae
- Subfamily: Solanoideae
- Tribe: Solaneae
- Genus: *Capsicum*

- Specific epithet: *annuum*
- Botanical name: *Capsicum annum* Linn.

#### VERNACULAR NAMES IN INDIA: <sup>[4]</sup>

- English : Chillies, Long Chillies, Red Chillies
- Hindi : Lalmirca
- Sanskrit : Katuvirah, Raktamaricah
- Telugu : Mirapakaya
- Kannada : Kempumenasu
- Malayalam : Mulaku, Kappalmulaku, Paccamulaku, Cuvannamulaku
- Tamil : Milagai
- Arabic : Filfil-e-Ahmar
- Ayurvedic : kantkari kul, Raktamirchi, Katuvira
- Unani : Surkh Mirchi
- Siddha : Milakkay

#### 3.2.3. GEOGRAPHICAL SOURCE: <sup>[5]</sup>

*Capsicum* is cultivated and collected in almost all the tropical countries. East Africa, West Africa and India are the regions producing the drug on commercial scale. In India it is grown in Andhra Pradesh, Uttar Pradesh, Gujarat, Maharashtra, Assam and Tamil Nadu.

#### 3.2.4. MORPHOLOGY: <sup>[6]</sup>

*Capsicum annum*, which is a suffrutescent annual shrub, grows up to 0.75-1.8 m in cultivated varieties with many angular branches. The leaves are simple of 'varying shapes and alternate, elliptical to lanceolate, with smooth margins (entire) usually wrinkled. The small flowers (around 1.5 cm, or 1 inch, in diameter) are white or violet, in clusters of two or more. The fruits are many-seeded berries which may be long, cylindrical, ovoid, obtuse or oblong, but with no sutures, red when ripe with a smooth shiny surface. Fruit is up to 12 to 25 cm in length and up to 7 mm in width with seeds many which are yellow, smooth, round, discoid with a spinescent protuberance on the edge. *Capsicum annum* fruits have characteristic odor and pungent taste.

### 3.2.5. CHEMICAL CONSTITUENTS:

The fruit of *Capsicum annuum* contains capsaicin (8-methyl-*N*-vanillyl-6-nonenamide) and several related chemicals containing a series of homologous branched- and straight-chain alkyl vanillylamides, collectively called *capsaicinoids* as their chief chemical entity. The major capsaicinoids present are capsaicin (48.6%) is quantitatively followed by 6,7-dihydrocapsaicin, minor capsaicinoids that are present are nordihydrocapsaicin(7.4%), homodihydrocapsaicin(2%), and homocapsaicin(2%). Other parts of the plant contain steroidal alkaloid glycosides (solanine, solanidine, solasodine). The seeds contain the steroidal glycosides capsicoside A through D, all furostanol. *C. annuum* is rich in carotenoid pigments, including capsanthin, capsorubrin, carotene, luteine, zeaxanthin, and cucurbitaxanthin A.

Other phytochemicals present are scopoletin, chlorogenic acid, alanine, amyrin, caffeic acid, camphor, carvone, cinnamic, citric acid, linalool, linoleic acid, oleic, piperine, vitamin B1, B3, C, E, oleoresin, hexanal, 2-isobutyl-3-methoxypyrazine, 2,3-butanedione, 3-carene, trans-2-hexenal, linalool; trans-*p*-ferulylalcohol-4-O-(6-(2-methyl-3-hydroxypropionyl) glucopyranoside and luteolin-7-O-(2-apiofuranosyl-4-glucopyranosyl-6-malonyl)-glucopyranoside; trans-*p*-feruloyl-beta-D-glucopyranoside; trans-*p*-sinapoyl-beta-D-glucopyranoside; quercetin 3-O-alpha-L-rhamnopyranoside-7-O-beta-D-glucopyranoside; luteolin 6-C-beta-D-glucopyranoside-8-C-alpha-L-arabinopyranoside; apigenin 6-C-beta-D-glucopyranoside-8-C-alpha-L-arabinopyranoside and luteolin 7-O-[2-(beta-D-apiofuranosyl)-beta-D-glucopyranoside]; preniroxanthin or all-E,3R,3'S,6'S)-beta,gamma-carotene-3,3',6'-triol; capsicosides A-D, 6",7"-dihydro-5',5'"-dicapsaicin, capsicosides E-G; 26-O-beta-D-glucopyranosyl-22-O-methyl-5alpha-furost-25(27)-en-2alpha,3beta,22xi,26-tetraol-3-O-beta-D-glucopyranosyl(-3)-beta-D-glucopyranosyl(1-2)-[beta-D-glucopyranosyl(1-3)]-beta-D-glucopyranosyl(1-4)-beta-D-galactopyranoside (1); 26-O-beta-D-glucopyranosyl-(25R)-5alpha-furost-20(22)-en-2alpha,3beta,26-triol-3-O-beta-D-glucopyranosyl (1-3)-beta-D-glucopyranosyl(1-2)-[beta-D-glucopyranosyl(1-3)]-beta-D-glucopyranosyl(1-4)-beta-D-galactopyranoside; and 26-O-beta-D-glucopyranosyl-(25R)-5alpha-furosta-3beta,22xi,26-triol-3-O-beta-D-glucopyranosyl(1-3)-beta-D-glucopyranosyl(1-2)-[beta-D-glucopyranosyl(1-3)]-beta-D-glucopyranosyl(1-4)-beta-D-galactopyranoside [7].

The vacuum isolated bell pepper oil contains 2-methoxy-3-isobutylpyrazine, trans-b-ocimene, limonene, methyl salicylate, linalool, and hex-cis-3-enol as major constituents. The other components identified in larger amounts in oil isolated at atmospheric pressure are non-1 - en-4-one, non-trans-2-en-4-one, nona-trans, trans-2, 5-dien-4-one, 2-entyl-furan and benzaldehyde. 2-isobutyl-3-methoxy pyrazine is an important flavor component of *Capsicum annuum*. Other important aroma components are nona-trans. cis-2, 6-dienal and deca-trans. trans-2, 4-dienal.

Paprika also contains sizable amounts (0.1%) of vitamin C. Paprika derive their color in the ripe state mainly from carotenoid pigments, which range from bright red (capsanthrine, capsorubin and more) to yellow. Capsicum or Cayenne is rich in vitamins A, C, iron and calcium. It contains vitamin G, magnesium, phosphorus, and sulphur; it also has some B-complex, and is rich in potassium [8].

#### NUTRITIONAL CONSTITUENTS:

Nutritional Components: Capsicum is rich in Vitamin C (ascorbic acid) and Zinc. It is also high in vitamins, A, C, rutin, beta carotene, iron, calcium and potassium. Capsicum also contains magnesium, phosphorus, sulphur, B-complex vitamins, sodium and selenium [9].

The nutritional breakdown of Capsicum is as follows:

Nutrient	1.80 gm. Of Capsicum
Water	0.145 gm.
Energy	5.724 kcal.
Energy	23.958 kJ.
Protein	0.216 gm.
Total lipid (fat)	0.311 gm.
Carbohydrate, by difference	1.019 gm.
Fiber, total dietary	0.490 gm.
Ash	0.109 gm.
Minerals	
Calcium	2.664 mg.
Iron	0.140 mg.

Magnesium	2.736 mg.
Phosphorus	5.274 mg.
Potassium	36.252 mg.
Sodium	0.540 mg.
Zinc	0.045 mg.
Copper	0.007 mg.
Manganese	0.036 mg.
Selenium	0.158 mcg.
Vitamins	
Vitamin C, total ascorbic acid	1.375 mg
Thiamin	0.006 mg
Riboflavin	0.017 mg
Niacin	0.157 mg
Vitamin B-6	0.037 mg
Folate, total	1.908 mcg.
Vitamin B-12	0.000 mcg.
Vitamin A, IU	748.980 IU
Vitamin A, RE	74.898 mcg_RE
Vitamin E	0.086 mg_ATE
Lipids	
Fatty acids, total saturated	0.059 gm.
10:0	0.001 gm.
12:0	0.001 gm.
14:0	0.002 gm.
16:0	0.042 gm.
18:0	0.009 gm.
Fatty acids, total monounsaturated	0.050 gm.
16:1 undifferentiated	0.004 gm.
18:1 undifferentiated	0.045 gm.
20:1	0.000 gm.

22:1 undifferentiated	0.000 gm.
Fatty acids, total polyunsaturated	0.151 gm.
18:2 undifferentiated	0.139 gm.
18:3 undifferentiated	0.012 gm.
Cholesterol	0.000 mg.
Phytosterols	1.494 mg.

## PHARMACOLOGICAL ACTIONS:

### i. Anti-neoplastic:

Capsaicin topically applied onto dorsal skin of female ICR mice strongly attenuated activation of NF $\kappa$ B and AP-1 induced by the typical tumor promoter, 12-O-tetra-decanoyl-phorbol-13-acetate<sup>[10]</sup>. Capsanthin, capsanthin 3'-ester, capsanthindiester, capsorubin, capsorubindiester, capsanthin 3,6-epoxide, cucurbitaxanthin A-3'ester and  $\beta$ -carotene isolated from the fruits of *C. annuum* demonstrated potent *in vitro* anti-tumour-promoting activity with inhibitory effects on Epstein-Barr virus early antigen activation induced by the tumour promoter 12-O-tetra-decanoyl-phorbol-13-acetate<sup>[11]</sup>.

After incubation of adenocarcinoma cell line with capsaicin for 24 h, cell viability decreased significantly in a dose-dependent manner and apoptotic bodies significantly increased. Capsaicin induced cell death via a Bcl-2 sensitive apoptotic pathway. Therefore, capsaicin induces protection from gastric cancer<sup>[12]</sup>.

Capsaicin has a profound antiproliferative effect on prostate cancer cells, inducing the apoptosis of both androgen receptor positive and negative prostate cancer cell lines associated with an increase of antibodies p53, p21, and Bax. It decreased the growth of human leukemic cells, gastric and hepatic carcinoma cells *in vitro*<sup>[13]</sup>.

Capsaicin suppressed the growth of leukemic cells, but not normal bone marrow mononuclear cells, via induction of G(0)-G(1) phase cell cycle arrest and apoptosis. Capsaicin-induced apoptosis was in association with the elevation of intracellular reactive oxygen species production. Interestingly, capsaicin-sensitive leukemic cells were possessed of wild-type p53,

resulting in the phosphorylation of p53 at the Ser-15 residue by the treatment of capsaicin. Abrogation of p53 expression by the antisense oligonucleotides significantly attenuated capsaicin-induced cell cycle arrest and apoptosis. Pretreatment with the antioxidant N-acetyl-L-cystein and catalase, but not superoxide dismutase, completely inhibited capsaicin induced apoptosis by inhibiting phosphorylation of Ser-15 residue of p53. Moreover, capsaicin effectively inhibited tumor growth and induced apoptosis with no toxic effects <sup>[14]</sup>.

## **ii. Analgesia:**

The analgesic effects of capsaicin are importantly enhanced during inflammation, supporting the fact that the stimulation of vanilloid receptor type 1 could perhaps constitute a suitable strategy to avoid inflammatory hyperalgesia <sup>[15]</sup>.

The neuropeptide substance P has been implicated in the pathogenesis of inflammation and pain in arthritis. The significant pain reduction of 57% and 33% was reported by the 0.025% capsaicin cream treated osteoarthritis and rheumatoid arthritis patients respectively <sup>[16]</sup>.

It has been suggested that treatment of cluster headache patients with topical capsaicin may desensitize sensory neurons by depleting the nerve terminals of substance P. which indicated that intranasal capsaicin provide a new therapeutic option for treatment of this disease <sup>[17]</sup>.

Capsaicin desensitizes some neurons and has provided moderate pain relief when applied to the skin surface in Post-surgical cancer pain. Oral capsaicin in a candy vehicle produced substantial pain reduction in patients with oral mucositis pain from cancer therapy <sup>[18]</sup>.

## **iii. Antiangiogenic activity:**

The induction of angiogenesis is a crucial step in tumor progression, and therefore, efficient inhibition of angiogenesis is considered a powerful strategy for the treatment of cancer. The lipophilic antimicrobial peptides from EML-CAP3, a new endophytic bacterial strain isolated from red pepper leaf (*Capsicum annuum* L.), exhibit potent antiangiogenic activity both in vitro and in vivo. The antimicrobial peptides effectively inhibited the proliferation of human umbilical vein endothelial cells and suppressed the in vitro characteristics of angiogenesis. It may thus be used for the treatment of hypervascularized tumors <sup>[19]</sup>.

**iv. Antiplatelet effect:**

Capsaicin was found to be a potent inhibitor of platelet aggregation and release reaction. It reduced the hemolysis of RBCs induced by hydrogen peroxide. Capsaicin has membrane stabilizing property by interference of activation of phospholipase A<sub>2</sub><sup>[20]</sup>.

**v. Dermatological conditions:**

The topically applied capsaicin, a known inhibitor of cutaneous vasodilatation produces relief on moderate and severe psoriasis. Significantly improved reduction in scaling and erythema was observed on sides treated with capsaicin compared to sides treated with vehicle. Burning, stinging, itching, and redness of the skin were noted by nearly half of the patients on initial applications of study medication but diminished or vanished upon continued application which suggest that topical application of capsaicin may be a useful in the treatment of psoriasis<sup>[21]</sup>. Topical capsaicin is well known to reduce nociceptive pain and neurogenic inflammation by depleting substance P. Topical 0.075% capsaicin cream was successfully used in treatment of acute lipodermatosclerosis and acute lobular panniculitis in pregnant woman<sup>[22]</sup>.

**vi. Dental agents:**

*In vitro*, capsaicin-evoked the release of immunoreactive calcitonin gene-related peptide from human dental pulp; this release provides a novel tool to determine the effects of pharmacological compounds on human nociceptor sensitivity for the study of peripheral neuropeptide secretion in normal healthy tissue<sup>[23]</sup>.

**vii. Diabetic neuropathy:**

Clinical trials performed in patients with diabetic neuropathy demonstrated a 50% improvement in pain status with use of capsaicin for 22 weeks. It works to excite nociceptive C-afferent neurons, causing the release of substance P, which is essential for transmission of nociception to occur in the nervous system. Repeated application of capsaicin depletes substance P, leading to inhibition of pain sensation<sup>[24]</sup>.

**viii. Antiparasitics:**

In an *in vitro* study, extracts from the leaves of *Capsicum annuum* resulted in the death of the cercaria of *Schistosoma mansoni* within 15 minutes. The active principles appeared to be water-soluble unsaturated compounds from the oils or their hydrolysis products<sup>[25]</sup>.

**ix. Larvicidal effect:**

The ethanol extract of *capsicum annuum* has been shown to have larvicidal activity against *Anopheles stephensi* and *Culex quinquefasciatus*. The treated larvae showed curling up, agitation, vigorous body movements which were the characteristics of neurotoxicity<sup>[26]</sup>.

**x. Antifungal:**

Peptides isolated from chilli pepper seeds inhibited the growth of yeasts *Saccharomyces cerevisiae*, *Candida albicans*, *Candida parapsilosis*, *Candida tropicalis*, *Pichia membranifaciens*, *Kluyveromyces marxianus* and *Candida guilliermondii*. Peptide fraction exhibited strong fungicidal activity against *Candida albicans*, *Saccharomyces cerevisiae* and *Schizosaccharomyces pombe* and also promoted several morphological changes to *C. albicans*. It also reduced the glucose stimulated acidification of the medium mediated by H (+)-ATPase of *S. cerevisiae* cells in a dose-dependent manner and caused the permeabilization of yeast plasma membrane to the dye SYTOX Green, as verified by confocal laser microscopy<sup>[27]</sup>.

**xi. Antiviral:**

Neuropharmacologic agents capable of disrupting normal virus-neuron interactions may provide an alternative strategy for the treatment of herpes simplex virus infections. Prophylactic treatment with capsaicin, alters function in sensory neurons, can protect guinea pigs against cutaneous herpes simplex virus disease, even though the compound has no direct antiviral activity. The civamide, the cis isomer of capsaicin, interfere with herpes simplex virus disease and reduce recurrent disease during latent infection<sup>[28]</sup>.

**xii. Antioxidant activity:**

Capsicum contains anti-oxidants such as tocopherols, ascorbic acid and b-carotene which are effective against cancer, heart disease and cataracts <sup>[29]</sup>.

Sinapoyl-E-glucoside, quercetin-3-O-rhamnoside-7-O-glucoside, quercetin-3-O-rhamnoside and luteolin-7-O-(2-apiosyl)-glucoside constitute the phenolic glycosides from *Capsicum annuum* have shown radioprotective and antiradical activities on human cell lymphocytes in response to oxidative damage induced by X radiation and their antioxidant abilities. <sup>[30]</sup>.

**xiii. Hypoglycemic effect:**

The crude extract of fruit was found to inhibit intestinal glucose absorption which may be partially responsible for lowering blood sugar <sup>[31]</sup>. Regular consumption of chili may attenuate postprandial hyperinsulinemia <sup>[32]</sup>.

**xiv. Hypocholesterolaemic and hypolipidemic activity:**

The plasma total cholesterol, triglyceride, LDL-C, VLDL-C, and VLDL-TG levels and the atherogenic index were all decreased, whereas the HDL-C level was higher in rabbits fed with 1% red pepper. Supplementation of red pepper increased fecal triglyceride excretion and showed fewer fat droplet deposits in the aorta than control group <sup>[33]</sup>.

Mice fed a diet containing 2% red pepper for 28 days had lower levels of triacylglycerides compared to control mice. Epididymal fat tissue was also reduced from 1.26 g in control rats to 0.7161 g in red pepper fed mice <sup>[34]</sup>.

**xv. Anti-obesity:**

Capsaicin present as one of the chemical constituents has been proved to have anti-obesity activity. Adipose tissue distribution between visceral and subcutaneous sites is controlled by afferent nerves present in Intestinal mucosa. Activation of the transient receptor potential vanilloid-1 channels by capsaicin prevents adipogenesis. By acting on transient receptor potential vanilloid-1-sensitive sensory nerves neurogenic mechanism modulates the regulation of fat metabolism enabling selective activation of network that regulates sympathetic nerve activity

causing lipolytic effect in response to a specific stimulation of gastrointestinal transient receptor potential channels. Dietary capsaicin enhances the expression of adiponectin and its receptor thereby reducing metabolic dysregulation in obese diabetic mice. The effects of capsaicin in liver and adipose tissue are due to its dual action on peroxisome proliferator-activated receptor alpha and transient receptor potential vanilloid-1 expression/activation. Upon capsaicin treatment in white adipose tissue thermogenesis and lipid metabolism-related proteins are altered. Capsaicin inhibits adipogenesis in preadipocytes and adipocytes and induces apoptosis. Epidemiologic statistics shows that consumption of foods containing capsaicin is associated with a lower incidence of obesity. Experimental evidence supports a role of capsaicin as an anti-obesity agent. Ingestion of capsaicin is associated with increase in energy expenditure through the activation of brown adipose tissue thereby increasing fats oxidation and improving lipolysis <sup>[35]</sup>.

#### **Memory deficit amelioration:**

The dietary ingestion of the red-bell pepper (*Capsicum annuum* L.) ameliorated the age-related disorders in the senescence-accelerated mouse SAMP8. SAMP8 mice that received a diet containing 0.1% (w/w) capsanthin displayed a considerable improved memory acquisition in passive avoidance tasks compared to those given the control diet. There was increase in choline acetyltransferase activity in the parietal cortex of SAMP8 mice fed the diet containing capsanthin when compared to mice fed with the common diet <sup>[36]</sup>.

#### **xvi. Immunosuppressants:**

Direct administration of capsicum extract and capsaicin resulted in suppression of interleukin (IL)-2, interferon (IFN)-gamma, IL-4 and IL-5 production. Furthermore, flow cytometric analysis revealed a reduced population of CD3(+) cells and an increase in CD19(+) cells. Capsicum extract and capsaicin modulate T cell-immune responses, and their immunomodulatory effects on are partly due to both TRPV1-dependent and -independent pathway. <sup>[37]</sup>.

#### **xvii. Cardiovascular Effects:**

Capsaicin has been shown to exert direct vasodilating effects through increased calcitonin gene-related peptide (CGRP) release. Transdermal capsaicin may improve ischemic threshold in

patients with stable coronary disease, probably through arteriolar vasodilation. Increased capsaicin-induced Nitric oxide availability could represent the principal mechanism of action<sup>[38]</sup>. In humans, capsaicin increased cutaneous and arterial vasodilation<sup>[39]</sup>.

#### **xviii. Gastroprotective:**

Capsaicin decreased the gastric basal output, enhanced the non-parietal component of gastric secretory responses, gastric emptying and the release of glucagon. Capsaicin prevented the indomethacin- and ethanol-induced gastric mucosal damage; meanwhile capsaicin itself enhanced gastric transmucosal potential difference. Capsaicin prevented the indomethacin-induced gastric mucosal microbleeding. The expression of capsaicin receptor and calcitonin gene-related peptide was found increased in the gastric mucosa of patients with chronic gastritis (independent of the presence of *Helicobacter pylori* infection), and capsaicin can be successfully used for the eradication of *Helicobacter pylori*-induced mucosal damage. It can be concluded that Capsaicin represents a new orally applicable gastroprotective agent in patients with different chemical and *Helicobacter pylori*-induced mucosal damage and in many other diseases requiring treatment with NSAIDs.<sup>[40]</sup>

Capsaicin inhibited the release of pro-inflammatory cytokine, interleukin-8 by *H. pylori*-infected gastric epithelial cells through nuclear factor-kappa B signal pathway. Thereby act as a potential anti-inflammatory drug by inhibition of the production of IL-8 in *H. pylori*-infected gastric epithelium<sup>[41]</sup>.

#### **xix. Respiratory agents:**

Cough reflex sensitivity to capsaicin is used as a testing mechanism in human pharmacological and clinical research. The cough sensitivity to capsaicin is used to the clinical evaluation of cough suppressants, such as benzonatate and guaifenesin<sup>[42]</sup>. In human research, capsaicin desensitized nasal mucosa and reduced allergic symptoms of nasal allergy or pain induced by other agents<sup>[43]</sup>.

**xx. Effect on cornea and conjunctiva :**

Oleoresins isolated from capsicum in the form of spray causes eye pain, stinging or burning, increase of tear secretion, temporary blindness, rarely, corneal abrasion, mouth and nose burning, runny nose, sneezing, choking sensation, breathing difficulties and asthma in patients with bronchoconstriction. Its local effects include rash, dermatitis, eczema and erythema on the affected area of skin, vesicles and blisters in a long-term exposure, headaches, dizziness, vomiting, pulmonary edema, acute respiratory failure, hypotension, chest pain and motor control loss <sup>[44]</sup>.

**USES:**<sup>[9] [45][46]</sup>

- Capsicum is stomachic, carminative, stimulant, antispasmodic, analgesic, alterative, astringent, haemostatic, and antiseptic in nature.
- Capsicum has a strong effect upon circulation, initially acting upon the heart and the large arteries, followed by a stimulant activity upon the arterioles and the capillaries.
- It exhibits a protective effect on the respiratory system.
- The capsaicin has substantial antigenotoxic and anticarcinogenic effects, and is an important dietary phytochemical with potential chemopreventive activity
- The powder is used in any catarrhal affliction as in colds, cough, asthma and urinary catarrh.
- Capsaicin is used primarily as a topical cream for pain caused by conditions such as arthritis and general muscle soreness.
- In cases of dyspepsia, flatulence and constipation, Capsicum promotes the digestive secretions and stimulates peristalsis.
- Capsicum is also indicated in tired, painful muscles, joint stiffness, and coldness in the extremities.
- Capsicum is applied topically as a powder on wounds to arrest bleeding, working rapidly to form a clot and seal off the wound.
- Capsicum is of great use in the treatment of indolent ulcers, abscesses, and sores.
- It is also an important among remedy to stop the process of mortification and gangrene, arresting decomposition and decay through its antiseptic properties.

- A particular form of capsicum causes intense eye pain and other unpleasant effects when it comes in contact with the face. This form is used in self-defense pepper sprays.
- It is also helpful in menstrual cramps.

**DOSING:**<sup>[7] [9]</sup>

**i. Applied to the skin:**

- For pain, including arthritis, neuropathy, and fibromyalgia: Creams containing 0.025% to 0.075% Capsaicin concentration when applied 3-4 times daily, upto 14 days provides maximum pain relief. Higher concentrations can be used for diabetic neuropathy.
- **For back pain:** Capsicum-containing plasters providing 11 mg capsaicin/plaster or 22 mcg/cm<sup>2</sup> of plaster applied have been used. The plaster is applied once daily in the morning and left in place for 4-8 hours.
- **For prurigo nodularis:** 0.025% to 0.3% of the active capsicum constituent capsaicin 4-6 times daily has been used.

**ii. Inside the nose:** For cluster headache 0.1 mL of a 10 mM capsaicin suspension, providing 300 mcg/day of capsaicin, applied to the nostril on the painful side of the head. Apply the suspension once daily until the burning sensation disappears. A capsaicin 0.025% cream applied daily for 7 days has been used to treat acute cluster headache attacks.

**iii. For Heart Palpitation:** In the acute stage, repeated dosages of one to two teaspoonfuls every half-hour (or more frequently when required).

**iv. Hemorrhage:** One Teaspoonful of powder in a cup of hot water. Let cool and drink the water; drink the cayenne as well if possible.

**CONCLUSION**

Keeping in view the medicinal properties of *Capsicum annuum*, an attempt has been made in this review paper to explore various dimensions of the drug including phytochemical and pharmacological studies carried out on this drug. With the current information, it is evident that

*Capsicum annuum* has pharmacological functions including antineoplastic, antidiabetic, antifungal, antiviral, antibacterial, antioxidant, antiangiogenic, analgesic, vasodilating, gastroprotective and antiobesity activity. The literature reports have revealed the potential of *Capsicum annuum* for drug development.

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