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Christmas pepper: An ancient spice with a substantial quantity of bioactive substances and pharmacological potential: A summary

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Abstract
Chili is utilized as a spice in practically every cuisine due to its pungency, colon, and flavour. Capsaicin is the primary bioactive ingredient in chili, responsible for its intense flavour and a variety of health advantages. The chilhuacle chili (*Capsicum annum* L.) is a Mexican native cultivar whose production has been highly valued since it is the major component in the traditional Mexican meal Oaxacan black mole. Capsaicin has a wide range of pharmacological applications, including natural pain relief, anthelminthic effectiveness, anti-inflammatory properties, pregnancy/lactation, antimicrobial, antifungal, and antiviral activity, urinary system abnormalities, and renal failure. This overview will stroll through the numerous phytochemical components and pharmacological activities of the plant *Capsicum annum*, which is renowned as an herbal godsend to all of us. This work compares *C. annum* in terms of plant agronomic features, biochemical composition, capsaicin and capsaicinoids concentration and nutraceutical and medicinal potential, and the impact of processing on fruit quality and key components.

Keywords: Chili pepper, *Capsicum annum*, capsaicinoids, antimicrobial, antifungal

Introduction
A significant commercial crop that is grown all over the world is chili (*Capsicum* spp.). It is a dicotyledonous flowering plant in the Solanaceae family that goes by many names, including hot pepper, chili pepper, bell pepper, etc. It has a surplus of nutritional and therapeutic value. *Capsicum annuum*, *Capsicum frutescens*, *Capsicum chinense*, *Capsicum pubescens*, and *Capsicum baccatum* are the five domesticated species of chili peppers.
Since the dawn of civilization, people have known that capsicum is a component of the human diet as a spice, a condiment, and a vegetable. Chili's green fruits are consumed as vegetables. The pungent and powerful aromas of mature dried fruits, on the other hand, make them an excellent spice. Capsaicin is regarded as a safe and efficient topical analgesic for the treatment of headaches, mastectomy pain, diabetic neuropathy, arthritic pain, herpes zoster-related pain, In Japanese cooking, the leaves are prepared both as greens and in a dish called tsukudani that can be kept for a long time.
Mexican chilies are primarily exported to the United States, Japan, Canada, the United Kingdom, and Germany Mexico currently ranks second globally in the export of fresh chilies and sixth globally in the export of dehydrated chilies.

History
John Clought Tresh originally reported capsaicin in crystalline crystal form in 1976. The term "capsaicin" as we use it nowadays has been attributed to an English scientist. Nelson and Dawson, who discovered the alkaloid's chemical formula in 1919, are responsible for revealing to us the alkaloid's molecular structure. By Spath and Darling in 1930, capsaicin was successfully synthesized for the first time. It should be mentioned that Kosuge and Inagaki identified other chemicals from the habanero pepper in 1961 that shared their structure and features. Later, these acquired the name capsaicinoids.
Chili peppers were undoubtedly used by Mexican Indians long before Jesus was born. R. S. Macneish, an archaeologist, discovered pepper seeds in Mexico that date to around 7500 BC.

On Columbus' second journey to the New World, the physician Chauca made a note of the Native Americans' usage of chili peppers in food and medicine.
Native Americans employed irritant smoke generated by burning chili peppers as a weapon against intruders. Early in the 19th century, chemical studies of the components of chili peppers were initiated. Thresh crystallized the chili pepper's chemical compound in 1846 and gave it the name capsaicin. Early in the 20th century, Nelson and Dawson identified the chemical compound make-up of capsaicin.

Plant profile
Synonyms - *Capsicum abyssinicum*, *Capsicum angulosum* Mill., *Capsicum axi* Vell., *Capsicum bauhinii* Dunal, *Capsicum caerulescens* Besser, *Capsicum cerasiforme* Mill., *Capsicum ceratocarpum* Fingerh., *Capsicum cereolum* Bertol., *Capsicum comarim* Vell., *Capsicum conicum* Lam., *Capsicum conoide* Mill.

Biological Source
The dried, ripe fruits of Capsicum minimum and *Capsicum annum* Linn., both members of the Solanaceae family, are the biological source of capsicum.
There are a variety of Capsicum peppers beside the common *C. annuum* L. (cayenne pepper, chili pepper) including *C. baccatum* L. (aji, aji amarillo, locoto), *C. chinense* Jacq. (aji dulce, habanero, rica red), and *C. pubescens* Ruiz and Pavón (rocoto, manzano).

Common Name
Chili pepper, red pepper, Christmas pepper, Tabasco pepper, cayenne pepper Scientific Name: *Capsicum annuum* L. (*Capsicum frutescens*)

Botanical Family: Solanaceae

Distribution and Ecology
This pepper is a native species of South America that is now cultivated worldwide in warm, dry clima.

Physical Description
This perennial vine has stems up to four meters (13 feet) long that are smooth, round, woody, and branching. The tiny white blossoms give birth to globular, sessile drupes that mature to a scarlet color.

Macroscopic description
Tree: It is a perennial shrubby herb. Their habits are sub-woody annual plants that may develop to an average height of 65 cm or more.

Leaves: Simple, glabrous, lanceolate to ovate leaves with a sharply acuminate apex and a cuneate or abruptly acute, petiolate base make up a plant's leaves.

Flower: The solitary flowers have a purplish-off-white tint. In a placentation, the flowers are borne at the node.
Stem: The stem, which can reach an approximate height of 60 cm (24 in), is heavily branched.

Fruits: Berries are the fruit, and when they are ripe, they can be green, yellow, orange, or red. The berry fruits are globose in shape with many seeds.

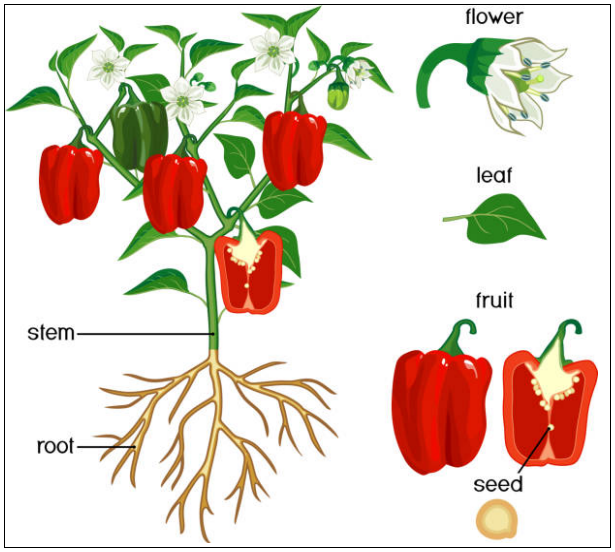


Fig 1: Parts of Capsicum plant

Geographical distribution
A member of the plant genus Capsicum, *Capsicum annuum* is indigenous to southern North America and northern South America. It is found throughout Maharashtra in India, including Hassan, Nasik, Pune, Karnataka, Mysore, Kerala, or Tamil Nadu.

Distribution and Ecology
This pepper plant is a native of Sri Lanka and India. Its distribution is worldwide. In the tropical regions of China, India, Indonesia, and the Philippine islands, it is commonly cultivated. Frost isn't tolerated by these plants.

Fruits of chili
Green chili: Hot green chilies are utilized as a spice in practically every cuisine, and sweet peppers are used in vegetable salads in Bangladesh. Green chilies are used to make a variety of delightful cuisines such as chili chicken, chili paneer, chili sauce, and so on. It can enhance the flavor and taste of any cuisine. Green chilies are strong in vitamin C, a powerful antioxidant that improves the human body's defenses against disease, and vitamin A, a fat-soluble vitamin and another important antioxidant that helps to reduce the health hazards caused by free radicals. Green chili peppers also contain a lot of vitamin E, which is necessary for the generation of some natural skin oils and helps to prevent premature skin aging. Green chilies have been related to a lower risk of heart disease.

Fig 2: Green Chilli

Red chili

Capsaicin, a phytochemical produced by red chili, is used as a spice and in medicine. Red chili capsaicin possesses a pungent active ingredient that has been found to promote stomach mucosal enema and hyperaemia, as well as a reduction in gastric acid secretion. Capsaicin aids in the metabolism of epoxide aromatic hydrocarbons, reducing their potential to bind to DNA. Because of the capsicum, red pepper has been shown to have anti-obesity, analgesic, and anti-inflammatory benefits in both animals and humans.

Fig 3: Red Chilli

Seeds of Chilli

Chili seeds are used to produce essential oil, which has a hot and spicy aroma. It has wonderful therapeutic properties such as the ability to increase blood circulation, lower blood sugar, aid in wound healing, and promote hair growth by delivering vital nutrients to the scalp. Chili seed essential oil is also used to treat joint and muscle aches, particularly those caused by arthritis and migraine. Because the scent of chili seed essential oil is so strong, it works best when combined with other essential oils to create an original scent with distinct properties.

Fig 4: Seeds of Chilli

Leaves of Chili

Chili pepper leaf is widely used in the production of various medicines and foods. All Capsicum species have edible leaves. Chili peppers, unlike almost all other Solanaceous crops, do not contain toxins in their leaves. The piquancy of chili leaves is mildly bitter but as hot as the fruit.

Fig 5: Leaves of Chili

Conventional practices

Cultural practices: Due to the pathogen's unique etiology, several cultural practices have been used as prerequisites for controlling post-harvest chilli anthracnose. These precautionary measures are put in place to reduce the rate of infection and infection pressure even before the fruits mature and are harvested. Than *et al*. reported in their review that pathogen-free chilli seeds should be planted and weeds eliminated. They also discovered that rotating crops that are not alternative hosts for *Colletotrichum* spp every 2-3 years is very effective for controlling post-harvest chilli anthracnose. Other sanitation practices include installing good drainage systems on the farm to channel out waste water or sewage during on-farm fruit disinfection, such as fruit washing at packing houses or during irrigation regimes, and finally removing plant debris that may serve as a source of inoculum. If a field has a history of disease, other crops should be rotated in isolation from other solanaceous plants for at least two years. By doing so, the pathogen's life cycle on the field is disrupted, and the chance of infection is reduced, because debris from most solanaceous crops (after harvest) can become inoculum and a haven for the fungus. It is also recommended to deep plough at the end of the growing season to completely cover diseased plants or to remove infected plant debris from the field. Early chilli planting or planting cultivars that bear fruit within a short ripening period is also recommended to allow the fruit to avoid fungal infection. Other alternative sanitation practices, such as weeding and the removal of infected or wounded fruits, should be performed on a regular basis to prevent pathogens from using such wounds as sites of infection.

International trade of chili

South Asian countries produce the majority of the world's chili. India is the world's largest producer and exporter of chili. According to FAOSTAT, the Food and Agriculture Organization of the United Nations, between 2004 and 2013, India produced an average of 1238084.1 tons of dry chili, surpassing China (261934.2 tons) and Thailand (156877.4 tons), as well as 14214800 tons of green chili, surpassing Mexico (1975819.7 tons) and Turkey (1892725.6 tons). India exported an average of 221425.2 tons of dry chili, while China exported 97787.3 tons, Peru has 47193.5

tons, Spain has 31611.1 tons, and Malaysia has 22383.1 tons, accounting for nearly half of the world's consumption demand. The remaining exports were dispersed across a number of countries, each contributing in small amounts. The United States imported approximately 102345.9 tons of dry chili, followed by Malaysia with 75107.8 tons, Thailand with 39321.8 tons, Sri Lanka with 34932.5 tons, and Spain with 33262.3 tons. Spain was not only the fourth largest exporter, but also the fifth largest importer. Mexico exported an average of 605484 tons of green chili, followed by Spain (464452.2 tons), the Netherlands (404548.8 tons), the United States (100820.3 tons), and Israel (96633.4 tons). The United States imported an average of 668522.9 tons of green chili, followed by Germany with 316149.5 tons, the United Kingdom with 150515.8 tons, France with 134363.5 tons, and Canada with 111205.6 tons. According to the data presented above, the global trade of chili is heavily reliant on India and China.

Toxicity data

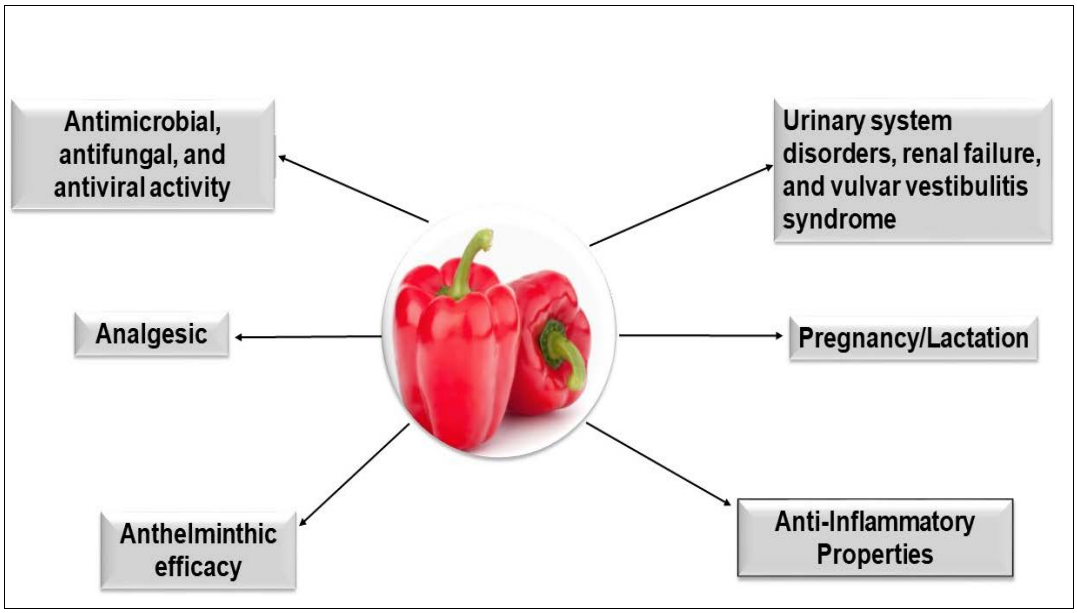
Poisonous Components Capsicum is the dried, ripe fruit of *Capsicum annum*, and capsaicin is the purified chemical that serves as capsicum's active ingredient. Capsaicin content increases as the fruit matures. Chili peppers have a capsaicin content of 1% dry weight on average. Capsicum oleoresin is a thick, dark reddish-brown liquid concentrate extracted from fruits using volatile solvents. The volatile component of the resin contains over 100 chemicals (e.g., alcohols, carbonyls, carboxylic acids, esters, pyrazine compounds, terpenes). However, the oleoresin's capsaicin content varies greatly, and the oleoresin does not uniformly mediate substance P release. This neuropeptide causes vasodilation by causing the endothelium to release nitric oxide.

Toxicity Reaction Mechanism Capsaicin's medical effects result from an intense excitation of primary afferent sensory nerves followed by a prolonged period of relative resistance to nociceptive chemical stimuli. Capsaicin inhibits the transmission of painful impulses from the periphery to the central nervous system by depleting substance P in sensory neurons, specifically in unmyelinated C-type and some myelinated A delta-type nerve fiber.10 Capsaicin reduces vasodilation and heat pain thresholds, resulting in increased pain sensitivity. Capsaicin desensitization to the stimulatory effect on sensory nerves occurs after repeated exposure. Red and black pepper both increased parietal and pepsin secretions, potassium loss, and stomach cell exfoliation in volunteer investigations. The clinical implications of these alterations are unknown. Despite significant interindividual variance, these studies imply that gastrointestinal bleeding may occur after consuming black or red peppers. However, there are insufficient clinical data to evaluate the effect of chronic pepper ingestion on the stomach mucosa. Dose Reaction in normal dosages, chili peppers are edible and harmless. Toxic kinetics there is little information available on the toxic kinetics of capsaicin and capsaicinoid compounds in humans. Piperine is secreted in breast milk after eating of black pepper, according to breast milk analysis.

Reported phytoconstituents & its pharmacological activity of different species

Reported Phytoconstituents: Capsaicin is a colourless, crystalline, and pungent component found in Capsicum in concentrations ranging from 0.5% to 0.9%. Capsicum's spicy phenolic component contains a percentage of 6, 7 dihydrocapsaicin. Twelve new acyclic glycosides (geranyllinalool derivatives) called capsainoside A-F (dimeric esters of acyclic diterpene glycoside) were discovered in a study of water soluble constituents of three kinds of *C. annum*. 11. The red paprika (*Capsicum annum* var. Longum nigrum) contain a carotenoid, cycloviolaxanthin [(3S, 5R, 6R, 3'S, 5'R, 6'R)- 3,6,3,6'-diepoxy-5,6,5',6; -tetrahydro-beta, beta carotene-5,5'- diol] besides 5,6-epoxycapsanthin, (8S)- capsochrome, karpoxanthin and violaxathin, cucurbitaxanthin A and B, 3,6- epoxycapsanthin. Ascorbic acid (0.1-0.5%), thiamine, red carotenoids such as capsanthin and capsorubin, and fixed oil (4-16%) are also found in chilies.

Pharmacological activity



Natural Pain Relief

According to the American Academy of Neurology clinical practice guidelines, the level of pain reduction provided by topical capsaicin is below what is deemed clinically essential for the treatment of chronic pain. A comprehensive review of research on herbal treatments for nonspecific lower back pain discovered modest evidence of a short-term impact for topically applied capsaicin, either as a cream or a plaster, on pain and function. Capsaicin was shown to be more effective than placebo in relieving pain in rheumatoid arthritis. Capsaicin cream (either 0.025% or 0.075%) proved beneficial in the treatment of postherpetic neuralgia when administered topically. It has been studied in the treatment of different types of pain, including as trigeminal and diabetic neuralgia, osteoarthritis, postsurgical neuralgias, and vulvar vestibulitis. A burning feeling at the site of application has been described as a side effect of topical capsaicin cream.

Anthelminthic efficac

In Gewane Agricultural Technical and Vocational Education Training College in Ethiopia, a 90-day research was undertaken to assess the anthelminthic impact of Chile or Mitmita (*Capsicum annum* longum) and a standard treatment such as Tricalbendazole on Fasciola infections to nutritional levels. The therapy efficacy was determined by the percentage of egg or fluke decrease, body weight growth, and blood parameter findings after 30, 60, and 90 days.

Anti-Inflammatory Properties

In animal studies, annum shown hypocholesterolaemia characteristics. A recent study found that hyperlipidaemia, inflammation, and oxidative stress are all linked to the pathophysiology of atherosclerosis and, as a result, an increased risk of cardiovascular disease. As a result, an agent with antioxidant and anti-inflammatory properties proved effective in the prevention of various illnesses. Chili pepper *C. baccatum* var. pendulum is widely consumed in Brazil, and a few research published in peer-reviewed journals focus on its carotenoid and capsaicinoid contents, as well as the antioxidant potential of its crude juice. Topical capsaicinoid patch treatments or local capsaicin injections (2, 10, 20 g/paw) had no influence on edema volume or weight. However, combining diclofenac with topical capsaicinoid-containing patches significantly increased diclofenac's efficacy onThe anti-inflammatory effects of *C. frutescence* ethyl acetate extract (CFE) on rat hind paw inflammation produced by sub plantar injections of fresh egg albumin (0.5 mL/kg) were investigated. C. frutescence ethyl acetate extract produced anti-inflammatory properties similar to diclofenac. Furthermore, *C. annum* inhibited the Soyal lipoxygenase (LOX) enzyme, demonstrating anti-inflammatory action. Green Capsicum inhibited more LOX (46.12%), yellow (44.09%), and red Capsicum (32.18%), according to the results. Carotenoid extracts from dried *C. annum* demonstrated significant peripheral analgesic effects at 5, 20, and 80 mg/kg, as well as inducing central analgesia at 80 mg/kg. The guajillo pepper carotenoid extracts also showed anti-inflammatory effect; at a dosage of 5 mg/kg, which is equivalent to the control treatment, they significantly reduced edema development. When compared to the control therapy, indomethacin produced equivalent results.

Pregnancy/Lactation

Animal studies have revealed both favourable and negative results. Capsaicin penetrates the placenta and has been shown to lower substance P in the fetus while also being neurotoxic. Rat pups' development rates were slower, and aberrant testicular descent was detected in pups born to capsaicin-fed rats. Other investigations, however, found no changes in rat pup deformities, epididymis or testicular weight, or plasma progesterone.

Antimicrobial, antifungal, and antiviral activity

Several scientific articles have demonstrated capsaicin's antibacterial action against gram-positive and gram-negative bacteria; however, the chemicals responsible for these effects are unclear. Capsaicin has been shown to inhibit *Bacillus subtilis*, *Streptococcus mutans*, *Streptococcus pyogenes*, Helicobater pylori, *Escherichia coli*, *Colletotrichum capsici*, *Enterococcus faecalis*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*; however, *in vivo* testing is required. Extracts of habanero, serrano, and morron chili types were shown to have strong inhibitory action against *Listeria monocytogenes*, *B. cereus*, *S. aureus*, and *Salmonella enteric*. Furthermore, discovered that jalapeo chili has significant antibacterial action against *L. monocytogenes*. Capsaicin exhibits antifungal activity, primarily against *Penicillium expansum*, *Trametes versicolor*, and *Gloeophyllum trabeum*. On the other hand, it can be used to treat various viral diseases such as guinea pig herpes simplex virus (HSV) illness, HSV infections, and vaginal herpes. Proposed that pepper products might be utilized to create novel antimicrobial agents for food preservation, control foodborne pathogens in foods, and/or prevent product spoiling without the need of synthetic preservatives.

Urinary system disorders, renal failure, and vulvar vestibulitis syndrome

Capsaicin preparations were originally employed in humans to treat painful disorders; however, its uses expanded throughout time. Capsaicin was originally used to treat bladder functioning abnormalities, such as enhancing motor responsiveness and reducing its diffusion to the kidney. 1 mm capsaicin improved urine frequency and incontinence in individuals with hyperreflexia, unstable, or hypersensitive bladders. Capsaicin therapy substantially prevented the development of hyper dynamic circulation and ascites, and renal function improved in cirrhotic rats. Furthermore, capsaicin reduces perfusion pressure, sodium/water excretion, and may increase urine volume and maximum cystometric capacity. A capsaicin hydrogel, on the other hand, was efficient in lowering bladder contraction but failed to generate overflow incontinence. In humans, intravenous capsaicin caused detrusor contractions and decreased the bladder volume threshold to reflex micturition.

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