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Review Article

Capsicum chinense Jacq. (Bhut Jolokia) – rich source of capsaicin with wide application and economic potential

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Abstract: Bhut jolokia, which is a cultivar of *Capsicum chinense* Jacq. is known to the world for its high capsaicinoids content. While wild *C. chinense* forms may be found in eastern lowland of South America, bhut jolokia is grown in the northeastern states of India. Evidences show that bhut jolokia has interspecific origin with introgression of genes of *C. frutecens* into *C. chinense* a natural hybridisation. The fruit of the plant and its leaves has been used as ethnobotanical medicine in different parts of the world. Phytochemical analysis has shown that the fruit is rich in capsaicinoids, which is the reason for its high pungency. Capsaicin and dihydrocapsaicin are the two major capsaicinoids adding pungency to chilli. Higher the capsaicin higher is the pungency. Recent studies has shown wide medicinal applications of capsaicin such as pain relief, anti-obesity treatment, as an antioxidant, antimicrobial agent and even as anticancer molecule. The government of Nagaland has patent rights and geographical indications for naga chilli, which will certainly help in the economic prospect of the region from its cultivation. Thus, this review is an attempt to highlight the latest research and developments in bhut jolokia, which has a huge economic potential to prosper the northeastern region of India.

Keywords: Bhut jolokia, *Capsicum chinense* Jacq., Capsaicinoids, Capsaicin, Medicinal, Patent rights

Introduction

The genus *Capsicum* belongs to the family Solanaceae (Nightshades) and the fruits of the plant are used widely as a spice to add flavour in food, natural plant colour, and pharmaceutical ingredient and as sprays for riot control and self-defence. The genus consists of about 32 species, among which the five major cultivated species are *Capsicum annuum* L., *Capsicum chinense* Jacq., *Capsicum frutescens* L., *Capsicum baccatum* L., and *Capsicum pubescens* Ruiz and Pav [1, 2]. The number might increase in near future as on a regular basis, new species are being identified and added to the list. Capsicum is believed to be originated in tropical South America [3], but are now grown worldwide. Christopher Columbus has been given the credit for introducing chilli to Europe and subsequently to Africa and Asia [4]. In India, *C. annuum* is most widely cultivated, whereas, the cultivation of *C. frutescens, C. chinense,* and *C. baccatum* is not common and are usually restricted to homestead gardening in different regions [5]. The northeastern part of India consisting of states like Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura is considered as hot-spot for chilli diversity due to its unique ecological conditions. A *Capsicum* landrace (Bhut Jolokia) from this region has been identified as the world's hottest known chili pepper with Scoville heat units (SHU's) rating of 1,001,304, a widely used heat measurement of chili peppers [6]. A number of variants of this chilli were noted in the northeastern region of India with different local names such as Naga chilli in Nagaland, Bhut Jolokia in Assam, and U-Morok in Manipur [7, 8]. Earlier this *Capsicum* landrace was identified as *Capsicum frutescens* Linn., however, its morphological characters resembles to *Capsicum chinense* species which is known to produce hottest chilli peppers in past. Later the dilemma on authenticity of Bhoot Jolokia was established through RAPD analysis as *Capsicum chinense* with inclusion of genes of *Capsicum frutescens* through natural hybridization by cross-pollination between species or any other method [6]. Thus, the presence of RAPD markers in 'Bhut Jolokia' that are specific to *C. chinense* and *C. frutescens* suggests an interspecific origin for 'Bhut Jolokia'.

Taxonomic Classification

Kingdom	-	Plantae
Division	-	Magnoliophyta
Class	-	Magnoliopsida
Order	-	Solanales
Family	-	Solanaceae
Genus	-	*Capsicum*
Species	-	*C. chinense* Jacq.

Synonyms

Capsicum sinense Murray
Capsicum toxicarium Poepp. ex Fingerh.

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Common Name

Assamese - Bhut Jolokia
English - Ghost Pepper
Manipuri - Umorok
Nagaland - Naga King Chilli

Habitat and Distribution

The plant is an erect bushy herbaceous annual plant, which can attain a height of 57-129cm. It can grow even more in semi-perennial situation. The plant is a self-pollinated species, but there are record, which shows considerable outcrossing in chillies with the aid of insect pollinators ranging from 7 to 91% [9, 10, 11]. Wild *C. chinense* forms may be found in eastern lowland of South America. Bhut jolokia is grown mainly in the state of Nagaland, Assam and Manipur and to some extent in Mizoram, Arunachal Pradesh and Meghalaya. It is also cultivated in the northeastern region of Bangladesh [12].

Morphology

Stem colour dark green.
Leaves have characteristic crinkle look as found in other *C.chinense* species, green in colour, ovate in shape.
Flowers grow like pendant in pair per axil, with creamy white corolla, anthers are blue and filaments are purple.
Fruits are elongated, sub-conical to conical in shape, 5-8 cm in length with an undulating surface, which on maturity changes colour from green to red.
Seed colour light brown, wrinkled.

Ethnobotanical Uses

The fruit of the plant, which is known for its strong pungency, has also been used in many ethnobotanical uses. The fruit if consumed in low quantity on a regular basis can help relief to asthma patients. The Maya people had also the tradition of using *Capsicum* to cure asthma cough and sore throat [4]. Regular consumption of the fruit in small quantity is also good for gastrointestinal disorders. The hot property of the fruit helps to tone the muscle and alleviating pain after hard work. Hot infusions of the fruit is used to treat toothache and muscle pain. There is also use of the tender leaves of the plant as a fine paste over boils, which helps in easy removal of pus [13]. In the Amazon region, the fruit is used as a remedy for stomachache and to cure hangover or hallucination. A decoction of the fruits and leaves are also used in Eastern Nicargua in postpartum abdominal and back pain, fever, respiratory and pulmonary disorder, skin rashes and sores [14, 15, 16].

Phytochemical Profile

The hot flavour of chillies is due to the presence of a group of closely related compounds called capsaicinoids. Capsaicinoids are amides produced by *Capsicum* species. These secondary metabolites are responsible for the strong and hot taste of the fruits, also known as pungency. Capsaicinoids consist of compounds that differ in the structure of branched fatty acid (acyl) moieties attached to the benzene ring of vanillylamine. Any variation in the chemical structures of the capsaicinoids, including the structure of the acyl moiety, affects the degree and the level of the pungency [17].

Capsaicin (8-methyl-*N*-vanillyl-6-nonenamide) and dihydrocapsaicin are the two major capsaicinoids found in hot peppers (more than 90% of the total capsaicinoids), whereas nordihydrocapsaicin, homodihydrocapsaicin, and homocapsaicin are present in lower amounts [18]. Levels of total capsaicinoids can be converted to Scoville heat units (SHU), a measurement for pungency developed by Wilbur Scoville. By definition, one part per million (ppm) of capsaicin has a pungency of 15 SHU. In the first ever report on the pungency of bhut jolokia, it was reported to be 855,000 SHU [19]. Subsequently in 2007, pungency was recorded as 1,001,304 SHU [6]. In a recent study of 2015, the average capsaicinoid content within 92 bhut jolokia accessions was 41.79 mg/g corresponding to 668,649 SHU. The capsaicinoid content among 92 accessions of bhut jolokia from northeast India varied from 11.95 to 72.05 mg/g with corresponding pungency levels of 191,135 - 1,152,832 SHU [20].

Economic Prospect

Correlation analysis between two major capsaicinoids, capsaicin and dihydrocapsaicin had shown a highly significant and positive correlation between capsaicin and dihydrocapsaicin. It clearly indicates that accumulation of capsaicin enhances the accumulation of dihydrocapsaicin irrespective of the genotype. The concentration of capsaicin was found to be higher as compared to that of dihydrocapsaicin in all the *Capsicum* with high pungency [20]. Therefore, the higher the pungency higher is the content of capsaicin, which has many established pharmacological activity. Capsaicin has a wide range of medicinal applications such as in pain relief [21, 22], anti-obesity treatment [23], as an antioxidant [24, 25], antimicrobial agent [26, 27] and as anticancer molecule [28]. There has been a high demand for this crop in both domestic markets as well as in abroad. The state government of Nagaland has got the patent rights of Naga King Chilli and got Geographical indication from Government of India under Registration and Protection Act, 1999. Most of the chilli species and varieties cultivated in India contain around 1% capsaicin but Naga chilli has around 2–4% capsaicin as reported by various researchers [19, 29]. It shows the fact that this chilli has high value for capsaicin content over the chillies grown in other parts of the country and hence can be used exclusively for capsaicin extraction. Low capsaicinoid content in commercial cultivars of *Capsicum* is not favourable due to increased cost of extraction of capsaicin.

Consequently, bhut jolokia with high capsaicinoid content has not only overcome this bottleneck but also created a demand in the world market for itself.

Conclusion

Bhut jolokia found in the northeastern states of India has been known to the world for its high capsaicinoid content. Fruit of the plant has ethnobotanical uses in different parts of the world. High capsaicin content and global demand has made the cultivation of this species of *Capsicum* a rewarding for the farmers of Northeastern India. Still the marketing of bhut jolokia follows a traditional trend though there are enough opportunity to utilize this crop for economic prosperity of the region.

Thus, this review attempted to look into the latest research and developments in bhut jolokia, which has a huge economic potential and can help in prospering the northeastern part of India.

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