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Chilli (*Capsicum chinense* Jacq.) production and post-harvest management: An overview

Ravi Kumar, Arvind Malik and Sunil Kumar

Abstract

Bhut Jolokia (*Capsicum chinense* Jacq.) is an indigenous variety of capsicum in the northeast region of India and has been known as the hottest chilli in the India. In this article, strategic production management, possible nutritional value and active compounds of Bhut Jolokia were reported for health benefit of different drug design. It has also been great prospective for its high pungency and medicinal value utilized by the native people of the northeast India. It is consumed in different form as normal chilli but have especial demand on national and international markets for its extra powerful pungency and aroma. Even though being a valuable crop with high potential value for exploring the worth and income sources for the indigenous people, so it is essential to emphasis on studies directed towards the different systematic production (morphological, cultivation practices, postharvest processing and marketing) and identification of different active compound e.g. capsaicin, squalene etc. for drug design of king chilli. Due to high demand, the present review is focused on standardizing the production and postharvest technology which may help to improve the yield, quality and shelf life extension for long chain marketing and distribution.

Keywords: Chilli, postharvest, capsaicin, proximate composition, marketing and distribution

Introduction

Bhut Jolokia has her nickname “ghost chili” because of her devilish sharpness. In fact, it can be dangerous for some popular people to taste this chili. It has happened before that inexperienced chili-eaters collapsed. It is also possible to hallucinate in pain and see ghosts. Chillies are one of the most important spices of cum vegetable crop grown in India with great export potential. Chilli is a most valuable fruit cum vegetables in all over the world and production is about 18.8 MT, as over 1.4 million hectare of fresh and dry chillies fruits in India are grown (Krishna *et al.*, 2007) [15]. Chillies are used as food additives or spices in many national cuisines due to their sensory attributes of colour, heat, pungency flavour, and aroma. They are a good source of vitamin A, C, and E, but the concentration depends on the cultivar (Bosland and Votava, 2000) [5]. Chillies were used fresh, canned, pickled, frozen, fermented, dehydrated, or processed to chilli powder. The medicinal values being identified scientifically in recent years and the presence of high level of antioxidants, anti-cancerous elements,

Capsaicin as a muscular pain reliever, have added additional importance (Shivanand, 2005) [36]. Bhut jolokia (*C. chinense* Jacq) also called “*bhutjolokia*” placed among hottest chillies (Wikipedia, April 2013), is an indigenous cultivar growing in Nagaland, Manipur and other part of northeast India. It has been declared as the hottest chilli of the World by the Defence Research Laboratory, Tezpur, Assam, India. Also, it has been reported as hottest chilli with 1001304 SHU (Verma *et al.*, 2013) [40]. The capsaicin content of Bhut jolokia fruits has been found to be very high as compared with the fruits of other chilli species (Baruah *et al.*, 2014; Sanatombi and Sharma, 2008) [2, 32]. The high foothill conditions with high nitrogen available in the region are suitable for the cultivation and production of an extensive range of capsicum crops including bhut jolokia (Rongsennungla *et al.*, 2012; Sharma, 2014) [30, 34]. Monsoon season with high humidity is ideal for the cultivation of the crop (Anon, 2008) [1]. Due to high pungency and aroma of the king chilli, it has an enormous scope both in international and domestic market. It has been reported that production of Bhut jolokia increases every year in north-eastern India (Meetei *et al.*, 2016) [21]. Green Bhut jolokia has huge demand owing to its aroma (Elias and Hossain, 1984) [9]. Also in season, the price of green Bhut jolokia (*bhutjolokia*) is reasonable 300-400 per kg but in off season the market price rises up (Malangmeih and Rahaman, 2016; Meetei *et al.*, 2016) [19, 21]. Huge quantity of green chilli has been found to be wasted in the field due to the lack of proper processing and preservation technology.

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After harvesting of king chilli, increase in the shelf-life of green Bhut Jolokia is very challenging due to its perishability; it is subject to quick worsening of shelf life during storage, transportation, and marketing (Chitravathi *et al.*, 2015; Edusei *et al.*, 2012) [7, 9]. Freshness is a prime requirement of green peppers consumed in India. However, freshness loss and reduced shelf-life occur because most supermarkets and retailers handle peppers improperly without optimal packaging and storage and quality can be improved and shelf-life extended for fresh bhut jolokia by modified atmosphere packaging MAP (Azlin *et al.*, 2014; Krishna *et al.*, 2007; Naik *et al.*, 2001) [2, 15, 24].

Botanical and morphological characters of chilli

Chilli is the fruit of plant belonging to the Family: Solanaceae; Genus: Capsicum; Species: *Capsicum frutescens* Jacquin. This chilli is one of the hottest on earth and the extreme variations among different cultivars include several colours, sizes and textures of fruits. Particularly, the colour ranges from light green, yellowish green to dark green in young fruits and gradually changes into light red, bright red and even chocolate while the texture varies from crumpled to semi smooth as well as gloomy with fleshy tissue. The fruit is sub-conical to conical in shape and about 2.40–2.85 cm wide at the shoulders and 6.10–9.20cm in length; Fruit surface: Rough, wrinkle with spikes and may weigh 14–18 g.

Cultivation and production practice

This chilli is grown mainly in the state of Nagaland, Assam and Manipur and to some extent in Mizoram, Arunachal Pradesh and Meghalaya which starts during February - March mainly in the hilly area and September-October in plains area (Baruah *et al.*, 2014) [2]. Bhut jolokia is highly perishable non-climatic crop and can be grown all the types of soil, but a deep loose soil is preferred. Good quality bhut jolokia can be produced under clay loam soil (Borgohain and Devi, 2007) [5]. The soil should be rich in organic matter with of pH 5.5-6.0. Bhut jolokia grows under monsoon climatic condition with generally high humidity. The rainfall range for cultivation is wide, ranging from 1200 to 4050 mm per annum and the climate is moderate with temperatures ranging between a maximum of 36 °C in summer and a minimum of 12 °C in winter (Anon, 2008) [1]. The cultivation practices should be well prepared, that is, land preparation, proper showing and transplanting, management of manuring and fertilizers and controlling of insect, pests and diseases for better cultivation and higher yield. The picking of either mature green or red fruits depends on the market demands. The number of picking varies from 15- 45 days depending on the growth and development of fruit (Meetei *et al.*, 2016; Sharma, 2014) [21, 34]. Best practice for production of bhut jolokia with proper Soil Treatment and mixture includes treat the seeds with bio-fertilizer such as azotobacter and phosphotika and Sow them in line at about 5 cm apart to avoid overcrowding of the seedlings. Mulching should be provided and the nurseries be irrigated every alternate day in the evening. When the seedlings become mature, it is ready for transplanting to the main field. Seedling root dip should be done for about 30 min in 1 kg azotobacter and 1 kg phosphotika in about 100 L. Bhut jolokia is a rainfed crop but watering should be done mixed with bio-agents at regular intervals.

Also, greenhouse production technology of Bhut jolokia standardized the technology Chilli. Greenhouse Bhut jolokia

grows rapidly under optimum environmental conditions, and fruit production begins 50-60 days after transplanting. For good fruit production, a temperature range of 25-28 °C during the day is desirable. Fertilizer management practices will, therefore, have to be planned to ensure that plant requirements are satisfied to achieve good yields of high-quality fruit. Harvest fruits when it has reached a uniform diameter throughout its length and may be harvested in green stage or as per choice in red ripe stage (50-65 days after flowering) (Katwale and Saraf, 1990) [14]. Immediately after harvest, fruit should be placed under conditions that will prolong its storage life. Packaging of fruits in shrink-wrap film before packing in cartons prevents moisture loss and maintains fruit quality. The best storage temperature is 10 °C, 3% O₂, 5% CO₂ with a relative humidity of 80-90% (Chitravathi *et al.*, 2015) [7]. Production of Bhut jolokia increases in Nagaland throughout the year.

Harvesting practices

Naga Bhut jolokia takes about 5 months to reach the harvesting stage from the time of transplanting. It is harvested at three different stages - green, yellow and ripened stages. For long distance market and vegetable purpose, harvesting is done at the green stage. For drying, pickling and seed purpose, it is harvested at yellowing to red stage. 50 plants yield about 6 kg fresh fruit per week for three months, which comes to approximately 1.5 kg per plant in three months. The average fresh fruit yield of this chilli is around 80-100 q/ha under rainfed condition while dry weight ranges from 10-12 q/ha.



Fig 1: Shows the red and green Chile

Physico-chemical composition of Bhut Jolokia

The proximate chemical compositions, such as moisture, ash, protein, fat, fibre, carbohydrate, TSS energy and ash content of green as well as red chilli, are determined. The standard official AOAC methods 19th Ed, 2012 are used for the determination parameters also as described by Orellana-Escobedo *et al.* (2012) [28]. Color is determined by Hunter Lab Colorimeter on CIE L*a*b* chromatic space, L (degree of lightness to darkness), a (degree of redness to greenness), b (degree of yellowness to blueness) values.

Previous research in Indian chili peppers showed results for moisture, ash, and protein on an average basis of 81.94, 1.27, and 1.82 g, respectively (Tandon *et al.*, 1964) [40]. Proximate composition was slightly different (moisture 68.50 g, ash 1.34 g, protein 4.00 g, and fat 1.10 g) and also carbohydrate content reported an average of 56.25%. Sweet pepper was found to have the highest crude protein value (3.51%) while the least value was found in bell pepper (2.64%) (Orellana-Escobedo *et al.*, 2012; Simonne *et al.*, 1997) [28, 38]. The metabolizable

energy values ranged from 196.33 KJ/mg (bell pepper) to 255.51 KJ/mg and fat content was 1.52% in *Capsicum annum* (Sweet pepper), 2.87% in *Capsicum frutescens* (Cayenne pepper) and 1.2% in ash (Ogunlade *et al.*, 2012) [27]. The proximate composition of capsicum fruit varied from variety to variety and location to location (Howard *et al.*, 1994) [13].

Postharvest management Bhut Jolokia in northeast India

In India, chilli is used in three different forms such as fresh green chilli, red grind and raw red. Ripen chillies are traditionally sun dried and procedure takes 3 to 4 days, depending on the weather conditions and then grinds in local huller mill and stored (Elias *et al.*, 1984) [9]. Mainly dry king chillies are sold due to their very high level of perishability. The Naga Bhut jolokia has a poor shelf life and deteriorates fast if stored under normal conditions for a long period. However, in cold storage the product may be stored for 8-10 months.

Packaging and storage structures

Packaging is an important function for every produce and so is in marketing of Chili. It is a practice to protect the produce from any damage during storage, transportation and other marketing aspects. Green chillies can be preserved and prevented from turning it red by removing the stalk and storing them in dry bags. Good packaging of chili not only facilitates convenience in transportation and storage but also attracts consumer to pay more. In India, chillies are packed mostly in gunny bags and rarely in bamboo are baskets (North eastern states). Only the exporters packed them in to good new gunny bags and sometimes low density polyethylene film pouches (Anon, 2008) [1]. Suitable marketing opportunities and infrastructure for processing bhut jolokia in this part of the country would help in promoting the cultivation of the crop. Bhut jolokia has the potential to become a major crop and reasonable pricing to production so as to make this crop more popular among the farmers. (Meghvansi *et al.*, 2010) [10]. Fresh bhut jolokia can be transported from northeast to other parts of the country and outside the country with high demand export due to pay premium prices for the product (Sharma *et al.*, 2010) [35] for improving the marketing system of this crop.

Preservation and marketing of Bhut Jolokia

The shelf-life of this chilli is limited to 3–5 days as a result of which considerable post-harvest losses are incurred. Pre-harvest sprays of plant growth regulators and other chemicals are known to be effective in enhancing the growth, yield, quality and shelf-life of Bhut jolokia (Katwale and Saraf, 1990) [14]. After harvest, chillies and peppers fruit remain biologically active and change in respiration rate, color, firmness and water loss. Shivel and wilting have an important effect on visual quality of chillies (Bosland and Votava, 2000) [5]. Chilli, a non-climacteric fruit (*C. annum* L.) deteriorated quickly during postharvest handling and storage (Naik *et al.*, 2001) [24]. Postharvest treatments e.g. low temperature storage, packaging etc. can delay these physiological changes, maintain quality and prolong storage life of chilli and pepper fruit (Chitravathi *et al.*, 2015; Manolopoulou *et al.*, 2010; Nyanjage *et al.*, 2005; Rahman *et al.*, 2012) [7, 20, 24, 28].

The bhut jolokia has a poor shelf life and deteriorates fast if stored under normal conditions for a long period. However, in cold storage, the product may be stored for 8-10 months.

Since the pungency of bhut jolokia is affected by several factors including agro-climatic conditions, studies on finding optimum conditions to achieve the maximum pungency level would be of great benefit. In-depth research should be directed towards phytochemical and pharmacological investigations of king chilli, and this could excavate novel bioactive compounds. The highest price was seen in the month of July-August and lower prices were seen from the months of September to January in all the markets. The chilli was found to fetch as high as Rupees 600 to 800 kg-1 in the month of July and April and as low as rupees 200 per kg during the period of September to January (Malangmeih and Rahaman, 2016) [19]. The quality and the scarcity of the chilli were high at the beginning of the harvest and the price shot up against the end of season.

Composition and potential value of chilli

Despite the long use of this fruit, a limited number of scientific studies and publications are available on Bhut jolokia (*Capsicum chinense* Jacq.). This variety is indigenous to the Northeast region of India but scientifically it has not been explored to its fullest. Therefore, the people of the north eastern India used the fruits in different food formulations such as flavouring curries due to its high-quality fragrance pungency, capsaicin which is great potential value in medicinal field (Davis *et al.*, 2007; Hayman and Kam, 2008; Kouassi *et al.*, 2012.; Wesolowska *et al.*, 2011a) [7, 10, 14, 41] and as such, it used for various medicinal treatments such as headache, night blindness spondylitis, digestive diseases (Sarwa *et al.*, 2012) [33] and to reduce chronic congestion (Bhagowati and Changkija, 2009) [3]. Malakar *et al.* (2018) [18] studied and identified 11 major active compounds with ethanolic extracts using GC-MS of chili. Capsaicin (14.99%), α -D-Glucopyranose, 4-O- α -D-galactopyranosyl-(24.92%), 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl (19.07%) and Squalene were major compounds identified in the fruit and considered to have pungency, antioxidant and anti-cancerous properties. *Bhut Jolokia* contains very high capsaicin content, ranging from 2.45 to 5.36% (Liu and Nair, 2010; Sarwa *et al.*, 2012) [16, 33]. The production of capsaicin in cell cultures showed that bhut jolokia has the potential to biosynthesize capsaicin significantly as compared with other species This capsaicinoids cause the spicy flavor (pungency) of chilli pepper fruit, and capsaicin found in capsicum species has been reported to have various pharmacological activities and some clinical applications (Ochoa-alejo and Ramirez-malagon, 2001) [25].

Capsaicin and dihydrocapsaicin were Capsaicin and dihydrocapsaicin were the dominant compound in capsicum variety for designing drug in pharmaceutical industries (Rohanizah and Ishak, 2012; Wesolowska *et al.*, 2011b) [42]. Similarly, they also contained 2H-Thiopyran, tetrahydro-antibacterial properties (Singh *et al.*, 2003) [38], 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one antioxidant properties (Lucie *et al.*, 2011; Yu *et al.*, 2013) [17, 43]. So the bhut jolokia has potential application and can be utilized for different medicine purposes such as pain reliever, cancer prevention, reduction of weight, gastrointestinal benefits, anti-inflammatory property, antioxidant activity etc. As a result, it is an ideal chilli variety needed for its commercial extraction of capsaicin for its utility potential in pharmaceutical industries (Higashiguchi *et al.*, 2006) [11].

Conclusion

Bhut jolokia is a fruit cum vegetable with great potential and economic importance. Bhut jolokia has lots of nutritional values and it contains capsaicin with medicinal potential. It has commercial implications in the pharmaceutical and food industry, hence its demand is on the increase. Bhut jolokia is very encouraging for designing new drugs with the help of these active compounds for the treatment of many infectious diseases and to improve the health status of the consumers. Due to its high demand and high price, the continuous production practices and, utilizing better technical inputs rising off-season grower, better storage facilities and packaging, and preservation handling in marketing chain distribution should be essential. Since it has high pungency, its aroma renders an immense scope both in domestic and international market, and as such, thorough commercialization and scientific exploration of the fruit is essential, as it serves as good source of income for local farmers and also offers great potential for future exploitation.

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