A review on strategic production management and utility potential of king chilli (Capsicum chinense Jacq): The hottest chilli in India

ABSTRACT

King chilli (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 king chilli 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.

Key words: King chilli, postharvest, capsaicin, proximate composition, marketing distribution.

INTRODUCTION

Chillies (Capsicum annum L.) are one of the most important spices of cum vegetable crop grown in India with great export potential. Chillii 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 chilli fruits in India are grown (Krishna et al., 2007). 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). 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). King Chilli (C. chinense Jacq) also called "bhujolokia" 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). The capsaicin content of king chilli 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). 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 king chilli (Rongsennungla et al.,...
Monsoon season with high humidity is ideal for the cultivation of the crop (Anon, 2008). 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 king chilli increases every year in north-eastern India (Meetei et al., 2016).

Green king chilli has huge demand owing to its aroma (Elias and Hossain, 1984). Also in season, the price of green King Chilli (bhutjolokia) is reasonable 300-400 per kg but in off season the market price rises up (Malangmeih and Rahaman, 2016; Meetei et al., 2016). Huge quantity of green chilli has been found to be wasted in the field due to the lack of proper processing and preservation technology. After harvesting of king chilli, increase in the shelf-life of green king chilli is very challenging due to its perish-ability; it is subject to quick worsening of shelf life during storage, transportation, and marketing (Chitravathi et al., 2015; Edusei et al., 2012). 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 king chilli by modified atmosphere packaging MAP (Azlin et al., 2014; Krishna et al., 2007; Naik et al., 2001).

**Botanical and morphological characters of king chilli**

King 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 as shown in Figure 1. The fruit is sub-conical to conical in shape and about 2.40-2.85 cm wide at the shoulders and 6.10-9.20 cm 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). King chilli is highly perishable non-climatic crop and can be grown all the types of soil, but a deep loose soil is preferred. Good quality king chilli can be produced under clay loam soil (Borghain and Devi, 2007). The soil should be rich in organic matter with of pH 5.5-6.0. King Chilli 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). The cultivation practices should be well prepared, that is, land preparation, proper sowing 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). Best practice for production of king chilli 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. King chilli is a rainfed crop but watering should be done mixed with bio-agents at regular intervals.

Also, greenhouse production technology of King Chilli standardized the technology of King Chilli. Greenhouse King Chilli 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). 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). Production of King Chilli increases in Nagaland throughout the year as shown in Table 1 (Sources: NEFDi data bank and Horticulture Department, Nagaland).

**Harvesting practices**

Naga King Chilli 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 (Figure 2).

Physico-chemical composition of king chilli

Fresh matured materials king chilli are procured from the local farmer's field located at Guwahati (Northeast, India). The proximate chemical compositions, such as moisture, ash, protein, fat, fibre, carbohydrate, TSS energy and ash content of green as well as red king chilli, are determined. The standard official AOAC methods 19th Ed, 2012 are used for the determination of the above mentioned parameters also as described by Orellana-Escobedo et al. (2012). 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.

The proximate compositions of the king chilli are shown in Table 1. 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). 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.,

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**Table 1:** Composition of king chilli (Malakar et al., 2018).

<table>
<thead>
<tr>
<th>Parameter analyzed</th>
<th>Green stage</th>
<th>Red stage</th>
</tr>
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<tbody>
<tr>
<td>Moisture (g/100 g)</td>
<td>86.75 ±0.82</td>
<td>83.26 ±0.56</td>
</tr>
<tr>
<td>Ash (g/100 g)</td>
<td>1.39 ±0.04</td>
<td>1.18 ±0.07</td>
</tr>
<tr>
<td>Protein (g/100 g)</td>
<td>1.75 ±0.06</td>
<td>1.86 ±0.05</td>
</tr>
<tr>
<td>Carbohydrate (g/100 g)</td>
<td>7.81 ±0.09</td>
<td>8.19 ±0.08</td>
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<tr>
<td>Fiber (g/100 g)</td>
<td>1.75 ±0.02</td>
<td>1.94 ±0.05</td>
</tr>
<tr>
<td>Fat (g/100 g)</td>
<td>0.1 ±0.01</td>
<td>0.12 ±0.01</td>
</tr>
<tr>
<td>Energy (KCal)</td>
<td>39.14 ±0.45</td>
<td>46.21 ±0.93</td>
</tr>
<tr>
<td>Vitamin C (mg/100 g)</td>
<td>109.36 ±0.90</td>
<td>110.19 ±0.45</td>
</tr>
<tr>
<td>TSS % °Brix</td>
<td>3.09±0.05</td>
<td>3.48±0.05</td>
</tr>
<tr>
<td>L</td>
<td>31.58 ±0.87</td>
<td>27.85±0.63</td>
</tr>
<tr>
<td>a</td>
<td>-13.05±0.28</td>
<td>42.13±0.39</td>
</tr>
<tr>
<td>b</td>
<td>21.46±0.76</td>
<td>18.15±0.84</td>
</tr>
<tr>
<td>chroma (C)</td>
<td>25.11±0.75</td>
<td>45.87±0.69</td>
</tr>
<tr>
<td>hue angle (H) °C</td>
<td>121.32±1.45</td>
<td>23.10±1.07</td>
</tr>
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</table>

Means ±SD (n=3).
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). The proximate composition of capsicum fruit varied from variety to variety and location (Howard et al., 1994).

Postharvest management king chilli 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). Mainly dry king chillies are sold due to their very high level of perishability. The Naga King Chilli 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 chilies can be preserved and prevented from turning it red by removing the stalk and storing them in dry bags. Good packaging of chilli not only facilitates convenience in transportation and storage but also attracts consumer to pay more. In India, chilies 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). Suitable marketing opportunities and infrastructure for processing king chilli in this part of the country would help in promoting the cultivation of the crop. King chilli 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). Fresh king chilli 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) for improving the marketing system of this crop.

Preservation and marketing of king chilli

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 King chilli (Katwale and Saraf, 1990). After harvest, chillies and peppers fruit remain biologically active and change in respiration rate, color, firmness and water loss. Shrivel and wilting have an important effect on visual quality of chillies (Bosland and Votava, 2000). Chilli, a non-climacteric fruit (C. annum L.) deteriorated quickly during postharvest handling and storage (Naik et al., 2001). 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).

The king chilli 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 king chilli 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\(^2\) 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). 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 king chilli**

Despite the long use of this fruit, a limited number of scientific studies and publications are available on King Chilli (*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, capsainin which is great potential value in medicinal field (Davis et al., 2007; Hayman and Kam, 2008; Kouassi et al., 2012; Wesolowska et al., 2011a) and as such, it used for various medicinal treatments such as headache, night blindness spondylitis, digestive diseases (Sarwa et al., 2012) and to reduce chronic congestion (Bhagwati and Changkija, 2009). Malakar et al. (2018) studied and identified 11 major active compounds with ethanolic extracts using GC-MS of king chilli. Capsaicin (14.99%), α-D-Glucopyranose, 4-O-α-D-galactopyranosyl-(24.92%),4H-Pyrans-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. King chilli also called *Bhut Jolokia* contains very high capsaicin content, ranging from 2.45 to 5.36% (Liu and Nair, 2010; Sarwa et al., 2012). The production of capsainc in cell cultures showed that king chilli has the potential to biosynthesize capsainc significantly as compared with other species. This capsaincoids cause the spicy flavor (pungency) of chilli pepper fruit, and capsainc found in capsicum species has been reported to have various pharmacological activities and some clinical applications (Ochoa-alejo and Ramirez-malagon, 2001).

Capsaicin and dihydrocapsaicin were the dominant compound in capsicum variety for designing drug in pharmaceutical industries (Rohanizah and Ishak, 2012; Wesolowska et al., 2011b). Similarly, they also contained 2H-Thiopyran, tetrahydro- antibacterial properties (Singh et al., 2003), 2,3-dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one antioxidant properties (Lucie et al., 2011; Yu et al., 2013). So the king chilli 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 capsainc for its utility potential in pharmaceutical industries (Higashiguchi et al., 2006).

**Conclusion**

King chilli is a fruiticum vegetable with great potential and economic importance. King chilli has lots of nutritional values and it contains capsainc with medicinal potential. It has commercial implications in the pharmaceutical and food industry, hence its demand is on the increase. King chilli 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.

**REFERENCES**


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