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A REVIEW ON DEHYDRATION OF CHILLI

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Abstract

Chilli is the most important spice in Indian cuisine. It is used in fresh form and dried form. Most of the dried chilli is transformed in to powder and exported to U.K., U.S.A. and other western countries. Dry chilli is extensively used as a spice in all types of curried dishes in India and other countries. It is also used for seasoning of egg, fish and meat preparations and also in sauces, chutneys, pickles, frankfurters etc. Pharmaceutical and cosmetic industries use chilli oleoresin of high pungency and low colour. This oleoresin known as oleoresin capsicum is used in pain-balms, vaporubs etc. since the pungent principle 'Capsaicin' serves as an effective 'Counter-irritant'. Drying is the important operation, where the water activity of the product is maintained to improve the storage life so that it is not spoilt by microbes. The stage of harvest and various drying methods had been given by researchers; this paper is an attempt to compile the drying methods. The drying characteristics like the decrease in ascorbic acid content and total carotenoids were observed in research findings of scientific work.

Key words : Ascorbic acid, chilli, carotenoids and drying.

Introduction

Chilli (*Capsicum annum* L.) is a quintessential spice in every Indian cuisine and is grown throughout length and breadth of country. It belongs to family Solanaceace. Its diploid chromosome number is 24. The fruit is technically a berry varies in colour and size in accordance with the variety; it may be cube-shaped, conical or spherical. Originated in South America, the crop was taken to old world by early explorers. Portuguese carried hot chilli from Brazil to India before 1595. Chilli is one of the richest sources of vitamin C and its content is more than that of tomato. Fruits accumulate maximum ascorbic acid when it turns to maturity. Chilli is the most widely used universal spice and named as "Wonder Spice". India is the largest producer and consumer of chilli among other major producers in the world. India contributes about 25% to total world production and remained in first position in terms of international trade by exporting 20% from its total production. India had produced about 10.64 lakh tonnes with an area of 6.5 lakh hectares under chilli cultivation during 2005-06. In 2006-07, production, according to trade sources, is 11.5 lakh tonnes, where as in 2007-08 production is anticipated to touch 13 lakh tonnes. India, being a largest producer, it is also the largest consumer. Domestic consumption accounts to around 7-8 lakh tonnes per annum.

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Active principle

Active principle for pungency is capsaicin (n-vanillyl-8-methyl-6 (c) noeamide) and its content in Indian varieties ranges from 0.002% to 0.86%. The principle colouring pigment of dried chilli is a carotenoid pigment, capsanthin.

Chilli is a seasonal and annually grown cash crop. Its sowing starts after monsoon showers commencement *i.e.*, from first week of August and extends till October. Growth period is around 4-5 months depending upon varieties cultivated and harvesting commences from the month of December. Arrivals start hitting the market from February and continue till April. The arrivals from Karnataka and Madhya Pradesh hit during middle of February. According to Gopalakrishnan (2007), the best temperature for ripening is 22-25°C. For fresh green chillies fruits are harvested 40-50 days after transplanting. For drying, chillies can be harvested 70-80 days after transplanting. The picking of green fruits continues for 2-3 months at 1-2 weeks interval. There are 5 to 6 pickings for green chilli and 3-4 for red ripe fruits.Pods left to ripen and to partially wither on plant are superior in colour,

flavour and pungency qualities than those picked when fully coloured but succulent. The use of partially withered ripe pods is the single condition required for high quality, secondary only to intrinsic properties of cultivar grown and has a greater influence on the final product than drying or storage methods.

Table 1 : Principle colouring pigment of chilli.

S. no.	Types of chilli	Total carotenoids (mg/g)	β- Carotene (mg/g)
1.	Chilli (Green)	10	6.8
2.	Red chilli (Dry)	127-284	1.27-2.84

Source: Pruthi (1998).

Table 2 : Major carotenoids.

S. no.	Types of chilli	Major carotenoids
1.	Chilli (Green)	Capsanthin, Capsorubin, Cryptocapsin, β–Carotene
2.	Chilli (Red)	β-Cryptoxanthin, Violaxanthin, Neoxanthin

Source: Nybe (2007).

Drying technology

Partial removal of moisture is drying. The term drying is generally used for drying under the influence of non-conventional energy sources like sun and wind. A word closely related to drying is dehydration. Dehydration is the process of removal of moisture by application of artificial heat under controlled conditions of temperature, humidity and air flow. The main objective of drying is removal of free water (lowering of water activity below 0.7) from fruits and vegetables to the extent where micro-organisms don't survive and reproduce (Kaensup *et al.*, 2002). Simultaneously, the total solids *viz.* sugars, organic acids are concentrated, excerting osmotic pressure to inhibit the micro-organisms. Thus, reduction in water content controls the biological and chemical forces respectively which act upon fruits and vegetables facilitating preservation of these perishables (Arora *et al.*, 2006) have described the conventional processing methods of chillies and have reviewed the research and developmental studies carried out in India and abroad to develop suitable post harvest technologies for this important cash crop.

Conventional processing

The varieties of chillies grown in India differ in the size, shape, colour and pungency of the fruits. The fruits may be thin and long, large and thick, short and bell shaped, small and round. The unripe fruits may be green, creamy, yellow or orange. Similarly, the ripe fruits may be of different shades of red. While most of the varieties of chillies are used as spice or for medicine, the variety with bell-shaped fruits is least pungent and is used as an ordinary vegetable. In case the drying operation does not start on the same day, the fresh chillies have to be spread under the shade overnight, as keeping chillies even for 24hrs cause considerable damage, leading to total spoilage within 4 days, if left, in heap form (Oberoi, 2005).

Traditional sun drying

Chillies and capsicums on harvesting have moisture content of 65% to 80% depending on whether partially dried on the plant or harvested while still succulent; this must be reduced to 10% to prepare dried spice. Traditionally, this can be achieved by sun-drying of fruits immediately after harvesting without any special form of treatment. Sun-drying is most widely used method throughout Asia, Africa, Central and South America. Even in United States, where artificial drying is practiced by virtually all commercial processors, sun-drying is still used by many growers of small areas. Fresh pods are spread out in sun on hard dry ground or on concrete floors or even on the flat roofs of houses in thin layers; frequent stirrings are given during day time so that drying is uniform and there is no discoloration or mould growth. The drying fruits are heaped at night and covered with tarpaulins or gunny bags. After 2 or 3 days, the larger types are flattened by trampling or rolling to facilitate subsequent packing in to bags for storage and transport. Drying by this procedure takes 5 to 15 days, depending on weather and produces 25 to 35 kg of dried spice from 100kg of fruit (Young *et al.*, 2006).

Bhopal trails

Bhopal centre of All India Coordinated Post Harvest Technology Scheme has also conducted drying studies for chillies on 7 different surfaces, namely mud floor, concrete floor, jute cloth, white canvas, tarpaulin, black and white polythene sheets, out of which olive green tarpaulin, black polythene have saved 21% of the time as compared to mud floor (Kaleemullah and Kailappan, 2005 and 2006). Poor handling of fruits prior to drying can result in bruising and splitting. Bruising shows up as discoloured spots on pods and spitting leads to an excessive amount of loose seeds in a consignment; there is a considerable loss in weight if dried fruits are sold without seeds. Chilli drying is the most important unit operation in post-harvest technology of this important cash crop. In conventional method of sun-drying ripe chillies yield dried fruits which is a cumbersome process and needs 3 to 15 days or even more depending up on weather conditions (Hunje *et al.*, 2007).

Improved "CFTRI" method of sun-drying

Drying in single and multi-tier tray system, in sun and shade and also blanching and pricking pre-treatments were studied. A 4-tier system of wire-mesh trays and a single tray of perforated aluminium both took 14 days in sun to dry fruits having moisture content of 72 to 74%, reducing it to about 6%, the normal Indian commercial traditional sun-drying methods take about 3 weeks to achieve a moisture level of 15 to 20%. 'Dipsol' is a water-based emulsion containing potassium carbonate (2.5%), refined ground nut oil (1%), gum acacia (0.1%) and butylated hydroxyl anisole (BHA) (0.001). Thus, 100 kg of 'Dipsol' containd-Potassium carbonate (2.5 kg), Refined Ground nut oil (1.0 kg), Gum acacia (0.1 kg) and BHA (0.001 kg), Dissolve potassium carbonate and gum Arabica in water separately. Similarly, dissolve BHA in refined groundnut oil. Mix water-phase solutions and add BHA dissolved in groundnut oil slowly while stirring. The mixture is passed through a homogenizer twice at 200 kg/sq. cm. 15 liters of emulsion is required to treat 100kg of fresh Chillies. It requires less space, helps in better retention of colour and pungency and gives superior quality product.

Pantnagar drying technique

Pantnagar centre of All-India Coordinated Post Harvest Technology scheme of ICAR has investigated drying characteristics of chilli (variety 'Pant-c'), both for sun-drying and hot air drying. Studies have been conducted for evaluating the performance of cement concrete floor, with black tar coating, wire mesh elevated to 0.5 to 1.0m high stand, with thickness of chilli bed varying between 1.11 and 1.19 cm. Heated air drying studies were conducted with and without stalks at 2 hot air temperatures (323° and 328°) and at 3 different velocities (1.00, 1.25, 1.50m/s) at 10cm bed thickness. Drying rates were computed using numerical differentiation technique. Concrete floor with tar coating was reported to be the best surface for sun-drying as it gave higher drying rates. Total average time to reduce moisture of Chillies to 5% (db) was about 20hr of sun exposure for concrete floor with tar coating. In heated air-drying, Chillies without stalks with air at 328°k and 1.5m/s velocity gave maximum drying rates. It was concluded that drying temperature of 50°C air velocity of 1.5m/s could be satisfactorily used for mechanical drying of Chillies without influencing the pungency of Chillies.

Solar drying

Recently, attempts have been made to develop solar equipment to improve upon the sun-drying techniques, which lead to better use of available solar radiation, reduction in drying time and cleaner and better quality product, free from dust, dirt and insect infestation. This equipment is called solar-drier.

Encouraged with the results of sun-drying studies, following solar driers have been designed and developed in India for sun-drying of chilli. A solar drier has been made near Pampore (J & K), which effects complete drying of the commodity in 4-5 days with a marked improvement in colour and storage characteristics. The gadget is very simple and is made of mud, stone, pebbles and glass panes only and is specially suited for rural areas. It can be conveniently constructed by village artisans. A unit of 2.5m × 2.5 m size can dry 80kg Chillies per batch (Ramesh *et al.*, 2001).

PKV Akola waste-fired drier

Akola centre of Post Harvest Technology Scheme has modified a waste-fired drier, developed by same centre for drying different agricultural commodities like sorghum cobs, grams and pods and for artificial drying of Chillies.The modified drier is reported to be suitable for drying 200kg red fresh Chillies per batch within a total period of 16hrs by reducing the moisture content of chillies to 16.5% from 73.40% (Hossain and Bala, 2000). The drier is connected to a blower, operated by 1 hp electric motor. A single person is sufficient for operating this drier.

CAZRI Solar drier

Central Arid Zone Research Institute, Jodhpur centre of Post Harvest Technology scheme is reported to have developed one solar drier using low-cost material for construction *viz.*, PVC sheet as transparent cover of the drier for providing green house effect bajra-husk as insulator and other materials like bamboo are used. The drier is provided with an aluminium chimney, painted black to serve as an exit for hot air. The performance evaluation of this drier during winter season (at jodhpur) showed that the drier took 9 days to reduce the moisture content of chillies from 83.6% to 3.5% in comparison to 21 days required to dehydrate moisture from the same quantity of chillies in open drying method (Joy *et al.*, 2001).

Artifial or mechanical drying

This has the advantage over traditional sun-drying in producing a better and more consistent quality product, taking less time and minimizing losses of the produce. Artificial drying has been used for many years in the United States for the pungent forms of capsicum annum grown in north and South Carolina and Louisiana and for pungent Tabasco chillies (*Capsicum frutescens*) which are also grown in Louisiana. The fruits are dried in heated buildings or more usually in tunnel driers or stainless steel

Plate 1 : Traditional Sun Drying.

continuous belt or belt-trough driers, exposing fruits to a forced current of air at temperatures of 50-60°c, thereby reducing their moisture content to 7-8% (Kumari *et al.*, 2003).

Optimum conditions for artificial drying

Mangaraj *et al.* (2001) reported that slicing or slitting pods reduced the drying time by half, and that there was no loss of intial colour on drying for 72 hrs at 60-75°C. Drying of sliced pods was found to have considerable advantages over whole pods; drying time was reduced and a superior initial colour was obtained at a temperature of 65°c. single layers of succulent whole pods dried to 8% moisture content in 12 hrs. and in 6hrs in sliced forms. Pods harvested when partially dried on plant took even shorter time for curing and exhibited even better quality (Kim *et al.*, 2002).

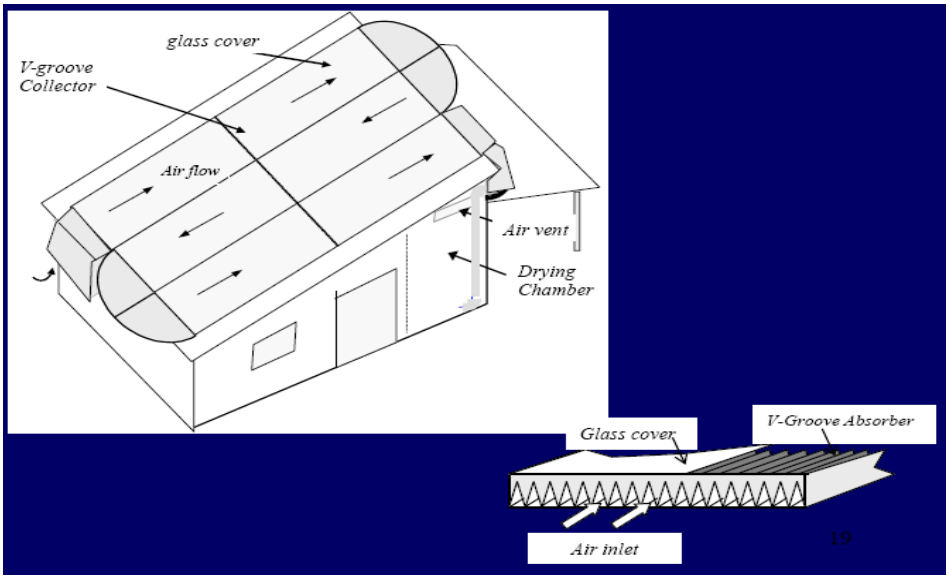

Plate 2 : Solar dryer.

Plate 3 : Drying chamber.

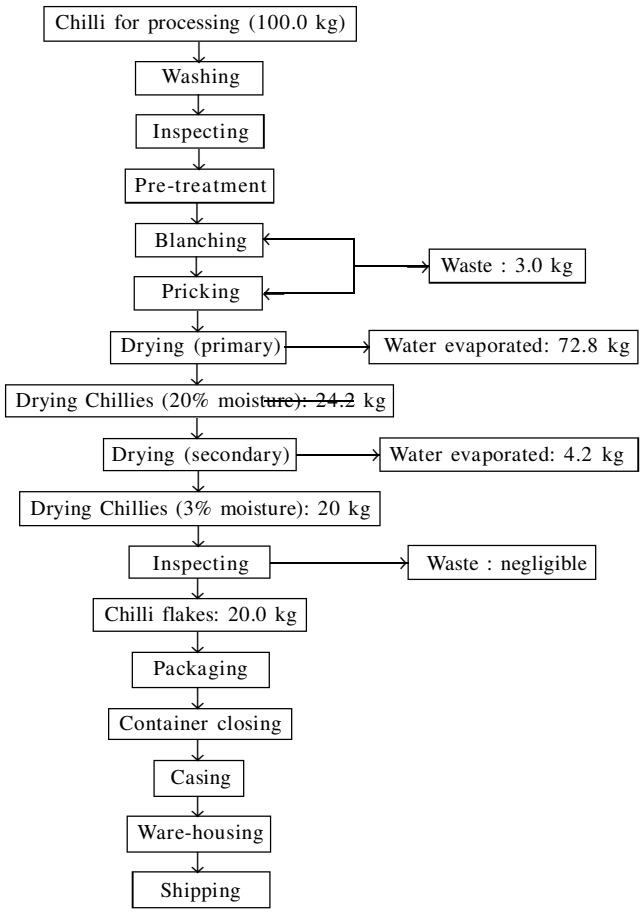

Plate 4 : Flow diagram for drying of chillies.

Microwave assisted vacuum

Chilli is a heat sensitive material. Conventional hot air drying produced very poor quality of dried chili. To improve the product quality, drying chili under vacuum condition was studied. In addition, microwave was used for increasing a drying rate, in order to improve process efficiency (Hossain and Bala, 2002). Results indicated that the chilli pretreated with 0.5% citric acid solution and dried at 1120W of power, 600mmHg of vacuum for 60minutes yielded dried chilli with similar colour to that of fresh chilli. Microwave-vacuum drying combines the advantages of both microwave heating and vacuum drying. Some fruits and grains have been successfully dried by microwave-vacuum drying techniques (Prez-Galvez *et al.*, 2004 and Oberoi *et al.*, 2005).

IARI chilli-punching machine

Drying operations of chillies could be made economical, if drying time can be reduced by punching the chillies. Realizing the importance of this technique, a chilli punching machine has been developed at IARI, New Delhi, which is capable of punching Chillies at the rate of 10kg/hr as compared to 1kg/hr manual method (Sanjuan *et al.*, 2003). The IARI machine is portable, easy to handle with a provision for adjusting gap between needles and tray. Four punching operations made on an average 20 holes per chilli and the holes punched by the machine are reported to be uniformly spread over the entire surface area of chillies.

Drying characteristics

During slow drying process the following changes have been observed in relation to carotenoid and ascorbic acid content. Enzymatic processes produce chain oxidation reactions, promoted by remaining water content and kinetically favoured by the increase in mean temperature, which affects ascorbic acid content decreasing a 66% during first 24hrs. During next 72 hrs its content totally diminished. (Perez-Galvez *et al.*, 2004 and Doymaz and Pala, 2002). During drying process, total carotenoids decreased by 20% in variety Jariza. During dehydration process, in Jaranda variety there was an increase of 2% in total carotenoid concentration. For Jariza the process generated a loss of only 7% in concentration (Gupta *et al*., 2002). Violaxanthin and capsorubin diminished in concentration by 35 and 30%, respectively. The mean concentration of capsanthin decreased by 11% (Kalmak *et al*., 2002). Drying of the red pepper samples were carried out, the unblanched samples presented only falling rate period while the blanched samples presented both constant and falling rate periods. Blanched samples dried faster than unblanched samples. The faster drying in case of blanched samples must be due to the cell wall destruction. Presence of constant rate period in the case of blanched samples should arise from damaging cell wall membrane due to the heat treatment, increasing the amount of the free moisture to be removed.

Conclusion

Chilli is an important spice crop which is exported in dried form to various parts of the world. A lot of changes like decrease in carotenoid content and ascorbic acid content take place in drying process. An attempt to make how best drying technology can be improved to meet international export standards was made. There are different kinds of drying techniques, which employs various driers, out of which sun-drying plays an important role in the life of farmers as it is the cheapest source and available all round the year, which can dry huge quantities of chilli. Improvements in case of sun-drying technique will be useful to farmers.

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