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Management of fruit rot of chilli during drying using solar tunnel dryer

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Abstract
Red chillies is one of the important spice crops of India. The fruit rot of chilli caused by *Colletotrichum capsici* (Syd.) butler and Bisby is one of the major constraints in the red chilli production in tropics and subtropics. The fruit rot stage is the most destructive which not only reduces yield but also quality of the fruit. In this context a study was conducted during *kharif* 2013-14 at Horticultural Reaserch Station, Devihosur, Haveri (Karnataka) where in chilli fruits after harvest were dried in solar tunnel drier, open sun and shade with various treatment combination and sequences. The results indicated that lowest fruit rot (24.2 PDI) in treatment having drying chillies 96 hrs in solar tunnel drier followed by 24 hrs of shade. Drying in shade (56.5 PDI) and heap drying (62.4 PDI) recorded highest incidence. Drying chillies 96 hrs in solar tunnel drier followed by 24 hrs of shade also recorded highest capsaicin (2.46 per cent) among all the treatments.

Keywords: Fruit rot of chill, solar tunnel dryer

Introduction
Capsicum annum L. (Chilli), is an annual shrub constitutes one of the most important spices cultivated all over the world. It belongs to the family solanaceae. India is the largest producer of chillies in the world, accounting for over 45% of the total area under cultivation. In India, dry chilli is grown over an area of 7.94 lakh hectares with production of 13.04 lakh tones and productivity of 1.6 tonnes per hectare. In Karnataka dry chilli occupies an area of 1.00 lakh hectares with production of 1.07 lakh tones and productivity of 1.06 tonnes per hectare (Anon., 2013) [2]. Chillies are consumed in green, red as well as in sun dried condition. Among the spices consumed per head in India, dried chillies contribute major share. It is used to prepare foods, snacks, sauces, widely used for colour extraction also used in medicine, explosives and also as insecticide. One of major use of chilli is extraction of oleoresin which is highly demandable in international trade. The major constraints in chilli production are the diseases. There are many pathogens causes' diseases on various parts of chilli (Saha nad Singh, 1988; Mukerji and Jayanthi Bhasin, 1986) [10, 6]. Among fungal disease the anthracnose or ripe fruit rot caused by *colletotrichum capsici* (Syd.) is limiting the profitable cultivation and seed production throughout the major chilli growing regions of India. This disease causes heavy loss (80 %) to the farmers. The farmers using unscientific methods of drying which lead to increased incidence of fruit rot. However, no efforts made to manage of this disease during drying of chillies. In this context the study was conducted to manage the fruit rot of chilli during drying using solar tunnel drier.

Materials and methods
The present study on drying of chilli (var *Byadgi dabbi)* was carried out in the Solar Tunnel Dryer (STD) of one tonne capacity installed at Horticulture Research Station, Haveri (Devihosur). The dryer has tunnel shape made of semi cylindrical metallic (galvanized pipe) structure covered with UV-stabilized transparent thermal polyethylene sheet of 200 micron (Plate 1.). Freshly harvested ripened chillies of score 5 were procured from the field and brought to STD. The treatments of following were laid out in randomized block design with three replications. The chillies were dried in STD and outside as per the treatments.

The details of the treatments are given here under.

Treatments

T_1 Drying chillies 24 hrs in solar tunnel drier followed by 96 hrs shade

T_2 Drying chillies 48 hrs in solar tunnel drier followed by 72 hrs shade
T_3 Drying chillies 72 hrs in solar tunnel drier followed by 48 hrs shade
T_4 Drying chillies 96 hrs in solar tunnel drier fol1owed by 24 hrs shade
T_5 Drying chillies 120 hrs in solar tunnel drier
T_6 Drying chillies in Open Sun for 120 hrs
T_7 Drying chillies in Shade for 120 hrs
T_8 Drying chillies in Heap (Farmer Practice)

The disease intensity in term of PDI (Wheeler, 1969) was recorded after imposing treatments.

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of numerical values}}{\text{Number of plants Observed} \times \text{Maximum Disease rating}} \times 100$$

Fruit moisture content, capsaicin content and oleoresin content were also recorded. Moisture content was determined by using moisture balance (Model: PI019319, A and D Company Limited, Made in Japan) before and after the fruits subjected to the treatments. Two gram of chilli fruit sample was placed in the sample dish and dried in the electric moisture balance until it automatically showed moisture in percentage. The instrument indicates the end point of measurement by a beep and gives constant value for moisture. Capsaicin was estimated was colorimetric method (Sadashivan and Manickam, 1996) [9]. In this method 500 mg of dry chilli powder was added into a glass stoppered test tube. Ten ml of dry acetone was pipette out into the flask and was kept in mechanical shaker for three hours. The contents were centrifuged at 10,000 rpm for 10 min. one ml clear supernatant was pipette out into a test tube and evaporated to dryness in a hot water bath. The residue was dissolved in 5 ml of 0.4 percent NAOH solution. 3 ml of 3 percent phophomolybdic acid was added. The contents were mixed and allowed to stand for 1 hour. The solution was quickly filtered into centrifuge tubes to remove any floating debris and centrifuged at 5000 ppm for 15 min. the clear blue colored solution was transferred directly into cuvette and the absorbance was read at 650 nm. Also, a blank reagent was run along with test samples. A standard graph was plotted using 20-200 µg capsaicin (Himedia) simultaneously i.e, 0.2, 0.4, 0.6, 0.8 and 1.0 ml of working standard solution was pipetted out and processed as above. Capsaicin percent was calculated by using the standard graph as follows.

$$\text{Capsaicin (\%)} = \frac{\text{µg capsaicin} \times 10 \times 100}{1000 \times 1000 \times 1 \times 0.5}$$

Colour index was calculated at the end of 120 hours of drying as per the formula given by Hegde (1998) [3]. Oleoresin content was estimated by following Gravity method (Ranganna, 1977) [8]. To a cleaned glass column, a small pinch of washed glass wool was added pushed into the bottom of the column using a glass rod and gently packed. A known amount (l0g) of finely powdered chilli sample was transferred into the column and closely packed by tapping it. After fixing this column to an iron stand vertically, cold acetone was added in the ratio of 1:10by weight to volume. It was added slowly from the top and the rate of flow of extract from the column was regulated and extract was collected in a porcelain dish. The extract was evaporated over water bath, dried and weighed again. The amount of oleoresin obtained was calculated by using following formula.

$$\text{\% Oleoresin} = (W3 - W2)/ W1 \times 100$$

W1 = weight of samples taken, W2 = weight of the empty porcelain dish, W3 = weight of the dish + sample extract after drying.
Stastistical analysis was carried out by following the standard statistical procedure (Panse and Sukhatme, 1957) [7].

Results and discussion

The maximum temperature of the air inside the dryer was observed to be 49 °C again. t the ambient air temperature of 32 °C. The moisture content of chillies, capsaicin content, colour index and fruit rot incidence varied significantly due to the treatments. The moisture content of chillies recorded minimum in T_5 (9.81 percent) which was on par with T_6 (9.90 percent), T_4 (9.99 percent), T_3 (10.22 percent), T_2 (10.35 percent) and T_1 (10.66 percent). The chillies kept under open shade drying recorded 14.50 per cent while heap drying recorded 18.12 per cent at the end of 120 hours. Similar results were obtained by Manjula *et. al.,* 2011 [5].

The capsaicin content of chillies recorded maximum in T_1 (2.46 per cent.) followed by T_5 (2.44 percent) which was on par. The chillies kept under open shade drying recorded 2.02 per cent while heap drying recorded 1.04 per cent at the end of 120 hours. With respect to the colour index the treatment T_1 (81.2) recorded significantly superior than all other treatments followed by T_2 (73.6). Least PCI was noticed in treatment with Drying chillies in open sun for 120 hrs (33.33). Direct sun light as well as increased temperature always depletes the colour in the chillies (Kaewkiew *et. al.*, 2014) [4].

The oleoresin content did not varied significantly between all the treatments. The oleoresin content of chillies recorded maximum in T_1 (8.24 per cent.) followed by T_5 (8.17 percent). The chillies kept under open shade drying recorded 8.00 per cent while heap drying recorded 7.89 per cent at the end of 120 hours.

With respect to the fruit rot lowest Percent Disease Index was recorded in the T_4 (Drying chillies 96 hrs in solar tunnel drier fol1owed by 24 hrs shade) (24.2 PDI). However, it was on par with T1 (27.2), T2 (25.4), T3 (26.8), T5 (26.9) and T6 (26.9). Drying in open shade recorded 56.5 PDI while heap drying recorded 62.4 PDI. Higher moisture percentage predisposes the chillies for post-harvest fruit rot. In case of heap drying which is practiced by the farmers, humidity will build up which is more congenial for the development of fruit rot (Agrios, 2005) [1].

Plate 1: Photographs showing solar tunnel drier designed for chilli drying

Table 1: Effect of methods of drying on fruit rot incidence and quality parameters of chilli

Sl. No	Treatment	Moisture (%)	Capsaicin (%)	Oleoresin (%)	Colour (PCI)	Fruit rot (PDI)
1	Drying chillies 24 hrs in STD# followed by 96 hrs shade	10.72 (19.22)*	2.46	8.24	81.2 (64.8)*	26.2 (30.8)*
2	Drying chillies 48 hrs in STD followed by 72 hrs shade	10.66 (19.01)	2.09	8.10	73.6 (53.9)	24.4 (29.6)
3	Drying chillies 72 hrs in STD followed by 48 hrs shade	10.35 (18.70)	2.20	8.04	64.8 (53.9)	26.2 (30.8)
4	Drying chillies 96 hrs in STD followed by 24 hrs shade	9.99 (18.60)	2.27	8.05	58.3 (52.1)	23.5 (29.0)
5	Drying chillies 120 hrs in STD	9.81 (18.42)	2.44	8.17	49.4 (45.9)	24.2 (29.5)
6	Drying chillies in Open Sun for 120 hrs	9.90 (18.39)	2.15	8.11	33.3(35.4)	26.7(31.1)
7	Drying chillies in Shade for 120 hrs	14.50 (22.62)	2.02	8.00	74.9(59.9)	56.5(48.7)
8	Drying chillies in Heap (Farmer Practice)	18.12 (25.6)	1.84	7.89	65.3 (55.5)	62.4 (52.2)
S. Em.		0.38	0.06	0.05	1.2	1.8
C. D. at 5 %		1.16	0.18	NS	3.6	5.4

*Figures in parentheses are arcsine transformed values #STD= Solar Tunnel Dryer

In the present study it could be concluded that for the better management of the fruit rot of chilli during drying as well as for the retention of moisture, capsaicin content, more colour index and oleoresin content is achieved by drying the chillies in solar tunnel dryer for 24 hours followed by shade drying for 96 hours is found useful.

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