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Studies on the drying behaviour of red chilli and it's effect on quality

Dawn C.P. Ambrose[1]*, Ravindra Naik[1] and Hrishikesh Patil[1]

[1]*Central Institute of Agricultural Engineering, Regional Station, Coimbatore 641007, India. *E-mail: dawncp@yahoo.com*

Abstract

Processing of chilli is an important aspect in the production of good quality chilli. Harvested chilli has moisture content about 80% (w.b) which has to be properly dried to keep away from aflatoxin infestation. Open yard sun drying is the conventional method being practised which takes long time for drying. Pre-treatment like destalking could reduce the drying time considerably resulting in uniformly dried product. The present work was aimed to find the effect of drying on the quality of chilli. Red chilli (variety: Sannam) was dried with stalk and without stalk under open sun and solar tunnel dryer. The drying behaviour of chilli was studied. The influence of drying on the quality parameters *viz.*, vitamin C content, colour (L*, a*, b* values), shrinkage and ASTA colour was found. Drying studies resulted in reduction in moisture content from 323% (d.b) to 8% (d.b). The time taken for drying under open sun drying and solar drying was 33 and 17 hours respectively for chilli dried with stalk. Similarly, the time taken for drying chilli without stalk under open sun drying and solar drying was 29 and 16 hours respectively. Quality analysis of dried samples showed higher vit.C (13 mg/100g) and ASTA colour value (67.4) for solar dried chilli without stalk.

Key words: Red chilli, with stalk, without stalk, drying, quality

Introduction

Red chilli also known as red pepper is the ripened fruit of capsicum annum L belonging to Solanaceace family. It is a highly pungent fruit, rich in vitamin C. When dried, it is called as dry chilli, which is an important spice used in culinary. It is also known as Wonder Spice because of its usage worldwide. Dry chilli adds taste, flavour and colour to a dish. It is an inevitable ingredient in pickles, sauces, ketchup, essences, oleoresins etc. There are many varieties of chilli differing in colour, size and pungency. The major producers of chillies in the world are India, China, Pakistan, Morocco, Mexico, Turkey and Bangladesh (Devi *et al.*, 2016, 2017).

Harvested chilli has moisture content about 80% (w.b) which is susceptible to fungal attack during storage. Chilli has to be dried to 10-12% (w.b) moisture content. Delay in drying leads to microbial infestation. Chilli has to be properly dried to keep away from aflatoxin infestation which would affect the export market. Open yard sun drying is the conventional method of drying which is still being practised extensively. Depending upon weather, variety, order of picking, generally it takes 15-20 days for drying. Prolonged drying results in product of inferior quality. An alternative to sun drying is solar drying which is eco-friendly and an economically viable technology to the chilli growers (Thiri *et al.*, 2020). Also it is a renewable energy method of drying considered to be cost effective yielding to better quality product. Nitin *et al.* (2020) reported that enclosed solar drying not only decreases the drying time but also reduces the risk of contamination when chillies are exposed to open environment. Apart from improved method of drying like the solar drying, various methods of pre-treatments *viz.*, blanching in hot water, soaking in chemical solutions, mechanical pretreatment have been devised which influences the drying time and quality. Results have indicated that pre-treated chilli dried faster than control (Tunde and Toyosi, 2010). De-stalking is the process of removal of stalk from the chilli. Pre-treatment like destalking of red chilli promotes uniformly dried product of better quality and appeal. De-stalked dried chilli fetches high market price.

Since drying of chilli takes a long period of time affecting it's colour and quality, several approaches have been envisaged to address the above issue. Hence the present investigation was carried out to find the effect of drying red chilli with and without stalk by solar tunnel drying and sun drying on the quality of the final product.

Materials and methods

Raw material: Red chilli (Sannam variety) was procured from the farmer's field at a village in Coimbatore Dt., Tamil Nadu, India. It was then sorted manually to remove foreign materials, defective, unripen chilli before drying.

Drying: Drying studies were conducted on red chilli with stalk and without stalk. One lot of cleaned red chilli was de-stalked (without stalk) and another lot was kept with stalk for drying studies. Drying was carried out in open yard by sun drying and in solar tunnel dryer. Under sun drying, red chilli samples with stalk and without stalk were spread on perforated stainless steel trays and dried for 7 hours in a day till it was completely dried. Both temperature and relative humidity was recorded at hourly interval, every day during drying. Drying was also carried out in solar tunnel dryer. The solar tunnel dryer is a polyhouse dryer suitable for drying of most of the food crops. It consists of a tunnel type semi-cylindrical drying chamber. A chimney provided at the top of the structure evacuates the moist air from the dryer. A door is provided in the front for easy handling of the produce. The maximum temperature of the air inside the dryer was observed to be 60-65°C.

The initial moisture present in the sample was determined by standard oven drying method (AOAC, 2000).

Quality parameters: The dried samples were analysed for their quality on colour value, coloring matter, percentage shrinkage and ascorbic acid content.

Determination of ascorbic acid: Ascorbic acid content of dried chilli samples was determined by titration method. About 10g of sample was blended with 3% metaphosphoric acid, made up to 100 mL and filtered. 10 mL of sample was pipetted into a conical flask and titrated with 2,6- dichlorophenol indophenols dye solution, to a pink end- point. Quantity of ascorbic acid (mg) present in 100 g was calculated as as per Srivastava and Kumar (1998).

Coloring matter: The coloring matter of dried chilli was measured as per the method described in Spices & Condiments (2015). Dried chilli was finely powdered and 70 g of powder was taken in a volumetric flask. The volume was made to 100 mL by using acetone and stoppered tightly. The sample was kept in dark for about 16 hours. The sample was then shaken well and allowed to settle for 2 min. before taking reading. The optical density of the sample was read at 460 nm wavelength using Spectrophotometer (Make: BioEra).

Coloring matter was calculated using the formula below.

Coloring matter (ASTA units) = [(OD x 16.4)/ Sample weight (g)]

Where, OD = Optical density.

Colour: Colour was measured using Colour Flex Meter (Hunter model). The instrument was calibrated prior to each experiment with white and black ceramic tiles. Measurement of color was done by determining L*, a* and b* values. Although, all the values of L*, a* and b* were measured, the a* value was considered as a color parameter of chilli in the analysis, since a* value represents a measure of redness of chilli.

Shrinkage: The measurement of shrinkage was carried out based on the displacement method to determine its apparent volume. Shrinkage was calculated as below:

Shrinkage (%)= [(V1-V)x 100]/V1

Where

V1-initial sample volume before drying

V-volume after drying

Statistical analysis: Data obtained from the three replicates of each treatment was subjected to ANOVA (analysis of variances) using statistical software, AGRES. Least Square Design (LSD) was used to test the significant difference between means at a confidence level of 95%.

Results and discussion

Drying characteristics of red chilli: Freshly harvested red chillies, both whole and de-stalked were subjected to sun drying and solar drying techniques. The initial moisture content of fresh red chilli was 80% w.b and chilli was dried until the equilibrium moisture content was reached.

Change in moisture content with time: The drying behaviour of red chillies at different drying conditions is shown in Fig. 1&2. As can be seen, the moisture content of chillies decreased linearly

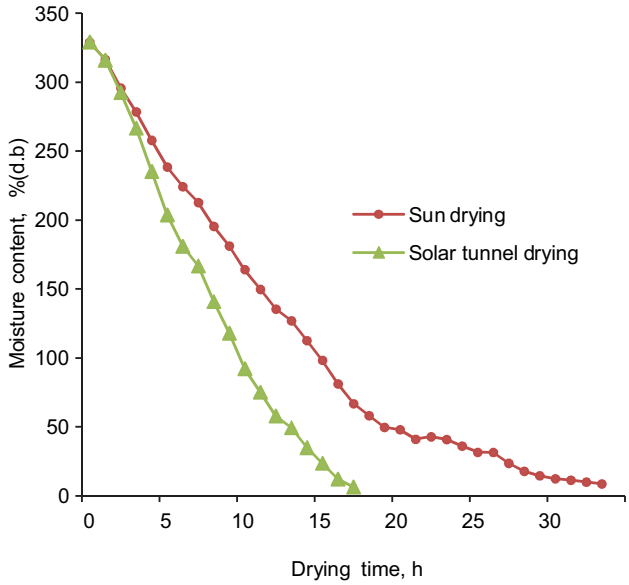

Fig. 1. Effect of drying chilli with stalk

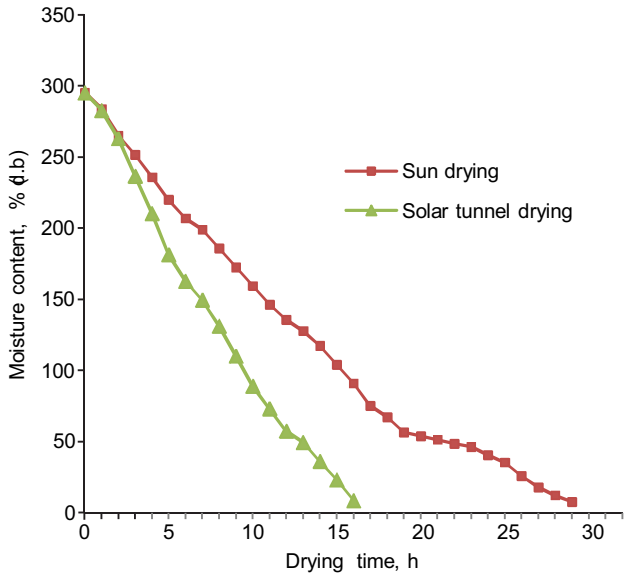

Fig. 2. Effect of drying chilli without stalk

with drying time. Moisture present initially varied between 295 % (db) and 323% (db) for samples without stalk and with stalk respectively. It may be due to the slight moisture loss during destalking treatment that the initial moisture content of destalked samples as they were kept for drying was lower than that of sample with stalk. The time taken for drying chillies with stalk was longer than that for destalked lot. The reason is basically the presence of stalk making it to take longer time for drying. Similar results on reduction in drying time were observed when chillies were punched (Mangaraj *et al.*, 2001) and also perforating the chilli skin (Muhidin and Hensel (2012).

It could be understood from the above figures that that moisture content of chilli decreased with the increase in drying time in both the drying methods. The time taken for drying under open sun drying and solar drying was 33 and 17 hours respectively for chilli dried with stalk as seen in Fig. 1. Similarly, the time taken for drying chilli without stalk under open sun drying and solar drying was 29 and 16 hours, respectively (Fig. 2).

Open sun drying of chilli took longer time to reach equilibrium moisture content as compared to the solar tunnel drying of chilli. Loss of moisture in solar tunnel drying was faster as compared to open sun drying. Similar finding was reported by Thiri *et al.* (2020) for Champion 777 variety of red chilli. It was reported from the study that the time required to reach the equilibrium moisture content was 23 and 19 hours for blanched sample and 25 and 19 hours for non-blanched samples for open sun drying and solar tunnel drying respectively. This is in agreement with the present investigation which reveals that pre-treatment and drying method influence the drying time. Temperature and relative humidity were recorded during drying for open sun drying and solar tunnel drying. The temperature during sun drying varied from a minimum of 31ºC to a maximum of 37ºC. The corresponding average temperature inside the solar tunnel dryer ranged from 52 to 65ºC. Relative humidity ranged from 19 to 32% for solar tunnel drying and 37 to 63% for open sun drying. The temperature inside the solar tunnel dryer was higher than the ambient temperature. This may due to the trapping of more solar energy inside the solar tunnel dryer. The final moisture content of chilli after drying ranged from to 8 % (d.b) depending on the drying conditions.

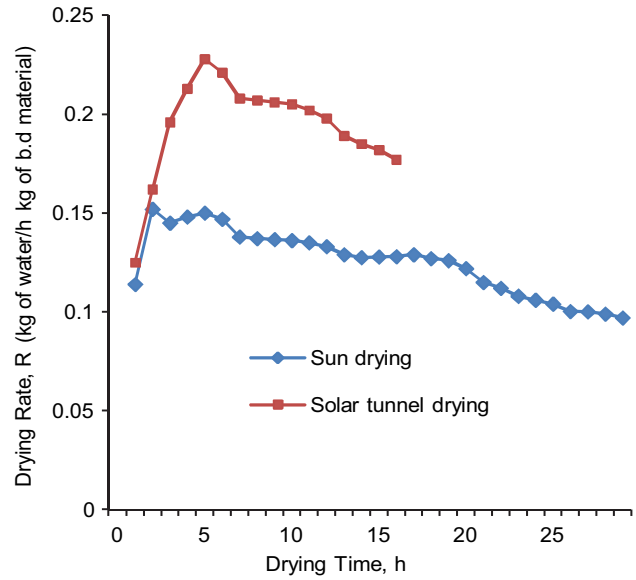

Fig. 3. Drying rate of chilli without stalk

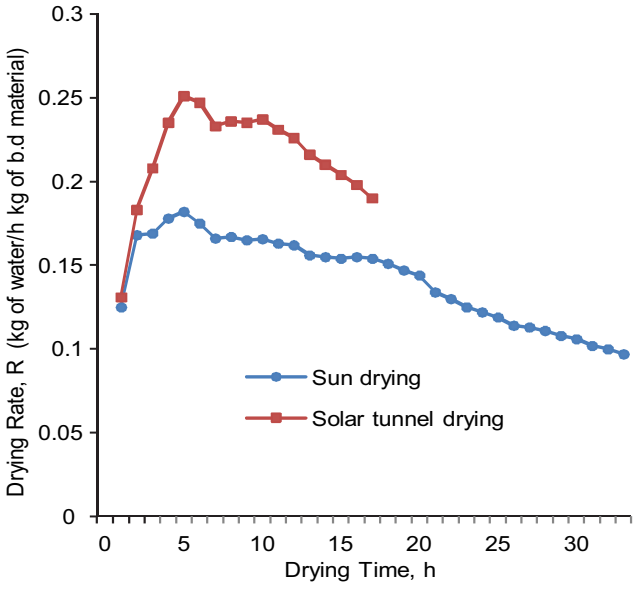

Fig. 4. Drying rate of chilli with stalk

Change in drying rate with time: The drying rate decreased with the duration of drying for chilli in both the drying methods as shown in Figs. 3&4. The drying rates were higher in the early part of the drying process and the rate was gradually reduced during drying due to decrease in moisture content. This finding was similar to Gupta *et al.* (2002) who also found that the rate was higher at the beginning of the process and then gradually reduced as the drying process progressed and the availability of moisture was reduced. In the case of solar tunnel drying, the drying rate of samples without stalk was higher compared to sun drying during the initial period of drying. Drying rate was seen higher in chillies dried without stalk as compared to chillies with stalk (Fig. 3). This clearly indicates the effect of stalk on drying rate. With the depletion of moisture, drying rate gradually decreased during the drying process.

Open sun dried samples took longer drying time than solar tunnel dried samples. Hence, the drying rate of red chilli in open sun drying was found to be lower. In the open sun drying method, the drying rate of sample without stalk was higher initially.

Effect of drying on the quality of red chilli: The important quality parameters *viz.* colour, ascorbic acid, ASTA colour value, % shrinkage were assessed are presented in Table 1.

Table 1. Quality parameters of dried chilli

Drying condition	Vitamin C (mg/100g)	Colour			Shrinkage (%)	ASTA Colour Value
		L*	a*	b*		
Sun drying-with stalk	11.21	43.49	16.06	14.95	53.34	61.32
Solar drying-with stalk	12.58	43.80	16.60	12.60	43.22	65.16
Sun drying-without stalk	11.77	44.94	17.18	11.27	42.14	63.28
Solar drying-without stalk	13.91	46.59	19.22	10.64	30.06	67.44

The vit. C content of chilli dried with stalk and without stalk under sun drying and solar drying condition is shown in Table 1. Higher content of vit. C was recorded for solar dried sample without stalk whereas sample dried with the stalk under sun resulted in lower value. This was in confirmation with the findings of Manjula and Ramachandra (2014) that the sample dried under solar tunnel drying was found to have better retention of ascorbic acid content as compared with open yard sun drying. The ascorbic acid of red chilli decreased during drying since it is heat labile. This variation in vit. C based on the drying methods adopted was found to be statistically significant ($P \leq 0.05$).

It could be seen from Table 1 that colour values (L*, a*, b*) varied significantly for the samples dried with stalk and without stalk. It was found that the sample dried without stalk resulted in highest a* (which indicates redness) under both the drying conditions. This may be due to lesser time taken for drying by sample without stalk compared to sample with stalk. As reported by Oberoi *et al* (2005) longer drying leads to oxidation of carotenoid pigment resulting in red colour of lesser intensity. Solar tunnel drying resulted in higher a* value between the two drying methods (Table 1). Similar results have been obtained by

Manjula and Ramachandra (2014) during drying of red chilli who have reported that Solar tunnel drying significantly improved the lightness and redness of dried chilli compared to the open yard sun drying method.

Shrinkage is a change in physical structure of product during drying which has a negative impact on the quality of a product (Senadeera *et al.*, 2020). Sun drying of chilli with stalk resulted in highest shrinkage value whereas lowest shrinkage value was observed in solar drying without stalk (Table 1). This could be explained by the fact that the generation of porous structure and the expansion of dried product during drying resulted in lower shrinkage of final product (Saengrayap *et al.,* 2015). Statistical analysis revealed that the drying method and pre treatment had significant effect on shrinkage ($P \leq 0.05$).

ASTA colour value of dried chilli samples is given in Table 1. Solar dried sample without stalk exhibited maximum colour value whereas sun dried chilli with stalk showed lower value. This variation on the basis of drying technique used was found to be statistically significant ($P \leq 0.05$).

In conclusion, the study clearly highlights the influence of drying techniques and pre-treatments on the moisture content, drying rate, and quality attributes of red chilli. Solar tunnel drying proved to be more efficient in reducing drying time and retaining key quality parameters like vitamin C, color, and minimizing shrinkage, particularly in samples without stalks. Open sun drying, while effective, required longer drying periods and resulted in higher shrinkage and lower color retention. These findings emphasize the importance of choosing the right drying method to achieve better quality and efficiency in chilli drying processes.

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