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Review Article

Study on Different Drying Methods of Red Chilli (*Capsicum annuum* L.)

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Abstract

The experiments were carried out at Postharvest Research Institute (PHRI), Department of Agriculture, Nay Pyi Taw and the Division of Postharvest Technology, Advanced Centre for Agricultural Research and Education (ACARE), Yezin Agricultural University (YAU) from April to August in 2019. This experiment was conducted to investigate the quality of dried chilli by open sun drying and solar tunnel drying. A factorial arrangement in completely randomized design (CRD) was laid out with four replications. The hybrid variety of Champion 777 red chilli was used as the pretreatment with blanching. The data on moisture content (% w.b), drying rate (%/h), water activity (aw), color difference (ΔE), browning index (BI), ascorbic acid content (mg/100g) and aflatoxin content (ppb) were collected. The final moisture content ranged from 5.8 to 7.3% (w.b) depending on drying method. The open sun drying method took the longest drying time of 23 hours for blanched chilli and 25 hours for non-blanched followed by the solar tunnel drying method (19 hours). Most of the treatments showed no aflatoxin content and there was permitted level in the blanched chilli of solar tunnel drying method. From these findings, the red chilli dried with solar tunnel had considerably lower in moisture content and water activity with less in browning index and color difference. Moreover, solar tunnel drying method retained more ascorbic acid content than open sun dried samples. Therefore, solar tunnel drying method was much better than open sun drying method with respect to less time for drying, low moisture content, bright red color with high ascorbic content.

Keywords: Ascorbic Acid; Aflatoxin; Color Difference; Drying Methods; Moisture Content

Introduction

Chilli is a vegetable plant belonging to the family of Solanaceae. Chilli is rich in vitamin A, B, C and E with minerals such as calcium, magnesium, phosphorus, etc. [1]. Chilli is an important culinary crop in Myanmar and it is a quintessential spice in every Myanmar cuisine. Chilli is grown throughout the country and it is a seasonal and annually grown cash crop. There are many varieties of chilli in Myanmar. Total cultivated area of chilli was 109,510 hectares in 2017-2018 [2]. Green chilli is used for hot flavor and spices in salads and dried chilli powder is used in dishes as condiments for flavouring and colouring in Myanmar cuisines.

Drying is a process that removes moisture by heat. It is one of the oldest food preservation methods. Drying is the most widely used in food preservation [3] and the traditional drying method is sun drying. Sun drying requires 7 - 20 days to reduce the moisture content to 10-15% in chilli depending on the weather condition [4]. Sun drying, hot air drying, solar tunnel drying and fluidized bed drying are the methods most commonly applied for drying chilli. Solar tunnel drying is a rather cheap method because sunlight is free, renewable and abundant-energy source. It is also an environmental friendly and economical drying method for rural farmers [5]. It is more convenient like sun drying for rural and other areas with scarce or irregular electricity supply. Therefore, solar drying is a good alternative for sun drying for the production of high quality dried products [6].

Most of the chilli powder production enterprises existed in Myanmar are of poor quality and poor hygiene. It can be seen that there are many kinds of chilli powder with various brands in local markets. Dyes are often used to brighten the colour of chilli powder, making it more attractive to consumers. Additionally, contamination of mycotoxin occurs in red pepper due to improper drying method and excess amount of moisture content. Dried chilli is susceptible to fungal proliferation in favorable conditions for mycotoxin contamination in conventional drying method [7]. Aflatoxin is a highly toxic mould which is a major problem to liver and kidney causing toxicity and carcinogenicity in human beings [8].

According to the above-mentioned problems, this study was focused on the drying technique useful for farmers and small scale producers. It is also needed to improve quality and hygiene of red chilli powder for food safety. Therefore, the present study was carried out to study the effect of open sun drying and solar tunnel drying method on quality of dried chilli.

Materials and Methods

The experiment on drying method was conducted at Postharvest Research Institute (PHRI), Department of Agriculture, Nay Pyi Taw from April to May in 2019. The measurements and quality evaluation were carried out at the Division of Postharvest Technology, Advanced Centre for Agricultural Research and Education (ACARE), Yezin Agricultural University (YAU). The experiment was laid out in factorial arrangement in completely randomized design with four replications. The first factor was drying methods of open sun drying and solar tunnel drying. The second factor was pretreatment; blanching and non-blanching. Treatment combinations were open sun drying with blanching (OB), open sun drying with non-blanching (ONB), solar tunnel drying with blanching (SB) and solar tunnel drying with non-blanching (SNB). Fresh red chilli of cv. Champion 777, collected from Nyaungdon Township, Ayeyarwaddy Division, was used as tested cultivar.

Fresh red chillies were collected and divided into two groups consisting of 20 kg for blanching with hot water at 90ºC for 3 minutes by the method of Ajaykumar, Sandeep and Madhukar [1] and the other 20 kg for non-blanching. The sample of 10 kg chilli was dried for each drying method.

Blanched and non-blanched chillies were dried by open-sun-drying and solar tunnel drying till equilibrium moisture content. Weight of samples was recorded beforehand and measured at every 1 hour intervals during drying process. The duration of drying time, relative humidity and temperature were recorded during drying process from 9:00 am to 5:00 pm. The data on moisture content (% w.b), drying rate (%/h), water activity (aw), color difference (ΔE), browning index (BI), ascorbic acid content (mg/100g) and aflatoxin content (ppb) were collected.

Data analysis

Analysis of variance and mean comparison were calculated with statistical package (Statistix version 8). The treatment means were compared by using the least significant difference (LSD) test at 5% level.

Results and Discussion

Change in moisture content with time

Figure 1 and 2 reveal the decreasing moisture content (% wb) during drying process of red chilli. The time required to reach the equilibrium moisture content was 19 and 23 hours for blanched sample and 19 and 25 hours for non-blanched samples in solar tunnel drying and open sun drying respectively. The duration was recorded from 9:00 am to 5:00 pm during drying. Temperature and relative humidity were recorded during open sun drying and solar tunnel drying. The ambient temperature during drying period varied from a minimum of 36ºC to a maximum of 51ºC. The corresponding average temperature inside the solar tunnel dryer ranged from 48ºC to 67ºC. Relative humidity ranged from 11% to 30% for solar tunnel drying and 12% to 44% for open sun drying. The temperature in the solar tunnel was higher than the ambient temperature. This is due to the trapping of more solar energy inside the solar tunnel dryer.

The initial moisture content of fresh chilli was 74% (w.b). After drying, the final moisture content of dried chilli ranged from 6.2% (w.b) to 7.3% (w.b) depending on the drying method (Table 1). The highest moisture content was observed in non-blanched sample in open sun drying while it was the lowest in blanched sample in solar tunnel drying. The reason may be due to the higher drying temperature inside the tunnel, which can favour more water loss from the red chilli.

No.	Sample	Drying Time (h)	Final Moisture content (% w.b)
1	Open sun drying with blanching (OB)	23	6.7
2	Open sun drying with non blanching (ONB)	25	7.3
3	Solar tunnel drying with blanching (SB)	19	6.2
4	Solar tunnel drying with non blanching (SNB)	19	6.4

Table 1: Final moisture content of dried chilli as affected by different drying methods.

Change in drying rate with time

The drying rates of both drying methods were higher in the early part of the drying process and slowly reduced due to decrease in moisture content. Open sun dried samples took longer drying time than solar tunnel dried samples. Hence, the drying rate of red chilli in the tunnel was found to be higher than that of the open sun dried samples. In open sun drying method, the drying rate of blanched sample was higher than non-blanched sample up to 4 hours, after that drying rates in both blanched and non-blanched samples were nearly the same during the drying process. This finding was similar to Gupta., *et al*. [9], who also found that the rate was higher at the beginning of the process, then gradually reduced as the drying process progressed and the availability of moisture was reduced.

Figure 1: Decreasing of moisture content (% w.b) with time for chilli dried in open sun.

Figure 2: Decreasing of moisture content (% w.b) with time for chilli dried in solar tunnel.

Figure 3: Decreasing of drying rate (% w.b/h) with time for chilli dried in open sun drying.

Figure 4: Decreasing of drying rate (% w.b/h) with time for chilli dried in solar tunnel drying.

OB: Open Sun Drying with Blanching; ONB: Open Sun Drying with Non-Blanching; SB: Solar Tunnel Drying with Blanching; SNB: Solar Tunnel Drying with Non-Blanchning.

Effect of different drying methods on moisture content

Figure 5 reveals the moisture content of chilli dried by two drying methods with blanching and non-blanching treatments. Solar tunnel dried blanched chilli showed significantly lower moisture content (6.2%) compared to open sun dried blanched one (6.7%) and non-blanched one (7.3%). Blanching considerably reduced moisture content compared to non-blanching.

Solar tunnel drying method resulted in high moisture loss. This was due to air temperature in the solar tunnel, which was observed to be much higher than the ambient air temperature in open sun drying. Similar finding has been reported by Hossain and Bala [10] on the average air temperature rise (21.62ºC) at the outlet of the collector over ambient air temperature during solar drying of chilli.

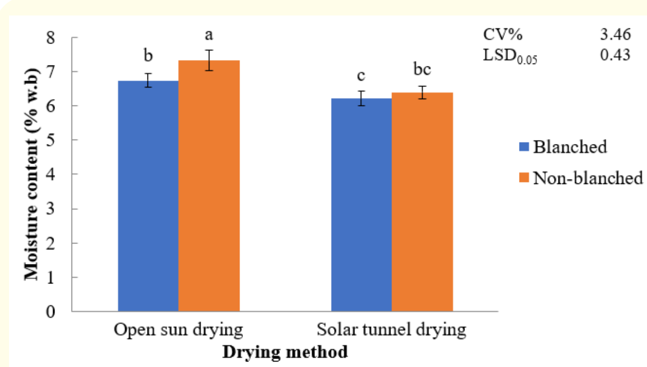

Figure 5: Effect of different drying methods and pre-treatment on the moisture content of dried chilli.

Effect of different drying methods on water activity

Figure 6 reveals the water activity of chilli dried by two drying methods with blanching and non-blanching treatments. Solar tunnel dried non-blanched chilli showed significantly low water activity (0.31) compared to open sun drying method for blanched (0.42) and non-blanched samples (0.38). Blanching treatment also exhibited significantly high water activity compared to non-blanched samples.

Solar tunnel drying method resulted in low water activity in dried chilli compared to open sun drying method. The value of water activity was lower in non-blanched samples as compared to blanched samples. Similar findings have been reported by Toure [11], who also observed that unblanched samples had a lower water activity than blanched samples of dehydrated okra.

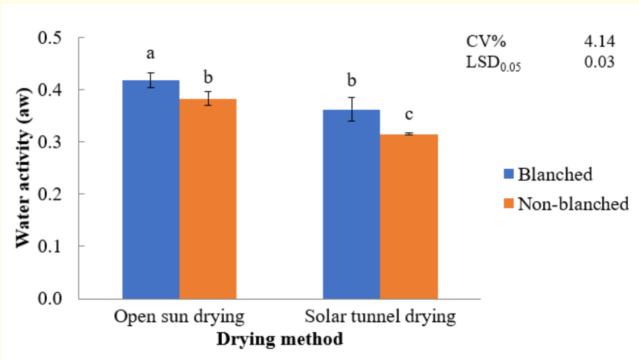

Figure 6: Effect of different drying methods and pre-treatment on the water activity of dried chilli.

Effect of different drying methods on color difference (ΔE)

Figure 7 reveals the color difference of chilli dried by two drying methods with blanching and non-blanching treatments. Solar tunnel dried blanched and non-blanched chilli showed significantly low in color difference compared to open sun dried non-blanched chilli.

Solar tunnel drying method resulted in low color difference. Similar findings by Hossain and Bala [10] described significantly higher mean color difference values in conventionally sun dried red chilli than those obtained from solar tunnel dried chilli.

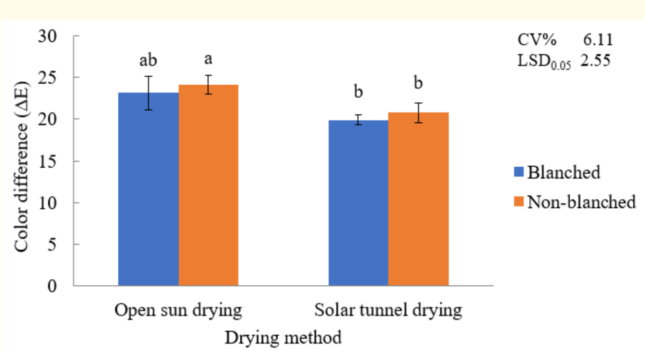

Figure 7: Effect of different drying methods and pre-treatment on the color difference of dried chilli.

Effect of different drying methods on browning index (BI)

The browning index of chilli dried by two drying methods with blanching and non-blanching treatments is presented in figure 8. Solar tunnel dried blanched chilli showed significantly low in browning index as compared to open sun drying method.

Solar tunnel drying resulted in low browning index. Open sun dried samples were high in browning index as compared to solar tunnel dried samples. Manjula and Ramachandra [12] also reported that the solar tunnel drying method significantly improved the lightness and redness of dried chilli compared to the open yard sun drying method.

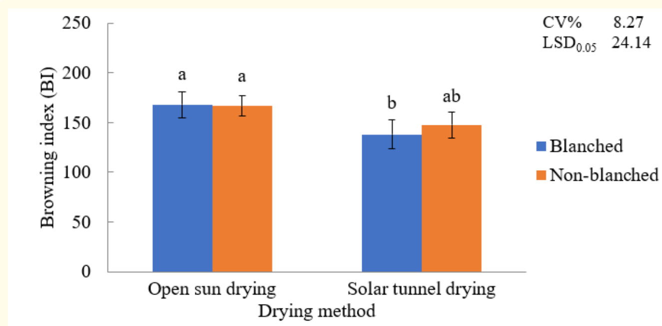

Figure 8: Effect of different drying methods and pre-treatment on the browning index of dried chilli.

Effect of different drying methods on ascorbic acid content

Figure 9 shows the ascorbic acid content of chilli dried by two drying methods with blanching and non-blanching treatments. Solar tunnel dried chilli shows significantly high ascorbic acid content (120.75 mg/100g) and (110.25 mg/100g) compared to open sun drying method (91 mg/100g) and (76.68 mg/100g) for blanched and non-blanched samples respectively. Manjula and Ramachandra [12] also reported 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. Blanching treatment also exhibited significantly high ascorbic acid content compared to non-blanched samples. Blanching treatment must have excluded the oxygen from the cells that perhaps resulted in checking the oxidative degradation of ascorbic acid. Similarly, blanching must have resulted in more retention ascorbic acid content in the produce during drying.

Total aflatoxin content (ppb) in all dried chilli

There was no aflatoxin content in all dried chilli samples except blanched sample in solar tunnel drying. The total aflatoxin content of solar tunnel drying with blanched sample was 0.06 (ppb) which was much below the maximum limit prescribed by CODEX. EU limit of the maximum level of total aflatoxin content was 10ppb [13]. These findings were similar to Manjula and Ramachandra [12],

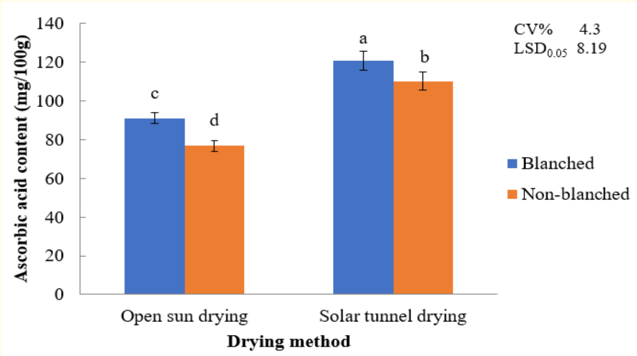

Figure 9: Effect of different drying method and pre-treatment on the ascorbic acid content of dried chilli.

who also observed that the solar tunnel dried samples were found with aflatoxin content much below the prescribed maximum limit of CODEX [14,15].

Conclusion

In drying without blanching chilli, the average temperature for open sun drying was around 45ºC and it took 25 hours while it was around 60ºC and 19 hours in solar tunnel drying. Based on the results, solar tunnel drying method was found most suitable due to rapid drying, considerably low in moisture content and water activity with less value of browning index and color difference as compared to open sun drying method. Moreover, solar tunnel drying method was significantly superior in retaining the ascorbic acid content than open sun drying. Blanched chilli had significantly higher in ascorbic acid content with less moisture content than non-blanched chilli.

Blanching should be done in drying of red chilli to retain ascorbic acid and less moisture content and to hasten the drying process. The aflatoxin content was found to be either nil or much below the permitted limits among the treatments. Further research on drying methods of red chilli for variation of capsaicin content needs to be conducted.

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