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Drying characteristics of chemical treated chopped green chillies under different dryer

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Abstract
Due to highly perishable nature chilies commonly encountered various postharvest problems; to deal such problems, drying was done using hot air oven and tray dryer. Three different temperatures (50, 60 & 70 °C) use in both dryers. Before drying chilies were chopped and dipped in Butylated-Hydroxy-Anisole and Potassium Carbonate solution. Overall drying rate increased with temperature in both dyers. Drying of dipsol green chilli took place in falling rate period. Initial moisture content of the green chilli was an average of 532.91±1 % d.b.

Keywords: Chopped Green Chilli, Drying, Tray Dryer, and Hot Air Oven &Moisture Ratio.

Introduction
Chili (*Capsicum annuum* L.*)* is a spice, a fruit vegetable widely cultivated in the world and which importance in human food (Dias *et al.*, 2013; Wahyuni *et al.*, 2013) [3]. Spices are the building blocks of flavor in foods (El-Ghorob *et al.*, 2010) [4]. The term 'spice' is often used to cover a wide variety of dried or natural aromatic vegetable products that are used in building the flavors and sometimes making food colorful. True spices are defined as parts of aromatic plants, such as bark, root, buds, flowers, fruits, and seeds that are grown in the tropics. Examples of spices include all spice, aniseed, caraway, turmeric, coriander, onion, garlic and chilli etc. Spices are sold in whole or in ground form. The aroma and strong pungent flavor of the spices, which is due to the presence of essential oil, ground spices release their flavor immediately when added to prepared dishes. In India, only two species viz. *Capsicum annum* and *Capsicum frutescens* are known and most of the cultivated varieties belong to the species *Capsicum annum* (Pal *et al.*, 2008) [8]. Chilli was introduced in India by the Portugese in Goa in the middle of 17th century and since then it had rapidly spread throughout the country (Topuz and Ozdemir, 2007) [9]. It is a rich source of vitamin A, C and E. Chilli is an important ingredient in day to day curries, pickles and chutneys, oleoresins, sauce and essence are prepared from chillies (Gallardo *et al.*, 2010) [5]. Chili contains seven times more vitamin C than orange. The chilli is very sensitive to temperature. Normally, conventional hot air drying temperature is maintained between 50-70°C. Due to the long drying process, the problem of darkening of colour, loss in flavour and decrease in rehydration ability occurs. Longer shelf life, product diversity and substantial volume reduction are the reasons for popularity of dried fruits and vegetables and this could be expanded further with improvements in product quality and process applications (Jasim and Shivare, 2001) [6]. To prevent significant quality loss and to achieve fast and effective dehydration various drying techniques have been developed. These improved methods could increase the current degree of acceptance of dehydrated foods in the market (Arora and Bharti, 2005) [2].

Materials and methods
The main objective of this experiment is to study the drying characteristics of dipsol chopped green chillis. The experiments were carried out in the Food Processing Laboratory of the department of agricultural engineering, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110, (U.P.) India.

Drying methods: The chilli samples were treated with Butylated Hydroxy Anisole and Potassium Carbonate solution than dried using tray dryer and hot air oven at three different temperatures, viz. (50, 60 & 70 ℃).

Cabinet tray dryer: A Cabinet type mechanical tray dryer (Industrial Dryer, M/s Navyug Udhyog Pvt. Ltd Ambala) was used to conduct drying experiment. The heating air circulated inside the cabinet with the help of circulating fan. The thermostatic controller (50-250℃) is attached with the heating unit to control the desired temperature for the drying experiment.

Hot air oven drying: The chilli samples were kept on hot air oven at 60, 70, 80±5°C till no further weight loss occurred. Hot air oven (Instron, IN-301 Model) used is a double walled chamber of size 78×27×116 (in centimeter). Outer chamber is made of stainless steel. Hot air ovens are electrical devices used in sterilization. The oven uses dry heat to sterilize articles. Generally, they can be operated from 50 to 300 ℃) (122 to 572 °F).

Drying characteristics analysis

Moisture content: Moisture content and total solids will be determined by method of AOAC (1990) [1].The moisture content (% w.b.) of sample was calculated by using following equation:

$$M\ C\%\ (w.b.) = \frac{(\text{initial weight} - \text{final weight})}{\text{initial weight}} \times 100$$

Measurement of Moisture ratio: Moisture ratio (MR) will be calculated as follows:

$$MR = \frac{M - M_e}{M_a - M_e}$$

Where:-

M_e - Equilibrium moisture content, %db

M - Moisture content at any time, %db

M_a - Moisture content at the start of drying, %db

Average drying rate: The average drying rates at different times were computed using formula suggested by Mishra (1991) [7].

Result and Discussion

Results of Dipsol chopped green chillis drying with tray dryer and hot air oven at three different temperatures, are presented in following heads. Samples were dried until they stop loosing moisture. Moisture content (wb %), dehydration ratio and average drying rate was measured. Dehydration ratio is an important factor, which shown bulk reduced in weight of the sample.

Drying Characteristics in tray drying: Dipsol chopped Green chilli dried using tray dryer at three different temperature viz. 50, 60 & 70 ºC. Moisture content (wb %) ranges from 84.20 to 8.41 at 50 ºC. Moisture ratio and average drying rate were ranged from 1.00 to 0.01 and 2.77 to 0.05 respectively after 480 minute. (Table 1). At 60 ºC, moisture content (wb %) ranges from 84.20 to 6.74. Moisture ratio and average drying rate were ranged from 1.00 to 0.00 and 2.11 to 0.03 respectively after 480 minute. (Table 2). Moisture content (wb %) ranges from 84.20 to 7.06 at 70 ºC. Moisture ratio and average drying rate were ranged from 1.00 to 0.01 and 2.37 to 0.03 respectively after 420 minute. (Table 3).

Drying Characteristics hot air oven drying: Dipsol chopped Green chilli dried using hot air oven dryer at three different temperature viz. 50, 60 & 70 ºC. At 50 ºC moisture content (wb %) ranges from 84.20 to 10.99. Moisture ratio and average drying rate were ranged from 1.00 to 0.00 and 1.61 to 0.03 respectively after 600 minute (Table 4). Moisture content (wb %) ranges from 84.20 to 9.84 at 60 ºC. Moisture ratio and average drying rate were ranged from 1.00 to 0.00 and 1.70 to 0.05 respectively after 600 minute (Table 5). At 70 ºC, moisture content (wb %) ranges from 84.20 to 12.22. Moisture ratio and average drying rate were ranged from 1.00 to 0.00 and 2.10 to 0.03 respectively after 600 minute (Table 6).

Conclusion

Hot air oven took more time to dry the sample as compare to tray dryer, which means that more moisture transfer took place in the case of tray drying than hot air oven drying. It took about 60 minute less time at 70 ºC as compare to 50 and 60 ºC to dry the sample completely in both type of dryer i.e. tray dryer and hot air oven.

Table 1: Drying characteristics behaviour of dipsol chopped chilli at 50 ^{0}C under cabinet tray dryer.

Time (Min)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	0.00
60	78.58	366.77	0.68	2.77
120	69.90	232.28	0.43	2.24
180	54.86	121.52	0.22	1.85
240	36.80	58.23	0.10	1.05
300	25.65	34.49	0.05	0.40
360	14.59	17.09	0.02	0.29
420	10.99	12.34	0.01	0.08
480	8.41	9.18	0.01	0.05

Table 2: Drying characteristics behavior of dipsol chopped chilli at 60 ^{0}C under cabinet tray dryer.

Time (MIN)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	0.00
60	80.25	406.33	0.76	2.11
120	74.52	292.41	0.54	1.90
180	66.20	195.89	0.36	1.61
240	52.48	110.44	0.20	1.42
300	28.18	39.24	0.06	1.19
360	14.59	17.09	0.02	0.37
420	8.05	8.75	0.00	0.14
480	6.74	7.23	0.00	0.03

Table 3: Drying characteristics behavior of dipsol chopped chilli at 70 ^{0}C under cabinet tray dryer.

Time (MIN)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	
60	79.61	390.51	0.73	2.37
120	73.45	276.58	0.51	1.90
180	64.89	184.81	0.34	1.53
240	52.12	108.86	0.20	1.27
300	30.55	43.99	0.07	1.08
360	8.41	9.18	0.01	0.58
420	7.06	7.59	0.01	0.03

Table 4: Drying characteristics behavior of dipsol chopped chilli at 50 ^{0}C under Hot Air oven.

Time (MIN)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	
60	81.36	436.39	0.81	1.61
120	78.01	354.75	0.66	1.36
180	73.78	281.33	0.52	1.22
240	68.24	214.87	0.39	1.11
300	60.00	150.00	0.26	1.08
360	46.44	86.71	0.14	1.05
420	21.98	28.16	0.03	0.98
480	14.13	16.46	0.01	0.20
540	12.34	14.08	0.00	0.04
600	10.99	12.34	0.00	0.03

Table 5: Drying characteristics behavior of dipsol chopped chilli at 60 ^{0}C under Hot Air oven.

Time (MIN)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	
60	81.17	431.01	0.80	1.70
120	77.40	342.41	0.64	1.48
180	72.52	263.92	0.48	1.31
240	66.02	194.30	0.35	1.16
300	58.42	140.51	0.25	0.90
360	47.77	91.46	0.15	0.82
420	33.47	50.32	0.08	0.69
480	17.49	21.20	0.02	0.49
540	12.22	13.92	0.01	0.12
600	9.84	10.92	0.00	0.05

Table 6: Drying characteristics behavior of dipsol chopped chilli at 70 ^{0}C under Hot Air oven.

Time (MIN)	MC (wb) %	MC (db) %	Moisture ratio	Average drying rate
0	84.20	532.91	1.00	
60	80.27	406.80	0.75	2.10
120	75.79	312.97	0.57	1.56
180	69.93	232.59	0.42	1.34
240	61.32	158.54	0.28	1.23
300	48.11	92.72	0.15	1.10
360	30.55	43.99	0.06	0.81
420	21.98	28.16	0.02	0.26
480	13.42	15.51	0.00	0.21
540	12.22	13.92	0.00	0.03

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