Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2939

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (6):** 649-655 (2017)

International Journal of Pure & Applied Bioscience

Research Article

OPEN ACCESS

Studies on Drying Characteristics of Fenugreek Leaves under Cabinet Tray Dryer at Different Temperatures

Sweta Singh[*1], Vishal Kumar[1], B. R. Singh[2] and Deepak Kumar Mishra[2]

[1]Department of Agril Engg and Food Tech, SVPUAT, Meerut 250110

[2]Department of Food Technology, Swami Vivekanand Subharti University, Meerut 250005

*Corresponding Author E-mail: swetaapfe@gmail.com

Received: 2.05.2017 | Revised: 5.06.2017 | Accepted: 9.06.2017

ABSTRACT

Physico-chemical analysis i.e. moisture content, drying rate, rehydration ratio and vitamin C were evaluated during the experiment. Experiments were also conducted to study the effect of drying condition and rehydration characteristics. It was found that total drying time considerably reduced with the increase in drying air temperature. Major drying took place in falling rate period. The average drying rate increased with increase in temperature and decrease with time and loading density. Chemically treated samples dried under cabinet tray dryer (CT, CB & UT) took lesser time than blanched and untreated samples. It was observed that total moisture loss increased with increase in drying temperature and decreased with decrease in drying temperature. Study revealed that chemically treated samples had higher rehydration ratio values than chemically blanched and untreated samples. The product quality was found to be most acceptable of fenugreek leaves treated in the solution of 0.1% $Mgcl_2$ + 0.1% $NaHCO_3$ + 2% KMS, dried under cabinet tray dryer using 3.0 kg/m^2 loading density at 65^0C.

Key words: *Fenugreek, Drying, Cabinet Tray Dryer, Treatment, Storage.*

INTRODUCTION

Fenugreek is one of the oldest cultivated spice crops of the world and grown for its medicinal value and forage in India, Western Asia and Nile Valley since remote antiquity. It is found growing wild in parts of northern India and cultivated all over the subcontinent for its green leaves and seeds. Fenugreek is a native of south-eastern Europe and Western Asia. India is also said to be a native of fenugreek[6].

According to history the name Fenugreek or foenum-graecum` is derived from Latin for `Greek hay`. It is said that the fenugreek seeds had been recovered from the tomb of Tutankhamen. The major fenugreek producing countries are India, Argentina, Egypt, Morocco, Turkey, Southern France, spain and china but India enjoys the status of largest producer in the world. In India its production is concentrated mainly in Rajasthan, Madhya Pradesh, Maharastra, Haryana, Punjab, Gujrat and Uttar Pradesh states.

Cite this article: Singh, S., Kumar, V., Singh, B.R. and Mishra, D.K., Studies on Drying Characteristics of Fenugreek Leaves under Cabinet Tray Dryer at Different Temperatures, *Int. J. Pure App. Biosci.* **5(6):** 649-655 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2939

Major fenugreek growing districts in Rajasthan are Nagaur, Jaipur, Jodhpur, Ajmer, Kota, Bhilwara and Nimbahera, where as in Uttar Pradesh, it is grown in Aligarh, Bulandshahar, Meerut and Bareilly and in Madhya Pradesh the districts are Jawra, Neemuch and Mandsaur. From the world production of fenugreek, it can be estimated that more than half is produced in India. India consumes domestically 90 percent of its own production and claims 70-80 percent of the world exports in fenugreek[2]. The Qasoori Methi, for its appetizing fragrance, comes from Qasur, Pakistan, and regions irrigated by the Sutlej River, in the Indian and Pakistani states of Punjab. Fenugreek green is a very popular curry cooked in the major sub-continental region of India and Pakistan, usually together with potatoes and/or spinach, and eaten with Roti or Naan (flatbread) or rice. It is usually eaten boiled in China, and central and Western Asia. The study of this research, dehydrated tomato powder was prepared by different drying conditions with pre-treatments. Drying is the moisture removing process from the products. Drying reduces the bacterial growth in the products. Tomatoes are commonly consumed fresh; over 80% of the tomato consumption comes from processed products such as tomato juice, ketchup and sauce[9].

All leafy vegetables can be dried in solar light via solar assisted methods or with added ventilation and heat to speed up the process. Drying in the solar light is least expensive method and quite viable if the climate is hot and dry during harvesting time but it is also the slowest method, large area requirements, high labour consuming method, insect infection and poor quality of end products. Drying is one of the cheap and common preservation method for biological products[7]. In addition to increasing variety in the menu, reducing losses, labour and storage space. dehydrated vegetables are simple to use and have longer shelf like than fresh vegetables along with concentration of nutrients[1]. The quality of the dehydrated product in terms of rehydration ratio, color and flavour retetention depends on the pretreatmeants and methods of drying. Major objectives of dehydration are to remove moisture as quickly as possible at a temperature that does not seriously affect flavor, texure and color of the food. Drying can be accomplished by a number of traditional and advanced techniques. Sun and oven drying are conventional heating methods where transfer of thermal energy from the product surface towards their centre is slow.

MATERIAL AND METHODS

The study was undertaken to develop the drying characteristics of fenugreek leaves and its qualitative evaluation for storage purpose in the Department of Agricultural Engineering and Food Technology, S.V.P. University of Agriculture and technology, Meerut. The present investigation on drying of fenugreek leaves was carried out under cabinet tray dryer.

Experimental plan

Fresh fenugreek leaves were washed thoroughly in fresh water so as to remove dust particles. Leaves were separated from the roots, stem and rest parts. Care was taken to avoid bruised and discolored leaves. Experiments were planned and conducted on the basis of review of earlier work on drying of high moisture leafy vegetables. It was observed that loading density (weight of sample per unit area) was mostly preferred for drying of leafy vegetable as like fenugreek. Hence, it was decided to use sample with a variable loading density of 2.0, 2.5 and 3.0 kg/m^2 of tray area and drying under cabinet tray dryer at different temperature conditions. Time of pretreatment of fenugreek leaves was decided on the basis of literatures available.

The levels of each variable were selected on the basis of the earlier research work and experiments. Chemical treatments were carried out by dipping the sample in the solution of 0.1% magnesium chloride, 0.1% sodium bicarbonate and 2% potassium metabisulphite for 15 min in distilled water at room temperature. Here, the ratio of fenugreek leaves to pretreatment mixture was taken as

1:5 (leaves:water)[3]. Blanching in boiling water in the ratio of 1:5 (leaves: water) containing 0.5% sodium metabisulphite as pretreatment for 2 min[8] was done. Untreated fenugreek leaves were dried as control samples. Pretreated samples were exposed to three levels of loading density viz. 2.0, 2.5 and 3.0 kg/m^2. The leaves were weighed and loaded in perforated stainless steel trays and subjected to thin layer drying under cabinet tray dryer.

RESULT AND DISCUSSIONS

The present investigation was undertaken to study the drying characteristics of fenugreek leaves and its qualitative evaluation during storage. In the experiment, fenugreek leaves were pretreated and categorized into chemically treated with 0.1% magnesium chloride ($MgCl_2$), 0.1% Sodium bicarbonate ($NaHCO_3$) and 2% Potassium Metabisulphite (KMS) for 15 min, chemically blanched in boiling water in the ratio of 1:5 (leaves: water) containing 0.5% sodium metabisulphite ($NaHSO_4$) for 2 min & fresh leaves (untreated) as a control.

Moisture content

The initial moisture content prior to drying was observed in the range of 654.740 to 733.11% (d.b.). The treated and untreated samples were subjected to drying methods and loading density. The change in moisture content with drying time for treated and untreated sample at different drying temperature conditions and at different loading density, exhibiting a non-linear decrease of moisture with drying time. In the falling rate period, the material surface was no longer saturated with water and drying was controlled by diffusion of moisture from the interior of the material to the surface. As expected, the drying time varied with drying method and loading density. The variation in moisture content with drying time for all treated and untreated samples under cabinet tray drying which also exhibits a non-linear decrease of moisture with drying time. Initially moisture content decreased rapidly with time and their after it becomes slow and slower at last a stage comes where it becomes saturated in cabinet tray dryer. The highest initial moisture content (%db) 733.11 of 2.5 kg/m^2 loading density at 65 ^{0}C cabinet tray dryer. The highest final moisture content 4.823 of 3.0 kg/m^2 loading density at 45 ^{0}C and minimum moisture content 4.496 of 2.0 kg/m^2 loading density at 55 ^{0}C under cabinet tray dryer. The highest drying time duration under 480 minutes of 3.0 kg/m^2 loading density at 45 ^{0}C and the minimum drying time duration 330 minutes 2.0 kg/m^2 loading density under 55 ^{0}C under cabinet tray dryer.

Overall drying rate

The overall rate of drying was calculated using the formula mentioned under section 3.8. It was calculated as ratio of difference of initial and final moisture content and total drying time. Overall drying rate varied from 1.048 to 2.043 % d.b. /min (Table 1.0) for the total range of variable under study. Normally, it can be expected that the overall drying rate should be higher at higher temperature linearly, which is reflected in the result presented in table 1.1 analysis by ANOVA test. It is seen that the overall drying rate decreased with increase in loading density in each drying methods.

It is also seen that the overall drying rate was slightly lower for chemically blanched and untreated sample than for chemically treated at almost all experimental samples. From an examination of data given in Table 1.1, it is obvious that the fenugreek treated chemically, dried faster than the others, as chemicals used in chemical treatment resulted into more expansion of fenugreek process caused faster heat and mass transfer between fenugreek surface and air, and therefore, increased drying rate.

The ANOVA was carried out for analyzing effect of drying method, loading density and treatment on overall drying rate and it was found that the effect the drying and loading density was significant at 5% level of significance as F_c is more than F_{tab} and the effect of treatment was insignificant at 5% level of significance. ANOVA is present in Table 1.1.

Table 1.0 Overall drying rates at experimental drying conditions under cabinet tray dryer (CTD)

Drying Methods	Loading Density (kg/m^2)	Treatment	Initial M.C. (% d.b.)	Final M.C. (% d.b.)	Drying Time (Min)	Overall rate (% d.b./min)
CTD (45 ^{0}C)	2.0 kg/m^2	CT	680.460	4.616	360	1.877
		CB	724.970	4.518	420	1.715
		UT	654.740	4.521	390	1.667
	2.5 kg/m^2	CT	678.760	4.641	390	1.729
		CB	730.400	4.552	450	1.613
		UT	655.340	4.568	420	1.550
	3.0 kg/m^2	CT	679.98	4.677	420	1.608
		CB	733.11	4.823	480	1.527
		UT	669.12	4.599	450	1.456
CTD (55 ^{0}C)	2.0 kg/m^2	CT	680.46	4.597	330	1.048
		CB	724.97	4.496	390	1.847
		UT	654.740	4.502	360	1.806
	2.5 kg/m^2	CT	678.76	4.621	360	1.873
		CB	730.40	4.531	420	1.728
		UT	655.340	4.547	390	1.669
	3.0 kg/m^2	CT	679.98	4.658	390	1.732
		CB	733.09	4.801	450	1.619
		UT	669.98	4.577	420	1.560
CTD (65 ^{0}C)	2.0 kg/m^2	CT	678.760	4.599	331	2.043
		CB	730.40	4.523	390	1.861
		UT	655.34	4.526	360	1.808
	2.5 kg/m^2	CT	679.98	4.634	360	1.876
		CB	733.11	4.779	420	1.734
		UT	669.98s	4.557	390	1.706
	3.0 kg/m^2	CT	678.760	4.599	331	2.044
		CB	730.40	4.523	390	1.861
		UT	655.34	4.526	360	1.808

Table 1.1 ANOVA for effect of drying conditions on overall drying rate

Source	***Df***	***S.S***	***M.S***	F_c	F_{tab*}
Drying method	4	3.104	0.776	38.800	2.63
Loading density	2	0.135	0.068	3.400	3.259
Treatment	2	0.073	0.036	1.800	3.259
Error	36	0.720	0.020		
At 5% level of significance					

Effect of loading density on rehydration characteristics

Rehydration Ratio is also minutely affected by the thickness of the samples (loading density applied to raw sample but it is clear that loading density does not affect much to rehydration characteristics). Table 2.0, showed the rehydrated sample for different loading density of 2.0, 2.5, and 3.0 kg/m^2 at different temperature under cabinet tray dryer. Statistical analysis showed that the loading density does not change the RR significantly ($P < 0.05$) in case of 15 min rehydration. However, effect of the other parameters such as drying and pretreatments were more pronounced than loading density in case of rehydration. RR (5 min) values at under cabinet tray dryer. The highest rehydration ratio 6.571 of 2.0 kg/m^2 loading density with chemical treated at 55 ^{0}C and lowest ratio 6.209 of 3.0 kg/m^2 loading density with chemical blanched at 65 ^{0}C for 5 minutes. The maximum rehydration ratio 7.801 of 3.0 kg/m^2 loading density with untreated at 55 ^{0}C and lowest ratio 6.528 of 2.0 kg/m^2 loading density with chemical blanched at 65 ^{0}C under cabinet tray dryer.

Table 2.0 Experimental data of rehydration ratio under CTD (cabinet tray dryer)

Temp.	Loading Density	Treatment	W_1 (g)	Rehydration Ratio (W_2/W_1)	
				5 min	15 min
CTD (45ºC)	2.0 Kg/m²	CT	1	6.565	6.813
		CB	1	6.297	6.579
		UT	1	6.322	6.668
	2.5 Kg/m²	CT	1	6.482	6.790
		CB	1	6.248	6.571
		UT	1	6.375	6.660
	3.0 Kg/m²	CT	1	6.471	6.773
		CB	1	6.229	6.568
		UT	1	6.423	6.801
CTD (55ºC)	2.0 Kg/m²	CT	1	6.571	6.899
		CB	1	6.393	6.789
		UT	1	6.516	6.852
	2.5 Kg/m²	CT	1	6.531	6.877
		CB	1	6.378	6.785
		UT	1	6.501	6.843
	3.0 Kg/m²	CT	1	6.423	6.873
		CB	1	6.362	6.735
		UT	1	6.489	7.801
CTD (65ºC)	2.0 Kg/m²	CT	1	6.479	6.773
		CB	1	6.249	6.528
		UT	1	6.301	6.648
	2.5 Kg/m²	CT	1	6.461	6.772
		CB	1	6.229	6.550
		UT	1	6.294	6.694
	3.0 Kg/m²	CT	1	6.453	6.751
		CB	1	6.209	4.549
		UT	1	6.403	6.784

Table 2.1 ANOVA for rehydration ratio at 5 min

Source	*Df*	*S.S*	*M.S*	F_c	F_{tab*}
Drying method	4	1.956	0.489	97.800	2.63
Loading density	2	0.060	0.030	6.000	3.259
Treatment	2	0.275	0.138	27.600	3.259
Error	36	0.190	0.005		
At 5% level of significance					

Table 2.2 ANOVA for rehydration ratio at 15 min

Source	*Df*	*S.S*	*M.S*	F_c	F_{tab*}
Drying method	4	2.831	0.708	5.851	2.63
Loading density	2	0.161	0.080	0.661	3.259
Treatment	2	0.915	0.457	3.776	3.259
Error	36	4.358	0.121		
At 5% level of significance					

Effect of drying conditions on ascorbic acid content

The ascorbic acid (Vitamin C) contents for dried fenugreek leaves are presented in Table 3.0, It shows that in case of cabinet tray dryer, the value of ascorbic acid (mg/100g) range were found as 94.569 to 104.312 of (UT) untreated samples, 99.104 to 88.201 of (CT) chemical treated and 69.113 to 78.203of (CB) chemical blanched with different loading density kg/m^2 (2.0, 2.5 and 3.0). The losses of ascorbic acid during dehydration process 52.196 to 65.508. It is found that the ascorbic acid content of untreated samples are more than that of chemically treated and chemically blanched samples. Loss of ascorbic acid was higher in chemically blanched samples; this might be because of the increased activity of ascorbic acid oxidizing enzymes due to heating. It is also observed that the loss of ascorbic acid content is higher when fenugreek leaves were dried at higher temperature. It was also observed that although at higher temperature in cabinet tray dryer, the loss of ascorbic acid was less as the drying time was shorter, Lakshmi[4] reported that losses of ascorbic acid content from green leafy vegetables ranged from 69 to 85% due to sun drying (34 to 40^{o}C) and 51 to 63% due to cabinet drying (55 to 65^{o}C) the extend of loss depends on the methods of processing. Increasing the rate of water removal, as in case of cabinet drying, is safe to minimize the loses of ascorbic acid, provided that there is no marked increase in the product[5]. The second reason for the loss of ascorbic acid may be due to the proportion of moisture content and dry matter in the finished product which might have affected the ascorbic acid in different drying conditions.

Table 3.1 shows the ANOVA for effect of drying parameter on ascorbic acid content of dried fenugreek leaves. It reveals that Fc for all drying method, loading density and treatment are higher than F_{tab}, thus indicating significant influence of drying method, loading density and treatments on ascorbic acid content at 5% level of significance.

Table 3.0 Experimental data for ascorbic acid content of dried fenugreek leaves

Temperature	Loading density	Treatments	ascorbic acid content (mg/100g)	Percentage loss in ascorbic acid
CTD (45ºC)	2.0 Kg/m²	CT	95.361	55.282
		CB	75.243	59.103
		UT	100.612	56.802
	2.5 Kg/m²	CT	97.019	54.805
		CB	77.991	56.103
		UT	102.534	55.178
	3.0 Kg/m²	CT	99.101	52.196
		CB	78.203	54.946
		UT	104.312	53.178
CTD (55ºC)	2.0 Kg/m²	CT	90.232	58.312
		CB	71.001	62.204
		UT	96.989	59.706
	2.5 Kg/m²	CT	91.998	57.008
		CB	73.012	60.106
		UT	97.989	58.801
	3.0 Kg/m²	CT	92.731	56.205
		CB	74.568	59.996
		UT	98.521	58.304
CTD (65ºC)	2.0 Kg/m²	CT	88.201	61.813
		CB	69.113	65.508
		UT	94.569	63.189
	2.5 Kg/m²	CT	89.673	60.468
		CB	71.202	63.613
		UT	95.996	62.229
	3.0 Kg/m²	CT	90.563	59.379
		CB	72.103	62.139
		UT	96.867	61.089

Table 3.1 ANOVA for effect of drying parameters on ascorbic acid content

Source	*Df*	*S.S*	*M.S*	F_c	F_{tab*}
Drying method	4	4411.684	1102.921	74.683	2.63
Loading density	2	159.282	79.641	5.393	3.259
Treatment	2	3109.031	1554.516	105.262	3.259
Error	36	531.641	14.768		
At 5% level of significance					

REFERENCES

1. Chauhan, S.K. and Sharma, C.R., Development of instant dehydrated sagg. *Beverage and Food World*, **20(4):** 25-26 (1993).
2. Edison, S., Spices – research support to productivity. In N. Ravi (ed.),The Hindu Survey of Indian Agriculture, Kasturi & Sons Ltd., National Press, Madras, pp. 101-105 (1995).
3. Kaur, P., Kumar, A., Arora. S. and Ghuman, B.S., Quality of dried coriander leaves as affected by pretreatments and method of drying. *European Food*

Research and Technology, **223:** 189-194 (2006).
4. Lakshmi, B. and Vimala, V., Nutritive value of dehydration green leafy vegetable powder. *J. Food Sci. & Tech*., **37(5):** 465-471 (2000).
5. Luo, Y., Mc Evoy, J.L., Wachtel, M.R., Kim, J.G. and Huang. H., Package atmosphere affects post-harvest biology and quality of fresh-cut cilantro leaves. Hortiscience **39(3):** 567-570 (2004).
6. Shanmugavelu, K.G., Kumar N. and Peter, K.V., Production Techniques Spices and Plantation Crops. Agrobios (India), Jodhpur, Rajasthan, pp.109-130 (2002).
7. Singh, K., Bawa, A.S. and Ahmed, J., Dehydration of onion slices. *Indian Food Packer*, **56(2):** 62-66 (2002).
8. Singh, U., Sagar, V.R., Behera, T.K. and P, S.K., Effect of drying conditions on the quality of dehydrated selected leafy vegetables. *Journal of Food Science and Technology*, **43(6):** 579-582 (2006).
9. Vishal, K., Singh, S. and Singh, B.R., The present review focus on preparation of dehydrated tomato powder by different drying condition with pre-treatment. *Chemical Review and Letters,* **21(06):** pp 291-299 (2017).