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Study on biochemical properties of dehydrated coriander leaves at different drying conditions

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Abstract
A study on biochemical properties (chlorophyll content, vitamin C and rehydration characteristics) of dehydrated coriander leaves in relation to was conducted at three drying conditions, namely, pretreatment, loading density and drying methods. A greenhouse type solar dryer (5m x 3m x 2.3m) of modified quonset shape covered with 200 micron UV stabilized polyethylene sheet was developed for dehydration of leafy vegetables. Dehydration of fresh coriander leaves at three levels of pretreatments viz. (i) dipping in a solution (leaves to water ratio: 1:5) containing 0.1% $MgCl_2$ + 0.1% $NaHCO_3$ + 2% KMS in distilled water for 15 min at room temperature, (ii) blanching in boiling water containing 0.5% sodium metabisulphite for 2 min, and (iii) untreated (control); three levels of loading density, viz. 2.0, 2.5 and 3.0 kg/m^2; and two levels of drying methods, viz. greenhouse type solar dryer and in open sun was done. The higher values of rehydration ratio, chlorophyll content and ascorbic acid content under greenhouse type solar dryer were observed as compared to open sun drying. The product quality was found to be most acceptable of coriander leaves treated in the solution of 0.1% $MgCl_2$ + 0.1% $NaHCO_3$ + 2% KMS, and dried under GSD using 2.5 kg/m^2 loading density. The developed greenhouse type solar dryer can be successfully used for dehydration of coriander leaves.

Keywords: Coriander, dehydration, chlorophyll content, ascorbic acid, rehydration

Introduction
Coriander is valued for its fruits called coriander seeds and the fresh green leaves called cilantro. The delicate young leaves are widely used in Latin American, Indian and Chinese dishes to impart flavor. Apparently 100 g fresh leaves of coriander contain moisture 87.9%, protein 3.5%, fat 0.6%, carbohydrate 6.5%, mineral water 1.7%, calcium 0.14%, phosphorus 0.067%, iron 10mg, vitamin A 10000 to 12000 IU and vitamin C 250 mg**.** The coriander leaves have pleasant aromatic odour. The entire plant when young is used in preparing chutneys, salad and sauces and the leaves are also used for flavouring and garnishing curies and soups. These can also be used for flavouring pasty, cookies, buns, cakes and tobacco products. The coriander leaves is also used as breath fresheners too and we feel sweeter breath as green plant pigment chlorophyll is a powerful breath freshener. The degree of greenness is important in determining the final quality of thermally processed green vegetables which gets their colour from chlorophyll pigments. Chlorophyll a appears blue - green and thermally less stable than chlorophyll b which appears yellow – green (Tan and Francis, 1962) [9]. For green vegetables, blanching and pretreatment prior to drying can aid the chlorophyll retention during drying operation. Several studies have been carried out to investigate the effect of pretreatment and hot air temperature on quality of processed vegetables (Kaur *et al.*, 2006) [3]. In India, fresh coriander leaves is abundantly available during winter from December to March but has very short shelf life even under refrigerated conditions. This leads to a market scarcity and a sharp rise in price during lean period. Fresh coriander leaves are perishable in nature and require immediate processing or preservation. During peak period, a considerable amount of the produce is wasted due to lack of proper post harvest processing technique. Therefore, there is a need for dehydrated leafy vegetables so that their availability time can be extended.

The proper drying techniques are the most important aspect of leafy vegetable preservation. The use of solar dryer helps not only to reduce the losses and improves the quality of product but also helps in conserving the conventional energy sources. The solar energy which is available in abundance in India is most commonly used for this purpose.

The greenhouse type solar dryer is based on greenhouse effect which traps the solar energy in the form of thermal heat within the cover, reduces the convective heat loss and resulting in a subsequent increase in temperature. These can be exploited in summer and during sunny days in any season for drying agricultural products and may become a more convenient alternative. Incorporating the solar dryer into a plastic covered greenhouse structure will also be cheaper than the mechanical drier. Although many solar dryers have been developed, greenhouse type dryers have great potential in India and may be constructed at farm level (production point) which minimizes the transport cost and losses during transport. Singh *et al.*, 2017 [8] developed solar dryer for dehydration of fodder crops and observed 39.8 ^{0}C temperature under the dryer when the ambient temperature was 29.5 ^{0}C. This provided the basic information and interaction on solar crop drying techniques encompassing the range of disciplines involved. Considering the importance of greenhouse type solar dryer and to enhance the availability of coriander leaves in off season, a greenhouse type solar dryer was developed for dehydration of coriander leaves and biochemical properties of dehydrated product was evaluated as compared to the dehydrated product of open sun.

Materials and Methods

A greenhouse type solar dryer (dimension: 5m x 3m x 2.3m; shape: modified Quonset) consisting of drying chamber oriented towards east-west direction and covered with 200 micron UV stabilized polyethylene sheet was developed at Horticultural Research Centre of SVP University of Agri. & Tech., Meerut, Uttar Pradesh. The important features of greenhouse type solar dryer are (i) cement concrete floor at the bottom, insulated with glass wool and covered with black painted iron sheet (22 gauge); (ii) 5" wide inlet opening of insect proof net throughout the length on south wall covered with plastics film with the rolling system; (iii) L shape (1.5m length) outlet opening on north wall; and (iv) Provision of black shade net (70%) system below the top glazing material. The schematic diagram of greenhouse type solar dryer is shown in Fig. 1.

Fig 1: Schematic diagram of greenhouse type solar dryer

Heat is accumulated inside the greenhouse type solar dryer after transmission of solar radiation through the plastics sheet due to greenhouse effect, and this thermal energy is utilized to dehydrate the crop. Coriander (cv. Pant Haritma) was arranged from Horticultural Research Centre of SVP University of Agri. & Tech., Meerut, and washed thoroughly in fresh water so as to remove roots and other unwanted materials. Dehydration of washed coriander samples was carried out as per the experimental plan given in Table 2. Three drying conditions, namely, pretreatment, loading density (weight of fresh coriander leaves per unit area kept on drying tray) and drying methods were selected on the basis of the earlier research work. Pretreated samples with respective loading density were exposed for dehydration under greenhouse type solar dryer and open sun, with three replications.

Table 1: Experimental Plan

S. No.	Drying Conditions	Range/particulars	Levels
1.	Pretreatments	T1: Dipping in the solution of 0.1% $MgCl_2$ + 0.1% $NaHCO_3$ + 2% KMS, for 15 min T2: Blanching in boiling water in the ratio of 1:5 (leaves:water) containing 0.5% sodium metabisulphite for 2 min T3: Control (untreated)	3
2.	Loading density	2.0, 2.5 and 3.0 kg/m^2	3
3.	Drying methods	GSD: Greenhouse type solar drying OSD: Open sun drying	2

The weight of coriander leaves samples were recorded using electronic balance. The drying started at 10:00 am and stopped at about 5:00 pm. Afterward, the samples were collected and kept in air tight plastics covers to induce uniform moisture distribution in coriander leaves. They were spread again on the trays in the next morning and the process was repeated until the final dehydration of coriander leaves. Environmental temperature and relative humidity under the greenhouse dryer and in open sun were measured using RH/ Temperature meter. The biochemical properties (chlorophyll content, vitamin C, and rehydration characteristics) of dehydrated coriander leaves were evaluated.

Measurement of Biochemical Properties

These characteristics were measured as per following methods:

Rehydration characteristics

The rehydration ratio (RR) and coefficient of rehydration (CR) were computed using the following equation (Ranganna, 1986) [7].

$$RR = \frac{W_2}{W_1} \quad \ldots (1)$$

$$CR = \frac{W_2 \times (100 - M_I)}{(W_1 - M_F) \times 100} \quad \ldots (2)$$

Where,

W_1 = Weight of the dehydrated coriander leaves taken for rehydration, g

W_2 = Drained weight of the rehydrated coriander leaves, g

M_F = Amount of moisture present in the dried sample taken for rehydration, g
M_I = Moisture content of sample before drying, %

Chlorophyll content
Total chlorophyll was measured following the method describe by Arnon (1949) [1]. Chlorophyll pigment was extracted from 1g dry matter in 80% acetone and was determined using spectral analysis (Beckman) by measuring the absorbance at 663 and 645 nm. The following equation was used to determine the Chlorophyll content.

Total chlorophyll (mg/g tissue) =

$$[20.2\,(A_{645}) + 8.02\,(A_{663})] \times \frac{V}{1000 \times W} \qquad \ldots (3)$$

Where,
A = Absorbance at specific wavelengths,
V = Final volume of chlorophyll extract in 80% acetone,
W = Fresh weight of the tissue extracted

Ascorbic acid content
The ascorbic acid content was estimated by 2, 6 – dichlorophenol indophenol dye visual titration method (Ranganna, 1986) [7]. The dye is blue in alkaline solution and red in acid solution. The dye colour is reduced by ascorbic acid to a colourless form. Five ml of HPO_3 was added to 5 ml standard ascorbic acid. Micro burette was filled with dye and titrated with dye solution to pink colour which persist at least 15 sec. Dye factor i.e. mg of ascorbic acid per ml of the dye, was calculated using the following formula.

$$\text{Dye factor} = \frac{0.5}{\text{titre}} \qquad \ldots (4)$$

Sample of 2 g blended with 3% HPO_3 and volume was made to 20 ml with HPO_3 and filtered. An aliquot (2 ml) of the HPO_3 extract of sample was taken and titrated against the standard dye to a pink colour end point which should persist for at least 15 sec. Titration was rapidly carried out and a preliminary determination was made of the titre. The experiment was repeated for getting accurate results and the value of ascorbic acid was calculated using following equation.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Vol. made up} \times 100}{\text{Extract taken for estimation} \times \text{Wt. of sample taken}} \qquad \ldots (5)$$

Statistical Analysis
The experimental data of biochemical properties of dehydrated coriander leaves was statistically and graphically analyzed with the help of spread sheet (EXCEL) on personal computer.

Results and Discussion
Experiments were conducted to evaluate the biochemical properties of dehydrated coriander leaves after dehydration in developed greenhouse type solar dryer and in open sun with selected levels of loading density and pretreatments. The average temperatures under greenhouse type solar dryer and in open sun were 42 ^{0}C and 29 ^{0}C respectively, during experimentation. The results obtained are discussed below.

Effect of drying conditions on rehydration characteristics
Table 2 shows the rehydration ratio (RR) and coefficient of rehydration (CR) for the dehydrated coriander leaves under GSD and OSD at selected levels of pretreatments and loading density. Two levels of time of soaking (5 min and 15 min) based on preliminary trials and previous works were selected. It reveals that the RR and CR decreased with decrease in temperature from 42 ^{0}C (GSD) to 29 ^{0}C (OSD). The highest values of RR and CR were 6.235 and 0.87 were observed maximum under GSD, respectively. McMinn and Magee (1997)[5] reported similar results with RR and found concurrent increase in rehydration ratio with drying air temperature. Prolonged drying periods, with low temperature drying, induce increased thermal disruption of the cell organization, reducing the rehydration ratio and coefficient of rehydration. Drying methods affect the RR and CR in rehydrated samples. The loading density doesn't affect much to rehydration characteristics. For example, RR (5 min) values at 42 ^{0}C under GSD, chemically treated samples at 2.0, 2.5 and 3.0 kg/m^2 are 5.597, 5.461 and 5.493 respectively. Variation between minimum and maximum value is merely 2.3%. The values of RR and CR in rehydrated samples for chemically treated leaves were 5.461 and 0.762 respectively while for blanched samples, these values were 5.259 and 0.678 and for untreated samples these were 5.406 and 0.777 respectively. This indicates that chemically treated samples have higher RR than untreated samples and more acceptable than boiling water treated one.

Table 2: Experimental data for rehydration ratio and coefficient of rehydration

Drying methods	Loading density (kg/m^2)	Treatment	W_1 (g)	W_2 (g)		Rehydration ratio (W_2/W_1)		Coefficient of rehydration	
				5 min	15 min	5 min	15 min	5 min	15 min
GSD	2.0	CT	1	5.597	5.965	5.597	5.965	0.779	0.830
		BW	1	5.282	5.724	5.282	5.724	0.687	0.744
		UT	1	5.302	5.832	5.302	5.832	0.762	0.838
	2.5	CT	1	5.461	6.235	5.461	6.235	0.762	0.870
		BW	1	5.259	5.723	5.259	5.723	0.678	0.738
		UT	1	5.406	5.813	5.406	5.813	0.777	0.835
	3.0	CT	1	5.493	5.851	5.493	5.851	0.766	0.815
		BW	1	5.145	5.469	5.145	5.469	0.666	0.707
		UT	1	5.483	5.843	5.483	5.843	0.792	0.844
OSD	2.0	CT	1	4.872	5.213	4.872	5.213	0.678	0.725
		BW	1	4.765	5.112	4.765	5.112	0.620	0.665
		UT	1	4.715	5.016	4.715	5.016	0.678	0.721
	2.5	CT	1	4.851	5.189	4.851	5.189	0.672	0.718
		BW	1	4.604	4.901	4.604	4.901	0.594	0.632
		UT	1	4.783	5.001	4.783	5.001	0.689	0.720

	3.0	CT	1	4.910	5.253	4.910	5.253	0.682	0.729
		BW	1	4.852	5.109	4.852	5.109	0.626	0.660
		UT	1	4.887	5.210	4.887	5.210	0.707	0.754

CT = chemical treated; BW = boiling water; UT = untreated; W_1 = weight of dehydrated coriander leaves taken for rehydration, g; W_2 = drained weight of rehydrated coriander leaves, g.

Effect of drying conditions on chlorophyll content

The experimental data for chlorophyll content and ascorbic acid content are presented in Table 3. The chlorophyll content fresh coriander leaves was found to be 1.689 mg/g tissue. Table 3 reveals that chlorophyll content of dried coriander leaves ranged from 1.097 to 1.468 mg/g tissue, 1.034 to 1.376 mg/g tissue and 1.187 to 1.515 mg/g tissue for untreated, boiling water treated and chemically treated samples, respectively. Maximum chlorophyll content (1.515 mg/g tissue) was found to be in chemically treated samples dried under GSD and 3.0 kg/m^2 loading density and minimum (1.034 mg/g tissue) was in boiling water treated sample dried under OSD and 2.0 kg/m^2 loading density. The loss in chlorophyll content compared to fresh sample was in the range of 10.29 to 38.77% with more losses observed under OSD condition. This may be due to the fact that drying by direct exposure to sun resulted in significant loss of pigments due to long time taken for drying, leading to more oxidation of carotene (Jayaraman *et al*. 1991) [2]. Lakshmi *et al*. (2000) [4] reported that loss of β-carotene from green leafy vegetables after drying was found to be in the range of 24-40% in sun-dried leaves and 6-25% in cabinet dried leaves. The results of the present study are thus in agreement with the results of the above studies. Pande *et al*. (2000) [6] found that solar dried coriander retain their flavour and exhibit only minor change in colour and appearance. Therefore, these observations are in line with those reported earlier. In general, total chlorophyll decreased for the dehydrated samples blanched under boiling water. The colour retention in chemically treated samples might have been due to KMS treatment with faster drying under GSD. Higher chlorophyll content for chemically treated samples may be because of KMS treatment. The lower chlorophyll content under OSD was due to inactivation of chlorophyllase enzyme which may be responsible for degradation of chlorophyll.

Table 3: Experimental data on chlorophyll content and ascorbic acid content of dried coriander leaves

Drying methods	Loading density (kg/m^2)	Treatments	Chlorophyll content (mg/g of tissue)	Per cent loss in chlorophyll	Ascorbic acid Content (mg/100g)	Percent loss in Ascorbic acid
GSD	2.0	CT	1.409	16.55	129.42	48.866
		BW	1.303	22.84	102.880	59.352
		UT	1.356	19.74	111.257	56.042
	2.5	CT	1.439	14.83	142.550	43.678
		BW	1.338	20.81	105.870	58.171
		UT	1.431	15.27	115.420	54.397
	3.0	CT	1.515	10.29	134.273	46.949
		BW	1.376	18.53	105.420	58.348
		UT	1.468	13.09	111.560	55.923
OSD	2.0	CT	1.143	32.33	70.560	72.122
		BW	1.034	38.77	51.420	79.684
		UT	1.097	35.06	62.370	75.358
	2.5	CT	1.159	31.35	77.560	69.356
		BW	1.094	35.25	65.560	74.097
		UT	1.142	32.38	72.640	71.300
	3.0	CT	1.187	29.73	74.970	70.379
		BW	1.145	32.21	60.710	76.013
		UT	1.177	30.34	68.560	72.912

Effect of drying conditions on ascorbic acid content

Table 3 showed that ascorbic acid (vitamin C) content of samples varied from 62.370 to 115.42 mg/100g in case of untreated samples, 51.42 to 105.87 mg/100g in case of boiling water treated samples and 70.56 to 142.55 mg/100g in case of chemically treated samples. The ascorbic acid content of fresh sample was 253.1 mg/100g. The loss of ascorbic acid ranged from 43.7% (chemically treated, 2.5 kg/m^2 and under GSD) to 79.7% (boiling water, 2.0 kg/m^2 and under OSD). Loss of ascorbic acid was higher when coriander leaves were dried after blanching in boiling water and exposed for longer time of drying. This might be because of the increased activity of ascorbic acid oxidizing enzymes due to heating, which leads to destruction of ascorbic acid and leaching of vitamin C in washing water. It was also observed that although at higher temperature under GSD, the loss of ascorbic acid was less as the drying time was shorter. Direct exposure of coriander leaves to solar radiation was avoided as there was the provision of black shade net below the top glazing material in drying chamber, which reduces the loss of ascorbic acid in the samples placed under the dryer. Lakshmi *et al*. (2000) [4] reported that losses of ascorbic acid content from green leafy vegetables ranged from 69 to 85% due to sun drying (35 – 40 ^{0}C) and 51 to 63% due to cabinet drying (60 – 70 ^{0}C). The extent of loss depends on the method of processing. Increasing the rate of water removal, as in case of cabinet drying, is safe to minimize the losses of ascorbic acid, provided there is no marked increase in the temperature of the product. That is the reason why loss of ascorbic acid was less during cabinet drying as compared to sun drying. The other reason for losses 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. In some cases, the loss of ascorbic acid was at par which might be due to cumulative effect of temperature, exposure time for drying, loading density and treatment conditions. Overall, maximum loss of ascorbic acid was observed in OSD products and least in GSD products.

Ascorbic acid content of chemically treated samples was more than that of boiling water and untreated ones. This observation was attributed to the protective effect of sulphite (KMS) on ascorbic acid oxidation.

Conclusion

The greenhouse type solar dryer was found suitable for drying coriander leaves. Total drying temperature considerably increased from 29 ^{0}C under open sun drying to 42 ^{0}C under greenhouse type solar drying method. The rehydration ratio and coefficient of rehydration of dehydrated coriander leaves were more under greenhouse type solar dryer as compared to open sun drying. The loss in chlorophyll and ascorbic acid contents of coriander leaves was less under greenhouse type solar dryer as compared to open sun drying. Better product quality in terms of chlorophyll content, ascorbic acid, and rehydration characteristics was found when coriander leaves were treated in the solution of 0.1% $MgCl_2$ + 0.1% $NaHCO_3$ + 2% KMS, and dehydrated under GSD using 2.5 kg/m^2 loading density.

References

1. Arnon DI. Plant Physiology. 1949; 24(1).
2. Jayaraman KS, Dasgupta DK, Babu Rao N. Quality characteristics of some vegetables dried under indirect sun drying. Indian Food Packer. 1991; 45(1):16-23.
3. Kaur P, Kumar A, Arora S, Ghuman BS. Quality of dried coriander leaves as affected by pretreatments and method of drying. European Food Res. and Tech. 2006; 223:189-194.
4. Lakshmi B, Vimala V. Nutritive value of dehydration green leafy vegetable powder. J. Food Sci. & Tech. 2006; 37(5):465-471.
5. McMinn WAM, Magee TRA. Physical characteristics of dehydrated potato – part I and II. Journal of Food Engineering. 1997; 33:37-55.
6. Pande VK, Philip SK, Sonune AV. Solar drying of coriander and methi leaves. Journal of Food Science and Technology. 2000; 37(6):592-595.
7. Ranganna S. Handbook of analysis and quality control for fruits and vegetable products. Tata McGraw-Hill Publishing Ltd. New Delhi, 1986.
8. Singh Sanjay Kumar, Pathak PK, Dwivedi PN, Sahay CS. Drying characteristics of berseem in a solar dryer with supplemental heating system. Range Management and Agroforestry. 2017; 38(1):143-146.
9. Tan CT, Francis FJ. Effect of processing temperature on pigment and colour of spinach. Journal of Food Science. 1962; 27:232.