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SHORT COMMUNICATION

Quality Comparison of Vegetables Dehydrated in Solar Drier and Electrical Oven

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ABSTRACT

Ascorbic acid, sugars, rehydration ratio and moisture were determined in the vegetables dehydrated separately in solar drier and in electrical oven under similar conditions by standard methods. Vegetables examined were cabbage, cauliflower, tomato, radish, turnip, *lahi, methi* and *palak*. It was revealed that in each case, contents of ascorbic acid were higher in solar-dried vegetables in comparison to oven-dried stuffs. This finding indicated superiority of solar driers over electrical ovens, both in reference to quality of the dehydrated vegetables and its overall cost of operation.

1. INTRODUCTION

Vegetables are generally dehydrated in electrical ovens when needed to be preserved for a long time. These days, solar driers have become more popular for this purpose. They are inexpensive in comparison to ovens and require no energy input other than the freely available solar energy. However, the comparative performance of these two processes has not been investigated in terms of biochemical constituents of the dehydrated vegetables. The understanding of performance of the equipment in relation to quality of dehydrated vegetables may prove to be of great value to the users at large. To meet the demand of the armed forces, a large scale production of dehydrated vegetables is an essential requirement and quality control is the most important aspect in the process.

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As a part of an investigation on the biochemical and nutritional changes, and quality in dehydrated vegetables, this study was carried out using fresh vegetables namely, cabbage, cauliflower, radish, turnip, tomato, *lahi*, *methi* and *palak*. Dehydration was done on both types of driers under similar parameters, viz. variety of the vegetables, size of the sliced vegetable and pre-treatment. Sugars (reducing, non-reducing and total), ascorbic acid, rehydration ratio and moisture were determined by standard methods.

2. MATERIALS AND METHODS

Fresh vegetables were picked from DARL Field Station, Hawalbagh, Almora. Table 1 and 2 show the details of the vegetables. The dehydration in electrical oven was carried out on SEE Dryers (Sehgal Engineering Enterprises, New Delhi). The drier is an air circulatory type with twenty four trays and of 81 × 41 × 3.5 cm dimension. The temperature of the oven was maintained at 35-40 °C in all the cases except in the case of tomato, where it was observed that at this temperature, tomato chips on the trays of the oven developed fungal growth, which could be due to the very high water content in the vegetable. Therefore, a higher initial temperature (60-65 °C; 3-4 hours) was maintained in this case and subsequently was lowered down to 35-40 °C. The drier was run uninterrupted at this temperature. The total time requirement for dehydration of the vegetables was recorded as 20-30 hrs. The dimensions of the solar driers used for the present investigations (procured from J S Fabricator Pvt. Ltd., Raj Nagar, Ghazibad) were 2.08 × 0.82 m, with frontal height of 0.21 m and rear height 0.55 m. The total time taken was 8-12 hrs (1-1.5 days), depending upon the solar intensity and type of vegetables being dried.

Initially the vegetables were thoroughly washed with water and the inedible portions were removed. They were cut into small pieces and washed again. Adhering water was removed by shade-drying for 10-15 minutes. The sliced vegetables were then divided into two portions. One portion was pre-treated by blanching[1] in boiling water whereas the other portion was left untreated. Although for the destruction of certain enzymes that cause discolouration and off-flavour, blanching is usually recommended. Some reports[1,2] mention that even after blanching, sun-dried vegetables after one year's storage developed off-flavour and discolouration. Therefore to check-up the quality and shelf-life of the dehydrated stuff, both the solar drier and electrical oven methods were followed.

The treated and untreated vegetable slices were then separately placed on the trays and the air-circulatory oven was run at 35-40 °C. After a 20-30 hours uninterrupted run, the vegetables became dry. They were sealed immediately in polythene bags. A portion of the material to be sealed was kept in a dessicator for the determination of moisture, ascorbic acid, sugar and rehydration ratio. In solar drying, the sliced vegetables (blanched and unblanched) were dried in a similar way by spreading them on the solar drier nets and placing the drier in the sun. The material was turned upside down after 4-5 hours to ensure efficient and uniform drying. After 8-12 hours of exposure, i.e., roughly 1-1.5 days, the vegetables were immediately sealed in polythene bags. In the course of solar drying, the drier was covered by a

Table 1. Ascorbic acid, sugars (on dry wt. basis) and rehydration ration in solar/oven dehydrated vegetables

Sl. No.	Vegetables	Solar/oven dehydrated	Moisture (% by wt)	Ascorbic acid mg/100 g	Sugars (% by wt.) Reducing	Non-reducing	Total	Rehydration ratio
	Cabbage (ARU Glory)	Solar	8.66	17.46	28.62	17.25	45.87	1.99
		Oven	18.47	11.03	27.10	14.45	41.55	2.20
2.	Cauliflower	Solar	4.90	5.20	6.07	16.19	22.26	3.20
	(Snowball-16)	Oven	13.57	4.16	2.10	5.60	7.70	3.95
3.	Radish (HR-102)	Solar	3.90	8.24	28.84	1.62	30.46	1.73
		Oven	16.85	5.74	30.45	12.03	42.48	1.75
	Turnip (Snowball)	Solar	3.87	5.30	34.15	6.00	40.15	1.90
		Oven	17.23	4.80	35.60	6.12	41.72	2.45
5.	Tomato (HT-6)	Solar	6.88	12.55	30.97	21.08	52.05	1.90
		Oven	13.47	9.39	45.99	19.26	65.25	1.91
6.	Lahi (ARU-Black)	Solar	10.60	9.80	3.39	9.35	12.75	2.03
		Oven	13.13	6.89	2.39	6.58	8.97	2.31
7.	Methi (Kasuri)	Solar	3.53	9.73	6.04	0.00	6.04	2.45
		Oven	10.75	6.60	5.30	0.00	5.30	2.39
8.	Palak (Local)	Solar	4.00	10.34	25.90	17.94	43.84	6.20
		Oven	10.73	3.35	17.86	13.41	31.27	7.00

Table 2. Contents of ascorbic acid and sugars (on fresh weight basis) in fresh vegetables

S.No	Vegetable	Ascorbic acid mg/100 g	Sugar (% by wt.) Reducing	Non-reducing	Total	Moisture (% by wt.)
1.	Cabbage (ARU Glory)	123.00	1.28	2.18	3.46	91.27
2.	Cauliflower (Snowball-16)	5.23	0.51	0.86	1.37	89.02
3.	Radish (HR-102)	11.95	0.41	0.84	1.25	93.49
4.	Turnip (Snowball)	21.14	1.57	0.31	1.88	86.40
5.	Tomato (HT-6)	28.96	2.01	2.89	4.90	92.13
6.	Lahi (ARU-Black)	23.73	0.80	1.20	2.00	82.71
7.	Methi (Kasuri)	44.98	0.36	0.00	0.36	78.25
8.	Palak (Local)	22.78	3.26	0.02	3.28	85.55

thick black sheet of polythene after the sunset to avoid entry of moisture during night.

Moisture was determined by direct heating method[3], ascorbic acid by 2,6-dichlorophenol-indophenol method[4] and reducing sugars by Lane-Eynon titration

method[5]. Total sugar was estimated by hydrolysing the extract prepared for reducing sugar by concentrated hydrochloric acid and non- reducing sugar was calculated by subtracting the value of reducing sugar from the value of total sugar. Rehydration ratio, i.e., the mass of reconstituted dehydrated vegetables divided by the mass of dehydrated vegetables before cooking (MR:MD), was determined as per ISI specifications[6].

3. RESULTS AND DISCUSSION

Moisture in solar-dehydrated vegetables was recorded as 4-8 per cent and in oven-dehydrated as 10-18 per cent. As expected, both treated and untreated vegetables gave similar values for ascorbic acid, sugars and other constituents. The values of ascorbic acid and sugars were calculated on the moisture-free basis and the results are shown in Table 1. Rehydration ratio is of much significance to assess the quality of dehydrated stuffs. These values are almost parallel in both the cases as given in Table 1.

From the data (Table 1), it is clear that solar-dehydrated vegetables have higher values of ascorbic acid in comparison to oven-dehydrated ones in every case. Sugars on the other hand, were found to have no such correlation. Even though in solar drying, vegetables are exposed to a higher temperature in comparison to the electrical oven (35-40 °C), it is found that there is more ascorbic acid retention in solar-dried vegetables than in oven-dried ones.

Fresh vegetables loose most of these bio-constituents when they are dried. Table 2 details out the available ascorbic acid and sugar contents in fresh vegetables, and when the theoretical values are calculated (on moisture-free basis), they are enormously high in comparison to the contents available in dehydrated vegetables in both the cases. But when a comparison in terms of preservation of bio-constituents in a vegetable dehydrated by two separate methods is made, it is indeed difficult to put forth a reasonable explanation for the greater retention of ascorbic acid in solar-dehydrated vegetables than the oven-dried ones. Although the phenomenon may be due to the shorter time taken in solar drying (8-12 hours) than in oven drying (20-30 hours), the plausible hypothesis perhaps could be as follows.

In solar drying, the stuff is exposed to solar radiation during dehydration. This could have inhibited irreversibly or destroyed completely the enzymes responsible for the destruction of ascorbic acid. In oven drying, since enzymes are not effected adversely at moderate temperature (35-40 °C), they degrade the substrate at a higher rate until the water content is reduced to such an extent that they loose their activity.

4. SUPPLY OF SOLAR-DEHYDRATED VEGETABLES

A large quantity of solar-dehydrated cabbage, radish, turnip, *lahi*, *methi*, *palak* and tomato were supplied to the army located at high altitude areas namely, Mana, Harsil and Joshimath. These were found to be highly acceptable and another lot from the same batch was further supplied as per their demand after a year. Even after a year of storage (in sealed polythene bags) the untreated vegetables retained their original colour and did not develop any off-flavour.

5. CONCLUSIONS

Solar dehydration technique is a superior method for dehydration of vegetables in comparison to electrical oven dehydration in terms of time, cost and quality of dried stuff with reference to bio-constituents. There is no need of treating the vegetables by blanching before dehydration and this can be dispensed with. The dehydrated products had a shelf life of 12-18 months when stored in sealed polythene bags (at room temperature of 10-35 ^{0}C and relative humidity 88-98 per cent) and retained their original colour, texture and flavour.

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