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COMMERCIAL DEHYDRATION OF VEGETABLES
Part –II. Processing Parameters for Various Vegetables

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Commercial scale dehydration trials were carried out on a locally designed tunnel dehydrator to evaluate processing conditions for 14 vegetables. Various processing operations have been described alongwith different parameters that yielded dehydrated product of good quality. It was found that dehydrated vegetables were organoleptically comparable to fresh ones and were acceptable upto one year when packed in air-tight tin containers.

Key words: Drying, Dehydration, Vegetable processing.

Introduction

Design, fabrication and operation of a twin tunnel dehydrator together with the economics of the process of vegetable dehydration have been described earlier [1]. The present paper deals with the process details with respect to slicing, sulphiting, blanching, tray-loading, dehydration and packing for different vegetables. Organoleptic tests on the stored products were performed to evaluate the shelf-life of the dehydrated vegetables.

Materials and Methods

For all dehydration trials, fresh good quality vegetables were procured from the local market. Edible portions of vegetables (except onions and garlics) were washed thoroughly in excess water and then peeled. Stalks and husks of garlic bulbs were eliminated by locally designed machine. Preparatory losses of various vegetables are listed in Table 1.

Vegetables were sliced to the required thickness (Table 1) with an electric slicer (Urschel, USA). Leafy vegetables were however, chopped into 12-25mm pieces and were sulphited by a 5 mins dip in 0.5% solution of sodium metabisulphite. Depadded peas, okra and bittergourd were however, sulphited after blanching and tomato slices were sulphited by spraying the solution over the vegetable. Blanching was carried out in live steam or hot water (95-100°) using a vegetable to water ratio of 1:1 (w/v) as indicated in Table 1. The time of blanching for each vegetable was determined according to the procedure described by Cruess [2]. Onions, garlics, fenugreek, ginger and mint were neither sulphited nor blanched.

The prepared vegetables were dried in the tunnel dehydrator as described earlier [1]. Tray load and drying temperatures used for various vegetables are given in Table 1. Each drying trial consisted of processing 1-2 tonnes of a particular vegetable. All moisture determination were made according to AOAC [3]. Dehydration ratio (D.R.) for each vegetable was calculated in two ways as described by Cruess [2].

Inedible parts such as seeds in bittergourd slices and hard stems in leafy vegetables, husk from garlic were screened out from dehydrated vegetables. All dehydrated vegetables were packed in air- tight tin canisters as described earlier [1]. The packed vegetables were stored at room temperature (15-30°) and tested organoleptically after 3-months intervals to evaluate the shelf- life.

Organoleptic tests. All the freshly dehydrated and stored samples of vegetables were evaluated for general acceptability. Initially, fresh vegetables were also evaluated for comparison with the freshly dehydrated samples. Dehydrated vegetable equivalent to 1 or 2 kg fresh (purchased basis) was reconstituted by soaking in excess warm water (40-60°) for 2-3 hrs. The reconstituted vegetable was then cooked as usual. An equivalent amount of fresh vegetable was also cooked similarly. The cooked samples were then evaluated by a panel of six trained judges for colour, texture and taste on a 10 point hedonic scale with 1-2 = unacceptable, 3-4 = poor, 5-6 = satisfactory, 7-8 = good and 9-10 = excellent. Average scores for each vegetable were then calculated.

Results and Discussion

Table 1 shows that there was a wide range of preparatory losses for various vegetables ranging from 10% for ginger to 52% for peas. These losses included both edible and inedible parts of the vegetables. The edible part was generally below 10%. There was some additional material loss during dehydration, detraying, packing etc. which has been taken into account for calculation of D.R. values. Preparatory losses account for the difference in the two D.R. values (purchased and prepared basis) for the same vegetable (Table 1). Table 1 also shows the slice size, tray load, dehydration temperature, blanching time and final moisture content for each vegetable. The optimum

TABLE 1. SOME DATA REGARDING DEHYDRATION OF VEGETABLES.

Vegetable	Preparatory loss (%)	Slice size (mm)	Blanching time (min.)	Tray load per tray[2] (kg)	Drying temp. (°C) 1st stage	Drying temp. (°C) 2nd stage	Final moisture (%)	Dehydration ratio (D.R.) Purchased basis	Dehydration ratio (D.R.) Prepared basis
Carrots	24	4	7(Steam)	1.50	80	65	4.5	16	12
Turnips	15	4	7(Steam)	1.00	70	55	4.5	15	12
Potatoes	14	5	6(Steam)	1.50	80	60	6.5	6	5
Onions	11	5	NB[3]	1.50	75	60	4.0	11	10
Garlic	15	3	NB	1.50	75	60	3.5	4	3.5
Tomatoes	15	6	NB	1.50	80	60	3.5	24	20
Bittergourd	33	6	5(Water)	1.50	75	55	4.2	24	16
Okra	15	12	5(Steam)	2.0	80	60	4.1	12	10
Spinach	42	12	5(Steam)	0.75	80	60	3.5	25	15
Fenugreek	45	12	NB	0.75	75	55	3.5	18	10
Peas	52	–	4(Water)	2.0	80	60	5.0	9	4
Mint	40	12	NB	0.75	70	55	3.5	18	11
Ginger	10	4	NB	1.50	70	55	4.5	7.5	6.5
Cauliflower	40	6	5(Steam)	1.50	70	55	4.2	20	12

(1) Each trial consisted of processing of 1-2 tonnes vegetable. (2) Tray size: 75cm x 37cm. (3) NB: Not blanched.

blanching time for each vegetable was the time of heat treatment adequate to inactivate catalase and peroxidase enzyme systems. Other parameters such as slice size, tray load, dehydration temperature etc. were optimized in preliminary experiments first in a cabinet dryer and then in the tunnel dryer to obtain good quality product. The above findings are in accordance with those mentioned in the literature [2,4,5]. Water blanching of certain vegetables was found to be more suitable than steam blanching as it resulted in better product appearance. In the case of bitter-gourd water blanching also extracted some of the bitter principle thereby improving the taste of the reconstituted vegetable as indicated by organoleptic tests (Table 2). Addition of sodium bicarbonate to the blanching water (pH, 7-8) improved the retention of green colour of peas and bitter-gourds. It has been shown that the use of alkaline additives to preserve the green colour in processed vegetables is quite effective [6,7]. Sulphiting of prepared vegetables resulted in significant colour improvement of the dehydrated products. The importance of this operation is well recognized [2,5,8]. Tomato, okra and spinach were sulphited by spraying the solution onto the vegetable slices and was found more practicable as it resulted in reduced juice loss and/or uniform spreading on the trays.

Organoleptic tests. Results of these tests (Table 2) showed that the dishes prepared from the reconstituted vegetables (zero time storage) were quite comparable to those prepared from fresh ones. All the dehydrated vegetables obtained scores of above 7.00, close to those of fresh vegetables, an indication of their quality being 'good' in some cases

TABLE 2. ORGANOLEPTIC SCORES OF SOME DEHYDRATED VEGETABLE DURING STORAGE AT ROOM TEMPERATURE.

Vegetable	Characteristic	Fresh vegetable	Organoleptic scores: Dehydrated, Storage period (month) 0	3	6	9	12
Carrot	Colour	9.0	8.0	7.5	6.0	6.2	6.2
	Texture	8.5	7.0	7.2	6.5	6.6	5.8
	Taste	9.0	8.3	7.2	6.0	6.0	5.5
Turnips	Colour	7.0	7.0	6.0	5.3	4.9	4.8
	Texture	8.5	8.2	7.2	7.0	6.2	5.0
	Taste	7.5	8.2	7.3	6.0	5.7	5.2
Potatoes	Colour	9.0	8.0	7.5	7.2	6.5	6.0
	Texture	9.5	9.0	8.2	7.0	6.4	5.0
	Taste	8.5	8.0	8.2	7.0	6.2	5.0
Bitter-gourd	Colour	8.0	8.0	7.5	6.2	8.5	6.5
	Texture	8.5	8.2	7.2	7.0	6.6	5.0
	Taste	8.0	8.5	8.0	7.2	6.9	6.0
Okra	Colour	9.0	7.5	7.0	6.3	5.8	5.0
	Texture	9.0	7.5	7.0	6.0	6.0	5.2
	Taste	8.5	8.0	8.2	7.2	7.0	6.0
Spinach	Colour	8.2	7.0	6.2	5.2	5.4	5.3
	Texture	8.5	7.0	6.2	6.0	5.5	5.2
	Taste	9.0	7.0	7.3	6.0	6.0	5.0
Peas	Colour	8.2	7.0	6.2	5.5	5.2	5.3
	Texture	8.0	7.3	6.2	5.2	5.2	5.0
	Taste	8.5	7.0	6.3	5.4	5.4	5.0
Cauli-flower	Colour	8.5	6.5	6.0	5.0	4.8	4.8
	Texture	8.5	7.0	6.0	5.5	5.2	5.2
	Taste	8.2	7.3	7.2	6.0	5.8	5.4

(turnips and bitter-gourds) the taste scores were even higher than the controls. This might be due to the fact that pungent/ bitter principle of these vegetable was eliminated to some extent during processing.

Organoleptic tests on stored samples showed that after a period of 3 months, all the vegetables except peas, obtained a taste score of 7.2 or above and after 6-months storage, these scores were 6.0 or above, inspite of the fact that some reduction in colour and texture scores was noted during this period. During further storage the colour of spinach, turnips and cauliflower was adversely affected probably because of browning. Keeping the taste score of '5.0' as the minimum value for acceptability [9], the approximate storage life of various dehydrated vegetables might be regarded as "one year".

Vegetables such as tomatoe, onion, ginger, garlic, mint and fenugreek were tested as flavouring adjuncts in the traditional dishes, each of these was found 'satisfactory' for one year. Fenugreek was found 'acceptable' even after a storage period of two years.

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