STUDIES ON THE EFFECT OF DRYING MODES ON QUALITY OF DEHYDRATED CABBAGE

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ABSTRACT

An investigation was carried out for justify the suitability of various dehydration techniques for desired quality of finished products. The cabbage (Brassica oleracea L. Var. Capitata), one of the commonly consumed green leafy vegetables was assessed for its commercial processing potential through dehydration technology. The fresh cabbage procured from commercial growing farms near Aurangabad city were washed, chopped into strips of uniform size and subjected to hot water blanching containing 2.0 per cent common salt. The pretreated cabbage were dehydrated under different drying conditions i.e. sun, shade and tray drying to safe moisture level. The dried samples were evaluated for their dehydration process features, nutritional and sensorial characteristics. The data on the dehydration technology revealed that tray dried cabbage found comparatively more wholesome, palatable and reported maximum retention of nutrients like vitamin C (42.9 %), calcium (87.2 %), iron (83.3%) coupled with superior dehydration and rehydration ratios and processing characteristics. The tray dried cabbage method was found comparatively superior in retention of sensorial quality features (appearance, color and overall acceptability) over sun drying and at par with shade drying.

Key words *: Cabbage; dehydration; pretreatment; rehydration; sensorial quality*

INTRODUCTION

The green leafy vegetables are seasonal, characterized by its intensive perishability and very poor keeping quality. The spoilage of large quantity of vegetables occurs due to seasonal glut coupled with inadequate and non-technological post harvest handling, transportation, storage and lack of processing facilities. The leafy vegetables have acknowledged for their nutrition safety due to predominant contributory share of vitamins and minerals. The dieticians recommended daily consumption of at least 116 g green leafy vegetables for balanced diet. The cabbage, one of the commonly consumed major green leafy vegetables assured health security by providing required dietary fiber, several essential minerals and vitamins to the human diet (Unde, et al., 2000). Cabbage, being highly perishable commodity owing to its high moisture content requires immediate processing by removal of moisture to a safe level (8 to 10 %) to ensure prolonged shelf life. Dehydration is one of the operationally feasible methods of preservation of surplus perishable produce in season to ensure its availability in off-season as preserved foods. The dehydrated cabbage is more concentrated form of micronutrients than any other processed product. The dried products are non-bulky, light in weight, cost effective and convenient to use. Their availability in off-season, easy storage and least microbial susceptibility to spoilage improved sensorial quality parameters are targeted during launching advances in dehydration techniques. The drying substantially reduces the cost of packaging, storage and transportation by reducing weight and volume of final product (Mandhyan, et al., 1988). Recently, reconstituted dehydrated products are becoming more popular in international market because of quality, which is at par with natural attributes. Therefore, in this investigation sincere efforts were made to introduce recent advances in dehydration technique like shade drying, tray drying to ensure acceptable quality attributes of finished products.

MATERIALS AND METHODS

Selection, preparation and analysis of cabbage

The green, fully matured cabbage was procured from the local vegetables market of Aurangabad city. The fresh cabbage were sorted; damaged and infected portions were discarded followed by washing in clean running water to remove the adhering dirt /dust and soil particles. The outer leaves of cabbage were removed, quartered, cored and cut into strips of uniform size of 2 cm thickness. These prepared pieces were blanched in hot water containing 2 per sent sodium chloride for 2 min. in order to inactivate in vivo polyphenol oxidase enzymes immediately followed by cold water treatment for 10 min. Pretreated cabbage

were surface dried on filter paper for draining the water and dried under different drying conditions such as exposure to direct sun light, shade and cross flow air cabinet dryer (tray drying). The temperature in cabinet tray drier was maintained at 55±2°C. All the samples were dried to end point of 8-10 per cent as a safe moisture level. The maximum temperature recorded during sun drying varied from 31.5 to 43.8°C. The temperature maintained during shade drying was 28°C. The atmospheric humidity as a drying monitoring parameter during experimental period was ranged from 40 to 78 per cent and 15 to 38 per cent respectively. The wind velocity recorded was 3.0 to 5.8 km/h. The time required for drying cabbage to safe moisture level under different conditions was also noted.The moisture, ascorbic acid (Vit. C), calcium and iron content of fresh and dried cabbage were determined by standard methods (AOAC, 1985). The dehydration and rehydration ratios were calculated (Sakhale, et al., 2001). Sensorial quality evaluation of fresh, dried and rehydrated cabbage for the different attributes viz. color, flavor, taste, texture and overall acceptability were carried out by a panel of eleven semi trained judges by using 9 point hedonic scale (Ranganna, 1997).

RESULTS AND DISCUSSION

The dehydrated cabbage on reconstitution is expected to be at par with freshly harvested cabbage in respect of nutritionally and sensorial quality parameters. The data emerged out in this investigation specially on effect of various modes of drying on critical processing features such as drying time, safe moisture content, dehydration and rehydration ratios in relation to quality of finished product are presented in Table 1.

Drying time

The data depicted in Table 1 revealed that tray drying required less time (5.9 h) for drying against 9.0 and 31.0 h incase of shade and sun drying respectively to exhibit safe moisture content of 8-10 per cent. The diversified time requirement pattern for drying the cabbage under the different modes inferred that the rate of moisture removal in tray drying was much faster than the sun and shade drying. The controlled conditions during tray drying might have resulted in faster drying of cabbage. The prolonged time required for shade drying of vegetables may be due to slow evaporation of moisture from cabbage as a result of low temperature of the circulating air in shade. The sun dried samples took intermediate time between tray and shade drying.

The integrated dehydration curves plotted under various drying conditions are shown in the following figure. It is clearly appeared from the curves that higher moisture losses incurred during initial hours of drying reported progressive dehydration phase followed by slow, linear and continuous decreasing trend in moisture loss confined to later phase of dehydration. The tray, sun and shade drying techniques reported decreasing pattern of moisture removal from the samples. Bhosale and Arya (2004) and Jayaraman, et al., (1991) also reported similar results.

Table 1. Effect of drying modes on dehydration process features of Cabbage

Modes of Drying	Dehydration process characteristic of cabbage			
	Drying time (h)	Dehydration Ratio	Rehydration Ratio	Moisture Content (%)
TrayDrying	5.9	5.9:1	1:5.2	8.2
Sun Drying	9.0	5.7:1	1:4.7	8.9
Shade Drying	31.0	5.5:1	1:4.9	9.5

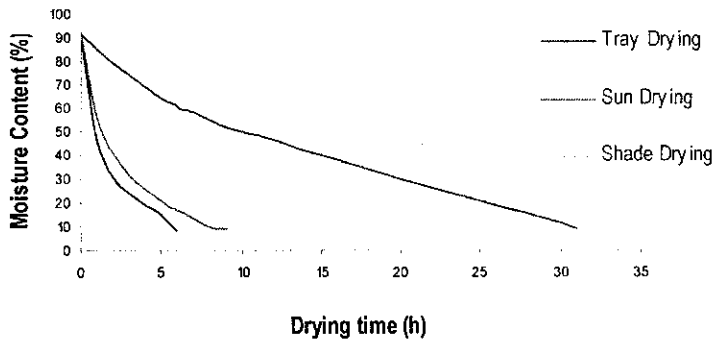

Fig.: Effect of drying modes on dehydration curves of cabbage

Moisture content

The data depicted in Table 1 also indicated pronounced effect of different drying methods on safe moisture content of cabbage. The initial moisture content of the fresh cabbage was found to be 91.4 per cent. The tray dried cabbage reported lower safe moisture content (8.2 %) against 8.9 % and 9.5 % of sun and shade drying respectively. It might have associated with controlled temperature and constant flow of air as a cumulative mass transfer driving force facilitating migration of moisture at faster rate. It was found that further drying of leafy vegetables during later phase of processing did not bring any considerable decrease in moisture content. The consolidated prediction on the basis of data generated confirmed the lowest safe moisture content of tray dried cabbage against sun and shade under controlled conditions. It helped significantly in justifying superior sensorial quality feature of tray dried cabbage over sun and shade drying. Similar types of results were also reported by Cheman, et al., (1997) and Pawar, et al., (1988).

Dehydration and rehydration ratio

The dehydration and rehydration ratios of cabbage dried in different drying conditions were determined and reported in Table 1. Lower the dehydration ratio, higher is the yield of finished product. The tray dried cabbage showed optimum dehydration ratio (6.9:1) and rehydration ratio (1:5.4) whereas, the shade dried cabbage exhibited lower dehydration ratio (6.5:1) and rehydration ratio (1:5.0) followed by sun dried samples. The shade dried cabbage exhibited lower dehydration ratio as compared to other drying methods. Similarly, the rehydration ratio was observed more in tray dried cabbage as compared to other drying methods. The data on dehydration and rehydration ratio are comparable with those reported earlier by Kowsalya and Vidhya, (2004) and Singh, et al., (2003). The data on effect of different modes of drying on percent retention of nutrients like ascorbic acid, calcium and iron content of fresh and dried cabbage are depicted in Table 2.

Ascorbic acid

The initial ascorbic acid (Vitamin C) content of fresh cabbage was reported 122.5 mg/100g. It is also observed that vitamin C content of tray dried cabbage decreased considerably as compared to various other modes of drying. The maximum percent retention of vitamin C was recorded in tray dried cabbage (42.9 %) followed by lowest in sun drying (30.5 %). The exposure of the cabbage to direct sunlight resulted in highest vitamin C loss during sun drying as compared to tray and shade drying. This is associated with high sensitivity of vitamin C to most assessable atmospheric constituents like oxygen, light and temperature. The maximum retention of vitamin C in tray dried cabbage may be due to controlled drying conditions and least exposure of vegetable to temperature and air (Goyal and Mathew, 1990).

Minerals

The initial calcium and iron contents of fresh cabbage were recorded to the tune of 39 mg and 2.8 mg/ 100g respectively. The data on retention of calcium content are depicted in Table 2 recorded maximum retention of calcium (87.2 %) in tray dried cabbage as compared to sun dried (74.4 %) and shade dried (82.1 %) respectively. However, the iron content of tray dried cabbage exhibited higher retention (83.3 %) followed by shade (78.5 %) and sun dried samples (66.0 %). The different modes of drying exhibited no significant change in mineral content of cabbage. The delineate reduction in calcium and total iron content after drying in open sun and shade drying might be due to synergistic effect of temperature and exposure to other atmospheric liable factors. However, irrespective of reduction in mineral content of dried cabbage, an appreciable retention of calcium and iron even after drying under various drying conditions. It is in agreement with results reported by Lakshmi and Vimala, (2000) and Raman, et al., (1988).

Organoleptic evaluation

The data on sensorial quality evaluation of fresh, dehydrated and rehydrated cabbage is presented in Table 3. The results indicated that cabbage was found unique in quality characteristics when fresh and also scored better for respective features after dehydration and rehydration. The optimum overall acceptability governed by sensorial quality features was reported in shade dried samples followed by tray dried and also exhibited higher score after rehydration. The dehydrated cabbage after rehydration found more acceptable to the consumers. The colour, flavour, taste and texture as predominant quality features were also found at par with fresh cabbage.

Table 2. Effect of drying modes on retention of nutrients in cabbage

Modes of Drying	Retention of Nutrients (%)		
	Ascorbic acid	Calcium	Iron
Tray Drying	42.9	87.2	83.3
Sun Drying	30.5	74.4	66.0
Shade Drying	34.7	82.1	78.5

*Each value is the average of three determinations

Table 3. Sensorial evaluation of fFresh, dehydrated and rehydrated cabbage*

Modes of Drying		Sensori quality features				
	Colour		Texture	Flavor	Taste	Overall acceptability
Tray Drying	F	8.1	8.3	8.6	8.4	8.4
	D	6.8	7.0	6.0	6.8	6.8
	R	7.0	7.2	7.2	7.0	7.0
Sun Drying	D	5.0	4.8	5.6	5.0	5.0
	R	4.9	5.1	5.8	4.8	4.8
Shade Drying	D	6.6	6.8	6.2	7.6	7.6
	R	7.0	7.0	6.8	7.2	7.2

*Each value is the average of ten determinations
F = Fresh, D = Dehydrated, R = Rehydrated.

CONCLUSION

The technological achievements of this study indicated that hot water blanching as commodity treatment underlined its significance in conserving sensorial quality features of tray dried cabbage. The interpretation of the data generated helped in developing the technology for drying of cabbage with maximum retention of vitamins, minerals and sensorial quality features and techno economical feature of processing. The total mineral content of leafy vegetables was not much altered during drying in different modes. The dehydration technique resulted in concentration of micronutrients especially minerals (three to five fold). An appreciable amount of nutrient retention was found in shade and sun drying. This gains the significance at Indian context. The preparation of cabbage powder to enrich various other processed food products to ensure nutritional security also needs further strategic investigation.

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