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ORIGINAL ARTICLE

Effect of processing parameters on physico-chemical and culinary quality of dried carrot slices

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Abstract The investigation was carried out to evaluate the carrot (*Daucus carota*) cultivars, to optimize the pre-treatments, time and temperature combination for drying carrot slices and to assess the suitability of the dried product for culinary preparations. Among the 4 cultivars, ('PC-34', 'Sel-21', 'Ambala Local' and 'Nantes') the last one showed the best physico-chemical characteristics for dehydration. The dried carrot slices with highly desirable physico-chemical characteristics could be prepared from 4.5 mm thick slices, blanched in water at 95 °C for 4 min followed by 2 stage phase drying at 90±5 °C for 2 h and at 60±5 °C for 7 h in a cross-flow hot air cabinet dryer. Dipping slices in 6% potassium metabisulphite solution prior to drying improved the rehydration ratio, colour, retention of ascorbic acid and carotenoids content of dried slices. The soup and curried product prepared from dried slices had highly acceptable sensory quality with 8.5 and 8.2 scores, respectively on a 9-point Hedonic scale.

Keywords Carrot · Physico-chemical characteristics Pre-treatment · Cabinet dryer · Dehydration · Sensory quality

Introduction

Carrot (*Daucus carota*) is a versatile root crop. It has multipurpose use in a number of vegetable preparations and sweet dishes (Kalra et al. 1987). The consumption of carrot is preferred by the consumers due to its high nutritive value, antioxidant, anticancerous and other medicinal properties (Suvarnakuta et al. 2005). It also possesses diuretic and nitrogen balancing properties (Anon 2002). Though there is sufficient production (3.5 lakh tons per annum) of carrot in India (FAO 2008), yet its availability is scanty for greater part of the year. Due to seasonal variations in price of carrots, the preparation of some carrot products is restricted to these seasons when it is available in plenty.

Dehydration of carrot seems to be convenient alternative for long term storage as compared to cold storage or canned products. The pre-treatments and methods of dehydration have been reported to influence the quality of dried products (Kulkarni and Govindene 1994; Waghmore et al. 1999; Krokida and Maroulis 2001). No detailed information is available on the preparation of dehydrated carrot slices. The present investigation was therefore undertaken with the objective to optimize the pre-treatments and drying conditions for preparing dehydrated carrot slices and to assess their suitability for culinary preparations.

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Materials and methods

Carrot (*Daucus carota*) cultivars 'PC-34' and 'Sel-21' were obtained from Vegetable Farm of the university and cultivars 'Ambala Local' and 'Nantes' were procured from local market. The carrots were weighed, washed thoroughly under tap water, surface water dried and sliced with food processor.

Blanching Preliminary trials were conducted with 2 kg of carrot slices to optimize the blanching time for hot water (95 °C), steam and microwave blanching. The blanching time was evaluated on the basis of negative peroxidase test and desirable quality characteristics of slices.

Table 1 Physico-chemical parameters of carrot cultivars

Cultivar	Total solids,%	TSS,%	Acidity, %	pH	Reducing sugars,%	Total sugars,%	Ascorbic acid, mg/100 g	Pectin,%Ca pectate	Total carotenoids, mg/100 g	β-Carotene, mg/100 g	Ash %
'Sel- 21'	10.6	9.9	0.06	6.5	1.98	4.3	2.3	0.21	30.7	7.5	0.87
'PC-34'	10.9	9.6	0.04	6.6	1.92	4.2	2.4	0.33	35.8	7.7	0.84
'Ambala Local'	11.1	9.0	0.06	6.5	1.56	4.4	2.4	0.81	34.6	7.6	0.89
'Nantes'	11.3	10.4	0.05	6.6	1.52	4.4	3.6	0.74	38.2	8.6	0.88
CD ($p \leq 0.05$)	0.2	0.2×10^{-5}	0.007	0.03	0.04	0.04	0.59	0.02	0.3	0.03	0.02

$n=3$, *TSS* Total soluble solids

Chemical pre-treatments Five kg slices were blanched in hot water, drained and dipped in solutions of different concentrations of ascorbic acid, brine, potassium sorbate and potassium metabisulphite (KMS). The ratio of slices to dipping solution was 1:2. No chemical dipping treatment was given to control after blanching.

Optimization of drying conditions The preliminary drying trials were conducted at 50±5°, 60±5°, 70±5°, 80±5° and 90±5 °C for drying of slices in a cross-flow hot air cabinet dryer (Frederick Herbert-Design 20, Bombay, India) after spreading the slices in a single layer on aluminium trays (90×60 cm). Two stage phase drying i.e. 90±5 °C for 2 h followed by 60±5 °C for 7 h was carried out in cross-flow hot air cabinet dryer. The slices were dried to a constant weight and the drying time was noted.

Physico-chemical analysis The fresh and dried carrot samples were analyzed for total solids, total soluble solids (TSS), titratable acidity, ascorbic acid and sugars by AOAC (2005) methods. The pectin, total carotenoids and non-enzymatic browning (NEB) as optical density (OD) of alcoholic extract of sample were determined by the methods given by Ranganna (1986). Hunter Lab Colour Difference Meter (Model: Mini Scan Xe Plus, USA) was used to measure the colour. The water activity of the dried sample was measured using water activity meter (Aqualab CX-3 TE, USA) based on principle of chilled-mirror dew point technique. Sulphur dioxide estimation was done by the method given by Ruck (1969). The dehydration ratio was determined by dividing the total solids in the dried product by the total solids in the raw material (fresh carrot). Modified USDA method (Ranganna 1986) was used for measuring the rehydration ratio (RR) of dried slices.

Sensory evaluation The rehydrated dried carrot slices were used for preparing carrot soup and cooked curried carrot, which were subjected to sensory evaluation by the semi-trained panel of 10 judges on a 9-point Hedonic scale (Amerine et al. 1965).

Statistical analysis The experiments were conducted with 3 replicates and completely randomized design (CRD) was adopted to calculate the statistical significance (Snedecor and Cochran 1968).

Results and discussion

Physico-chemical properties of fresh carrot cultivars There were noticeable varietal differences in some physico-chemical constituents (Table 1). Because of the highest total solids, TSS, ascorbic acid, pectin, total carotenoids, β-carotene, and lowest reducing sugars, the cultivar 'Nantes' was the best among the cultivars tested. Due to presence of hairy roots and irregular surface, there were higher preparatory losses in 'PC-34' and 'Sel-21' to the extent of

Table 2 Effect of slice thickness on physico-chemical properties of dried carrot slices (water blanching 4 min and drying at 60±5 °C in cabinet dryer) of cultivar 'Nantes'

Slice thickness, mm	Total solids, %	Dehydration ratio	Rehydration ratio	NEB, OD at 440 nm	Drying time, h
3.0	93.9	8.3	6.0	0.024	12
4.5	93.9	8.3	6.0	0.026	12
5.0	93.8	8.3	5.9	0.031	12
7.0	93.6	8.2	5.4	0.106	14
10.0	93.3	8.2	5.1	0.119	15
CD ($p \leq 0.05$)	0.07	0.04	0.04	0.003	–

$n=3$, *NEB* Non-enzymatic browning

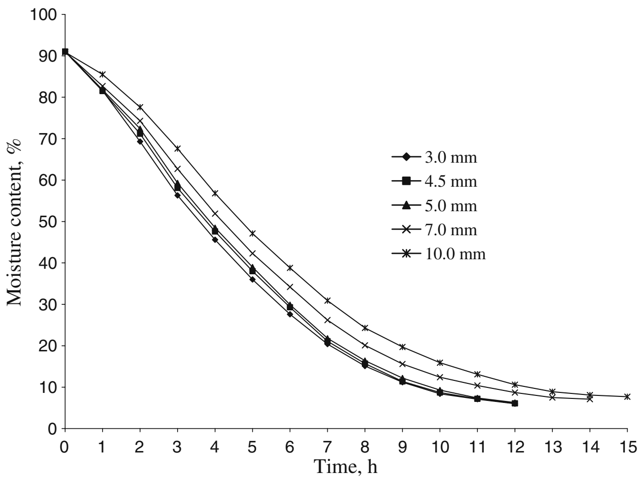

Fig. 1 Effect of slice thickness on the drying behaviour of carrot slices of cultivar ‘Nantes’

57.4 and 59.8%, respectively. This led to more wastage in these cultivars as compared to ‘Nantes’ in which the loss recorded was 30.1%. Kaur et al. (1976) also found that ‘Nantes’ cultivar contained the highest amount of dry matter 10.0% among the cultivars ‘Nantes’, ‘Pusa Kesar’, ‘Suchet-Sharbati’, ‘No. 29’ and ‘Sel-233’ but the values reported were lower than those found in the present study. Krarup et al. (1986) reported that cultivar ‘Nantes’ had dry matter 10.7%, soluble solids 8.0%, pH 6.4, total sugars 6.3% and ascorbic acid 3.5 mg/100 g, showing slight variations in compositions from our investigation.

Effect of slice thickness The least moisture content was obtained in 3 mm thick slices after 12 h of drying and hence maximum total solids, dehydration ratio and RR and lowest NEB after drying at 60±5 °C, while in the case of 4.5 mm thick slices all these parameters were comparable with those of 3 mm thick slices (Table 2). The slices with 7 and 10 mm thickness took longer time of 14 and 15 h, respectively for dehydration (Fig. 1). Moreover, they had excessive browning and lower RR. Statistically there was a significant ($p \leq 0.05$) difference in the final composition and quality of slices of different thicknesses. The slicing process was more time consuming in case of 3 mm thick slices as compared to 4.5 mm thick slices and the physico-chemical properties were almost comparable, therefore carrot slices of 4.5 mm thickness were judged suitable for dehydration.

Steam blanching The carrot slices of 4.5 mm thickness which was blanched for 2 min, the peroxidase test was found negative. After 3 min blanching, slices disintegrated into pulpy mass, so 2 min steam blanching was found better for 4.5 mm thick slices. Wu et al. (1987) reported that peroxidase, catalase and pectinesterase in diced carrots could be inactivated (greater than 97%) after 1 min steam blanching. Steam blanching for 2 min was found necessary to maintain maximum flavour quality with minimum textural losses. From Table 3, it is evident that there was a significant difference in NEB of unblanched and steam blanched (2 min) carrot slices. The higher value of OD (1.269) was recorded for control than the blanched ones (0.098). There was a slight difference in total solids, RR and dehydration ratio of blanched and unblanched slices. But in case of blanched slices, RR was higher (4.7) as compared to control (4.6).

Table 3 Effect of blanching on physico-chemical properties of dried carrot slices (slice thickness 4.5 mm and drying at 60± 5 °C in cabinet dryer) of cultivar ‘Nantes’

	Total solids,%	Dehydration ratio	Rehydration ratio	NEB, OD	Drying time, h
Steam blanching					
Control	92.9	8.2	4.6	1.269	14
2 min	92.9	8.2	4.7	0.098	12
CD ($p \leq 0.05$)	0.03×10^{-4}	0.04	0.05	0.003	–
Microwave blanching					
Control	92.8	8.2	4.6	1.265	14
1.5 min	93.1	8.1	4.7	0.062	7
2 min	93.2	8.2	4.8	0.054	7
2.5 min	93.2	8.3	4.9	0.046	7
3 min	93.2	8.3	4.9	0.044	6
CD ($p \leq 0.05$)	0.02×10^{-4}	0.02	0.03	0.003	–
Water blanching					
Control	92.9	8.2	4.6	1.266	14
3 min	93.8	8.3	5.8	0.031	12
4 min	93.9	8.3	5.9	0.026	12
5 min	93.9	8.3	6.0	0.023	12
CD ($p \leq 0.05$)	0.2×10^{-5}	0.02	0.03	0.003	–

n=3, *NEB* Non-enzymatic browning

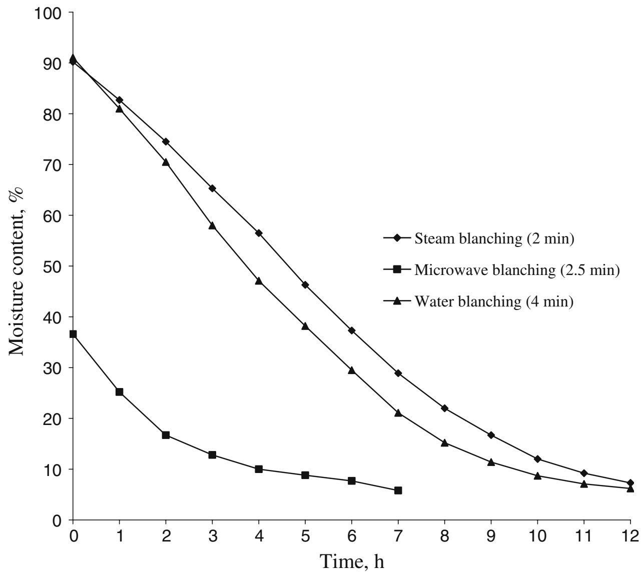

Fig. 2 Effect of different blanching methods on the drying behaviour of carrot slices of cultivar 'Nantes'

Microwave blanching Carrot slices of 4.5 mm thickness were heated in microwave for time intervals of 1.5, 2.0, 2.5 and 3.0 min. Total solids were highest (93.2%) in 3 min blanched carrot slices which were closely followed by 2.5 min blanched slices (93.2%) and lowest (93.1%) in 1.5 min blanched slices. RR was also highest (4.9) in 3 min blanched carrot slices while the least RR (4.7) was in 1.5 min blanched slices. OD of the dried carrot slices increased with decrease in blanching time. Among the different blanching times maximum OD (0.062) was recorded in 1.5 min blanched slices while minimum OD (0.044) was recorded in 3 min blanched slices. Dehydration ratio was highest (8.3) in 2.5 min blanched slices and minimum (8.1) in 1.5 min blanched slices. It is obvious that 2.5 and 3 min microwave blanching produced the dried products, which were almost comparable with respect to moisture, total solids, RR and NEB. Therefore, 2.5 min microwave blanching was the best for dehydration of slices.

Table 4 Effect of pretreatments on physico-chemical properties of dried carrot slices (slice thickness 4.5 mm, water blanching at 95 °C for 4 min and after dipping in different concentrations for 10 min, drying at 60±5 °C in cabinet dryer) of cultivar 'Nantes'

Pretreatment concn	Total solids,%	Dehydration ratio	Rehydration ratio	NEB, OD	Concentration
Ascorbic acid, ppm					
Control	93.9	8.3	5.9	0.036	ND
250	93.9	8.3	5.9	0.021	3425
500	93.9	8.3	6.0	0.018	5325
750	93.9	8.3	6.0	0.017	7450
CD ($p \leq 0.05$)	NS	NS	NS	0.003	3.77
Brine,%					
Control	93.9	8.3	5.9	0.034	ND
2	93.6	8.3	5.7	0.037	8.78
4	93.2	8.2	5.5	0.045	20.57
6	93.0	8.2	5.2	0.051	31.46
CD ($p \leq 0.05$)	0.02×10^{-4}	0.04	0.04	0.006	0.04
Potassium sorbate, ppm					
Control	93.9	8.3	5.9	0.031	ND
350	93.9	8.3	5.9	0.029	546.24
670	93.9	8.3	5.9	0.028	775
CD ($p \leq 0.05$)	NS	NS	NS	NS	8.22
Potassium metabisulphite,%					
Control	93.9	8.3	5.9	0.034	ND
0.10	93.9	8.2	6.0	0.031	ND
0.15	93.9	8.2	6.0	0.029	ND
0.20	93.9	8.3	6.0	0.026	ND
5.0	93.8	8.3	6.1	0.017	1168 ppm
6.0	93.8	8.3	6.2	0.011	1332 ppm
CD ($p \leq 0.05$)	0.02×10^{-4}	0.02	0.03	0.003	14.3

Drying time in all cases was 12 h

n=3, *NEB* Non-enzymatic browning, *NS* Non-significant, *ND* Not detected

Water blanching The dehydration ratio (8.3) was highest in 4 min blanched carrot slices due to highest total solids content (Table 3). Mazza (1983) reported that water blanching before air drying of carrot cubes increased the drying rate. RR was highest (6.0) in 5 min blanched carrot slices which was closely followed by 4 min blanched slices (5.9) and it was lowest (5.8) in 3 min blanched slices. A significant ($p \leq 0.05$) decrease in the optical density (OD) of dried slices was recorded from 0.031to 0.023 when blanching time was increased from 3 to 5 min. Carrot slices blanched for 4 min also showed lower NEB (0.026 OD) than those blanched for 3 min. Thus, 4 min water blanching was the best among the different blanching times. Baruffaldi et al. (1983) reported that 99.4% peroxidase activity was destroyed in carrot ('Nantes' cv.) slices of 2 mm thickness after 4 min water blanching at 92 °C.

Water blanching (95 °C for 4 min) was the best on the basis of physico-chemical properties of the dried product, as the slices had minimum browning (0.026 OD), maximum total solids (93.9%) and RR (5.9). Figure 2 shows that the best drying was in the 2.5 min microwave blanched slices due to partial drying during blanching but the physico-chemical properties were better in 4 min water blanched carrot slices. Srivastava and Sulebele (1975) observed that hot water blanching resulted in better colour and flavour of the dehydrated product (cauliflower) as compared to steam blanching. Polyak-Feher et al. (1992) investigated that water blanching at 95 °C for 1 and 2 min or for 4 min at 93 and 85 °C were more effective for inactivating peroxidase than steam blanching at 100 °C for 1 and 2 min in green peas.

Ascorbic acid Ascorbic acid pre-treatment had a significant effect on NEB of dried carrot slices (Table 4). The lowest OD (0.017) was recorded for slices pre-treated with 750 ppm ascorbic acid solution with a little increase (0.018) in 500 ppm pre-treated slices, while highest OD (0.021) was in 250 ppm pre-treated slices. With increase in ascorbic acid concentration NEB decreased due to antioxidizing effect of ascorbic acid. The ascorbic acid content of dried slices increased with an increase in the concentration of dipping solution.

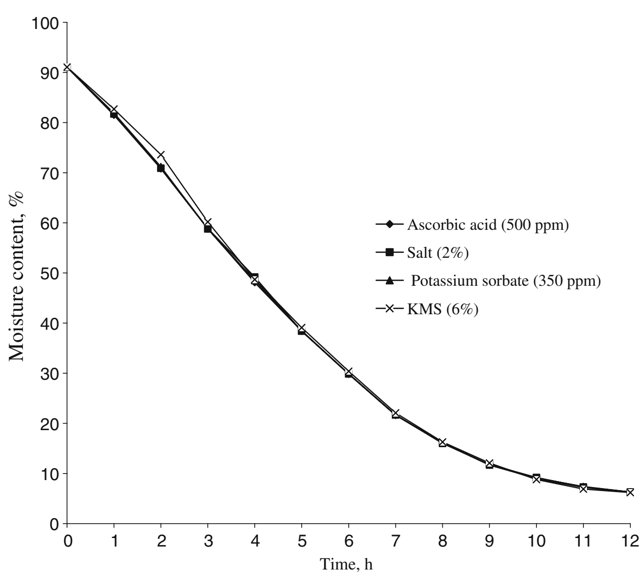

Fig. 3 Effect of different pre-treatments on the drying behaviour of carrot slices of cultivar 'Nantes'

Salt The lowest RR (5.2) was recorded in 6% brine pre-treated slices and highest (5.7) in 2% brine pre-treated slices (Table 4). Mazza (1983) also observed that carrot cubes dried after dipping in 10% brine solution had lower total solids content and lower RR due to decreased moisture removal during dehydration.

Slices pre-treated with 6% brine were of darker colour with highest OD (0.051) whereas carrot slices pre-treated with 2% brine were of lighter colour (0.037 OD), but least OD (0.034) was recorded in carrot slices dried without brine pre-treatment. Dehydration ratio also decreased with increase in the brine concentration. With increase in the brine concentration, there was increase in the salt concentration in the final product.

Potassium sorbate In 350 and 670 ppm potassium sorbate pre-treated fresh carrot slices, sorbic acid concentration was recorded as 546.2 and 775 ppm, respectively in the dried product (Table 4). According to PFA (2003), in case of prunes maximum allowable limit for sorbic acid is 1,000 ppm.

Potassium metabisulphite Dipping time of 40 min was found optimum due to adequate absorption of KMS by the carrot slices (Table 4). Slices were dipped in different concentrations of KMS solution for 40 min. RR was highest (6.2) in 6% KMS pre-treated slices followed by 5% KMS (6.1). Among the different concentrations, the least (6.0) RR was recorded in

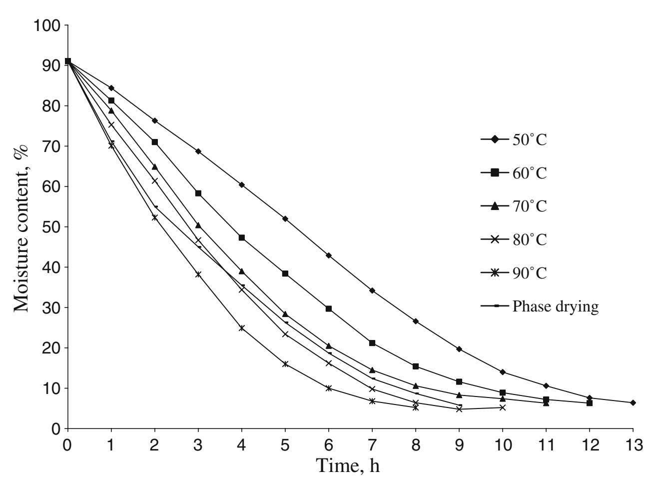

Fig. 4 Effect of drying temperature on the drying behaviour of carrot slices of cultivar 'Nantes'

Table 5 Effect of drying temperature on physico-chemical properties of dried carrot slices (slice thickness 4.5 mm, water blanching at 95 °C for 4 min) of cultivar 'Nantes'

Drying temp, °C	Total solids,%	Dehydration ratio	Rehydration ratio	NEB, OD	Drying time, h
50±5	93.9	8.3	5.4	0.025	13
60±5	93.9	8.3	5.9	0.027	12
70±5	93.9	8.3	5.8	0.038	11
80±5	94.8	8.4	5.8	0.046	10
90±5	94.7	8.4	5.7	0.053	8
Phase drying	94.8	8.3	6.0	0.028	9
CD ($p \leq 0.05$)	0.02×10^{-4}	0.01	0.03	0.002	–

n=3, *NEB* Non-enzymatic browning

0.1% KMS pre-treated slices. RR increased with increase in the KMS concentration. The present finding is concordant with the results of Latapi and Barrett (2006) and Shilpa et al. (2008). Deterioration of colour was more in slices pre-treated with lower concentrations of KMS than those pre-treated with higher concentrations. This difference might be due to the antioxidant effect of KMS. Mir et al. (2009) reported that KMS pre-treatment at concentration of 6% for 60 min prior to drying in solar tunnel dryer helped significantly in improving and maintaining the quality of dried apricots. Lowest OD (0.011) was recorded in slices pre-treated with 6% KMS solution, whereas highest OD (0.031) was recorded in 0.1% KMS. Mulay et al. (1994) observed that the NEB in KMS pre-treated samples was lower as compared to sugar pre-treated samples, which confirmed the inhibitory effect of SO_2.

Significant ($p \leq 0.05$) difference was observed with different concentrations of KMS in the dehydration ratio of the slices. The results are in conformity with those reported by Mazza (1983). Concentration of the dipping solution had a profound influence on the SO_2 retention of the dried carrot slices. In case of 0.10, 0.15 and 0.20% KMS pre-treated slices SO_2 content was negligible but there was a significant increase in the SO_2 retention in the slices pre-treated with 5 and 6% KMS, which were 1,168 and 1,332 ppm, respectively. Bhatia et al. (1962) observed that steeping of pineapple in 0.25 to 2.5% KMS solution for 30 min was insufficient to give the desired concentration of SO_2. Maximum upto 2,000 ppm SO_2 is allowed in case of dehydrated vegetables (PFA 2003).

From Table 4, it is apparent that the dried product with best physico-chemical properties was obtained from 6% KMS pre-treated carrot slices due to highest RR (6.2) and lowest NEB (0.011 OD) among the other chemical pre-treatments i.e. ascorbic acid, salt and potassium sorbate pre-

Table 6 Effect of treatments on physico-chemical properties of dried carrot slices

Parameter	Control	Potassium sorbate	KMS	CD ($p \leq 0.05$)
Total solids,%	93.8	93.7	93.7	0.2×10^{-5}
Total soluble solids,%	55.0	50.0	60.0	0.04
Water activity	0.367	0.362	0.365	NS
Titratable acidity,%	0.80	0.48	2.80	0.04
pH	5.8	6.2	5.4	0.04
Ascorbic acid, mg/100 g	11.5	9.4	22.9	0.04
Reducing sugars,%	30.2	25.9	16.3	0.04
Total sugars,%	42.9	42.1	43.2	0.2×10^{-5}
Pectin,%	9.8	10.1	10.0	0.04
Total carotenoids, mg/100 g	159.8	161.2	219.4	0.1
β-Carotene, mg/100 g	67.8	68.2	72.1	0.05
Hunter colour value				
L	65.6	65.8	66.3	0.07
a	24.3	25.3	26.7	0.04
b	26.5	27.4	29.5	0.04
Rehydration ratio	5.9	6.3	6.4	0.04
NEB, OD	0.105	0.102	0.001	0.2×10^{-5}
SO_2, ppm	–	–	1191.2	0.2×10^{-5}
Sorbic acid, ppm	–	492.4	–	0.2

n=3, *NEB* Non-enzymatic browning, *NS* Non significant, *KMS* Potassium metabisulphite treated carrot slices. Arya et al. (1982) reported that colour and rehydration ability of dehydrated carrots could be improved by KMS treatment. There was no effect of pre-treatments on the rate of moisture removal from the carrot slices during dehydration (Fig. 3).

Effect of drying conditions The drying of carrot slices was faster at higher drying temperature (Fig. 4). RR was highest (6.0) in the phase dried carrot slices which was followed by slices dried at 60±5 °C (5.9) and lowest (5.4) in slices dried at 50±5 °C (Table 5).

The NEB of slices dried at different drying temperature varied significantly ($p \leq 0.05$). The slices dried at 50±5 °C had least OD (0.025) with a slight increase in case of carrot slices dried at 60±5 °C (0.027) and phase dried carrot slices (0.028). However, carrot slices dried at 90±5 °C showed maximum browning (OD 0.053). This was higher ($p \leq 0.05$) than those of slices dried at 70±5 °C (OD 0.038) and 80±5 °C (OD 0.046). Dehydration ratio was highest (8.4) in slices dried at 80±5 °C and 90±5 °C and lowest (8.3) in slices dried at 50±5 °C.

Temperature above 60 °C produced product with excessive browning and unacceptable taste and below 60 °C took longer time for drying. Therefore, 60±5 °C was found optimum for drying of carrot slices. On the other hand, phase dried slices had more RR and took less time for drying as compared to drying at 60±5 °C with almost comparable colour. Mohamed and Hussein (1994) also reported that rehydration ability was adversely affected more by long drying time than high drying temperature. Drying behaviour was better in case of phase dried samples as compared to those dried at constant temperatures in the cabinet dryer. Therefore, phase drying at 90±5 °C for 2 h and further at 60±5 °C for 7 h was found optimum for dehydration of carrot slices.

Physico-chemical characteristics of dried carrot slices Total solids were highest in untreated samples and lowest in KMS pre-treated samples (Table 6). A significant ($p \leq 0.05$) difference was observed in the TSS of all the samples. There was no significant difference in the water activity of control, potassium sorbate and KMS pre-treated samples. Titratable acidity was maximum (2.8%) in KMS pre-treated carrot slices as compared to untreated (0.80%) and potassium sorbate (0.48%) pre-treated carrot slices. Treatments had an appreciable effect on the ascorbic acid retention of dried carrot slices. Maximum retention of ascorbic acid was noticed in KMS pre-treated product (22.9 mg/100 g) while, minimum retention was in potassium sorbate pre-treated samples (9.4 mg/100 g) with control being intermediate between the two (11.5 mg/100 g). This might be due to higher retention of SO_2 in KMS pre-treated samples. Sulphites minimize the losses of ascorbic acid in dried fruits as reported by Atkinson and Strachan (1962). Also sulphites are antioxidants that prevent oxidative losses by acting as reducing agents (Gould and Russel 1991). In case of KMS pre-treated samples, the reducing sugars were lowest (16.3%) while total sugars were highest (43.2%), which might be attributed to the protective effect of sulphites towards hydrolysis and inversion of non-reducing to reducing sugars. The lowest pectin content (9.8%) was in control and highest (10.1%) in potassium sorbate pre-treated samples, which was closely followed by (10%) KMS pre-treated samples. Likewise, the RR was also lowest (5.9) in control and highest (6.4) in KMS pre-treated samples. The NEB was minimum in KMS pre-treated carrot slices, which might be due to higher SO_2 concentration. Use of sulphites reduces NEB in dried tomatoes (Atkinson and Strachan 1962, Latapi and Barrett 2006). The highest Hunter *L*, *a* and *b* values were recorded in KMS pre-treated samples. This might be attributable to the effect of KMS in preserving the colour quality of dried carrot slices during dehydration. Similar trend was also observed in case of carotenoids retention in dried carrot slices.

Sensory quality The scores for appearance, flavour, texture and overall acceptability were maximum for KMS pre-treated carrot soup (Table 7). The carrot soup prepared from dried carrot slices pre-treated with 6% KMS prior to drying had the highest overall acceptability with score of 8.5. The

Table 7 Effect of treatments on sensory score (on 9-point Hedonic scale) of carrot soup and cooked curried carrot prepared from dried carrot slices

Treatment	Appearance	Flavour	Texture	Overall acceptability
Carrot soup				
Control	8.1	8.2	8.1	8.2
350 ppmK-sorbate	8.4	8.4	8.2	8.3
6% KMS	8.6	8.5	8.4	8.5
CD ($p \leq 0.05$)	NS	NS	NS	NS
Cooked curried carrot				
Control	8.0	8.2	8.0	8.1
350 ppmK-sorbate	8.1	8.4	8.1	8.2
6% KMS	8.5	7.5	8.5	8.2
CD ($p \leq 0.05$)	NS	0.6	NS	NS

n=9 panel members, *NS* Non-significant, *KMS* Potassium metabisulphite soup prepared from KMS and potassium sorbate pre-treated carrot slices had rating 'liked very much' on 9-point Hedonic scale.

Appearance and texture scores were highest for the curried product prepared from KMS pre-treated carrot slices but score for flavour was highest for the product prepared from potassium sorbate pre-treated samples, as there was a slight aftertaste of SO_2 in the product prepared from 6% KMS pre-treated slices (Table 7). While, the product prepared from untreated carrot slices had the lowest score (8.1). Significant ($p \leq 0.05$) difference was observed for the scores of flavour among the various treatments.

Conclusion

Cultivar 'Nantes' was the best for the preparation of dried carrot slices. The dried carrot slices with desirable physico-chemical characteristics could be prepared from 4.5 mm thick slices, blanched in water at 95 °C for 4 min followed by two stage phase drying at 90±5 °C for 2 h and followed by drying at 60±5 °C for 7 h in cross-flow hot air cabinet dryer. Dipping in 6% KMS solution prior to drying improved the rehydration ratio, colour and retention of ascorbic acid and carotenoids. Though the sensory quality of dried slices used for preparing soup and curried products was highly acceptable, the product prepared from KMS and potassium sorbate pre-treated slices had higher overall sensory scores than control. However, the flavour score of cooked curried carrot prepared from KMS pre-treated slices was lower than control and potassium sorbate pre-treated slices.

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