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Osmotic dehydration technique used for preparation of carrot (*Daucus carota* L.) candy

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Abstract
The study conducted at Department of Post Harvest Technology, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during year 2017. For preparation of carrot candy using different levels of sugar/syrup treatments (S_1- Mixing of 500 g sugar / kg pieces, S_2 - Mixing of 750 g sugar / kg pieces, S_3 - Mixing of 1000 g sugar / kg pieces, S_4- Mixing of 1 kg 50° Brix syrup / kg pieces and S_5- Mixing of 1 kg 60° Brix syrup / kg pieces, S_6- Mixing of 1 kg 70° Brix syrup / kg pieces) and KMS (K_1-0 ppm, K_2-1000 ppm and K_3-2000 ppm). The experiment was laid out using completely randomized design with factorial concepts. The yield of carrot was found maximum in candy prepared by using 1kg syrup (50^0B) having 1000 ppm KMS per kg pieces (K_2S_4). Whereas, mass transfer-in and out for carrot candy were found minimum in candy prepared with same treatment. The acidity (%) of candy was decreasing with the advancement of storage period. The TSS of carrot candy was found maximum in candy prepared by using 1kg syrup (50^0B) with 1000 ppm KMS per kg pieces (K_2S_4) and minimum TSS was found in candy prepared by using 1000 g sugar per kg pieces along with 2000 ppm KMS (K_3S_3). The maximum carotene and moisture content were found in candy prepared by using 1kg syrup (50^0B) per kg pieces containing 1000 ppm KMS (K_2S_4).The maximum total and reducing sugars were found in candy prepared with same treatment while, they were minimum in candy prepared by using 1000 g sugar per kg pieces along with 2000 ppm KMS (K_3S_3). Overall findings of investigation revealed that carrot candy can be prepared by mixing of 1 kg syrup (50^0B) per kg pieces along with 1000 ppm KMS followed by gradual rise (10^0 B) in the syrup strength up to 70^0B was found better.

Keywords: Carrot candy, osmotic dehydration

Introduction
Carrot (*Daucus carota* L.) belonging to Apiaceae (previously Umbelliferae) family grown throughout the world. It is one of the most important and popular root vegetable grown extensively in various countries particularly during winter season.

Among the various vegetables, carrot is the best source of carotene, which is precursors of vitamin A and also rich source of ascorbic acid and are known as vitaminized food with moisture, protein, fat, carbohydrates, sugars and fiber, respectively (Haq and Prasad 2015) with essential nutrients for maintaining health. Due to the health and nutrition benefits of the carrot, its commercialization and industrialization in the form of different products is very important in fulfilling the nutrient requirements of the people particularly as a cheap source of vitamin A. Besides the carotene and carotenoids, vitamin A conversion from β-carotene is very fast as compared to other carotenoids (Van *et al*., 1996) [6].

Carrot is lonely coloured root crop with different types of pigments in the form of carotenoids and flavonoids that impart antioxidant properties in addition to colour (Rodriguez-Amaya, 2011) [7].

There are many carrot cultivars having variation in shape and colour. The European or western carrot groups mostly grown in temperate region are cold tolerant. They are orange in colour and rich in carotene content. In these cultivars the central core is indistinct and more nutritive.

Carrots are being consumed in various forms *viz.*, salad, soup, stews, curries, pies and sweetmeats. They are cooked and processed into various value added products *viz.*, canned carrots, chips, candy, *kheer*, *halwa*, powder, juice, beverages, wine, preserve, intermediate moisture products and jams as blending agents as reported by Lingappa and Naik (1997) [8].

Osmotic dehydration is divided into two steps, dipping of the fruits/vegetables in concentrated sugar syrup/ brine solution which is called osmosis while,

drying of the products by means of dryers that is dehydration. Osmotic dehydration (OD) is a technique applied to fruit and vegetable products to reduce their moisture content and increase soluble solids content.

Candy is a sweet product prepared from fruits or vegetables by impregnating them with sugar syrup followed by draining of excessive syrup and then drying the product to a shelf stable state (Mehta and Bajaj, 1984) [9]. The maintenance of colour, texture, taste and aroma are major problems in preparation of candy. So, there is urgent need to standardize the process for preparation of candy from carrots.

Materials and methods

Experiment was carried out in Center of Excellence on Post Harvest Technology, Department of Post Harvest Technology, ASPEE College of Horticulture and forestry, N.A.U., Navsari. The carrots were weighed and washed thoroughly in clean water, trimmed and hand peeled by means of peeler and cut into cuboids (15×15mm ±1mm) by means of hand operated diecer. Later on, the carrot pieces were blanched for 5 min. Simultaneously, sugar syrups of 50^0 B, 60^0 B and 70^0 B were prepared by adding table sugar to hot water and strength of sugar syrup was measured using abbe refractometer. After that freshly prepared syrup/direct sugar (500 g, 750 g and 1000 g) were mixed with blanched carrot pieces as per treatments for osmosis. Then required quantities of citric acid (0.2 percent) and potassium metabisulphite (0 ppm, 1000 ppm and 2000 ppm) were mixed in syrup containing pieces. The pieces were left overnight in syrup. After 24 hours, syrup was drained out, TSS and weight of syrup were recorded. The TSS of drained out syrup was raised 10˚ Brix by adding table sugar and then pieces were again kept in syrup for overnight. The process was repeated till the TSS of syrup reached to 70^0 Brix. Then pieces were rinsed in warm water for 10 seconds and dried in hot air tray drier at temperature of 60 ^{0}C for 8 hours. After dehydration, samples of carrot candy were packed in the polyethylene bag which was sealed air tight and stored at room temperature for further observations. The same process was carried out with three repetition as per experimental design.

A total 18 treatment combinations were used for preparation of carrot candy with three different levels of potassium metabisulphite (factor 1) and six different levels of sugar/syrups (factor 2). The processed candy was stored at room temperature for periodical evaluation at 0, 2, 4 and 6 months for studying qualitative status of fresh product and changes during storage.

Selection of carrots
↓
Washing, Trimming, Peeling and Cutting
↓
Addition of sugar / syrup as per treatments
↓
Addition of KMS as per treatments
↓
Keeping over night
↓
TSS of syrup increased by 10º B every day till 70º B
↓
Rinsing of candy
↓
Drying (Carrot candy)
↓
Packaging
↓
Storage

Result and discussion

1) Yield (%), Mass transfer-in (%) and Mass transfer-out (%): Data shows Table1in that among different treatments the yield of carrot candy varied from 51.26 percent to 68.18 percent, with maximum in candy prepared by using 1kg syrup (50^0B) per kg pieces (S_4). Data shows that among different sugar/syrup treatments the mass transfer-in for carrot candy varied from 12.33 percent to 18.26 percent, with maximum in candy prepared by using 1000 g sugar per kg pieces (S_3) and minimum in candy prepared by sugar/syrup treatment using 1 kg of syrup (50^0B) per 1kg pieces (S_4) whereas, the mass transfer-out for carrot candy varied from 22.72 percent to 28.83 percent, with maximum in candy prepared by using 1kg sugar syrup (70^0B) per kg pieces (S_6) and minimum in candy prepared by using 1 kg of syrup (50^0B) per 1kg pieces (S_4).

2) Acidity (%): Decrease of acidity in carrot candy during six month storage was found maximum 0.217 percent to 0.207 percent in (K_2 S_1), 0.243 percent to 0.233 percent in (K_1S_3) and (K_2 S_3) while 0.247 percent to 0. per kg pieces with 1000 ppm KMS, 1000 g sugar per kg pieces with 0, 1000 and 2000 ppm KMS and 1 kg (50^0B) sugar syrup along with 2000 ppm KMS, respectively. However, non-significant differences were observed in acidity among interactions of sugar/syrup treatments and KMS concentrations during six months of storage. There was a tendency that the higher concentration of sugar solution used, lower the acidity and on the contrary the lower the concentration of sugar solution used the higher the acidity and osmotic process which makes water to move out of the food into the solution and leach out the natural solutes (organic acid) from the food into the solution and acidity is ultimately reduced, Hasanuzzaman *et al.,* (2014) [10]. 237 percent in (K_3 S_3) and 0.213 to 0.203 percent in (K_3S_4) in candy prepared by using 500 g sugar.

3) Total soluble solids (TSS) (%): Increase of TSS in carrot candy during six month storage was found minimum (70.02°Brix to 70.28°Brix) and (70.85^0B to 71.11^0B) in candy prepared by using 1000 g of sugar and 50^0B sugar syrup per kg pieces along with 2000 ppm KMS (K_3S_3) and (K_3S_4). However, the effect of interaction was found non-significant. The increase in TSS might be due to reduction of moisture content in product during storage. The increase in TSS during storage in the present investigation are in line with the observation reported by Nayak *et al.,* (2012) [11] for *aonla* candy.

4) Carotene (mg/100 g): Decrease of carotene content in carrot candy during six month storage was found maximum (54.34mg/100 g to 48.58 mg/100 g) in candy prepared by using 500 g sugar per kg pieces with 2000 ppm KMS (K_3S_1) and minimum (39.68 mg/100 g to 39.63 mg/100 g) in candy prepared by using 1000 g sugar per kg pieces along with 2000 ppm KMS (K_3S_3). However, non-significant differences were observed in carotene among interactions of sugar/syrup treatments and KMS concentrations during six months of storage. The carotene level of the product was decreased significantly irrespective of the treatment up to the end of the six months of storage. The pattern of decreasing of carotene mg/100 g during storage might be due to oxidative breakdown, isomerization or enzymatic destruction of pigments as well as increasing heating time during processing and increasing temperature at ambient condition during storage. The carotene is also sensitive to heat same as an ascorbic acid. It was also noticed that the decrease in carotene

content during storage may be attributed to its sensitivity to light and oxygen. Similar findings were earlier reported by Madan and Dhawan (2005) [12] in carrot candies prepared in sugar.

5) Moisture content (%): Significant decrease of moisture content in carrot candy during six month storage was found maximum (12.11 percent to 10.03 percent) in candy prepared by using 750 g of sugar per kg pieces along with 1000 ppm KMS (K_2S_2) and minimum (8.69 percent to 8.35 percent) in candy prepared by using 1000 g of sugar per kg pieces with 2000 ppm KMS (K_3S_3). However, non-significant differences were observed in moisture among interactions of sugar/syrup treatments and KMS concentrations during six months of storage. The decline in moisture content might be attributed to evaporation of moisture from the candy. The decrease in moisture content during storage in the present investigation are in line with the observation reported by Tripathi *et al.* (1988) [13] and Nayak *et al.* (2012) [11] for aonla candy.

6) Total sugars (%): Significant increase of total sugars in carrot candy during six month storage was found minimum (60.23 percent to 59.17 percent) in candy prepared by using 1 kg syrup (70^0B) per kg pieces without KMS (K_1S_6). The increase in total sugars during storage in the present investigation are in line with the observation reported by Priya and Khatkar (2013) [3] for *aonla* preserve and Phisut *et al.* (2013) [2] for cantaloupe candy.

7) Reducing sugars (%): Increase of reducing sugars in carrot candy during six month storage was found minimum (8.02 percent to 8.12 percent) in candy prepared by using 1000 g sugar per kg pieces along with 2000 ppm KMS (K_3S_3). The increase in reducing sugars during storage might be attributed to hydrolysis of non-reducing sugars to reducing sugars (Pawar *et al.*, 2013) [4]. The increase in reducing sugars during storage in the present investigation are in line with the observation reported by Priya and Khatkar (2013) [3] for *aonla* preserve, Phisut *et al.* (2013) [2] for cantaloupe candy and Babariya *et al.* (2014) [5] for papaya candy.

Table 1: Effect of different treatments on yield (%), mass transfer-in (%) and mass transfer-out (%) of carrot candy

Parameters	KMS Concentration (K) ppm	Sugar /Syrup Treatments, (S)									
		S_1	S_2	S_3	S_4	S_5	S_6	Mean	S.Em±	CD at 5%	CV %
Yield (%)	K_1- 0	62.36	56.20	50.81	68.54	65.25	54.25	59.57	K=1.36 S=1.93 K×S=3.34	NS 5.53 NS	9.71
	K_2 – 1000	63.98	56.35	52.85	69.54	65.34	54.38	60.41			
	K_3 – 2000	60.89	55.56	50.11	66.47	64.58	53.41	58.51			
	Mean	62.41	56.04	51.26	68.18	65.06	54.01	59.49			
Mass transfer-in (%)	K_1 - 0	14.58	16.27	18.45	12.15	13.39	17.28	15.35	K=0.09 S=0.12 K×S=0.21	0.25 0.35 0.61	2.40
	K_2 - 1000	14.84	15.64	17.37	12.03	13.39	16.32	14.93			
	K_3 - 2000	15.28	16.27	18.97	12.81	14.11	17.30	15.79			
	Mean	14.90	16.06	18.26	12.33	13.63	16.97	15.36			
Mass transfer-out (%)	K_1- 0	25.79	28.35	29.24	23.14	24.83	28.94	26.72	K=0.25 S=0.36 K×S=0.62	0.73 1.03 NS	4.03
	K_2 - 1000	26.61	27.69	29.24	21.05	24.75	28.48	26.30			
	K_3 - 2000	26.74	28.44	30.75	23.98	25.46	29.08	27.41			
	Mean	26.38	28.16	29.74	22.72	25.01	28.83	26.81			

Table 2: Effect of different treatments on acidity (%) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	Acidity (%)							
		Sugar /Syrup Treatments, (S)						Mean (K) Mean (P)	Grand Mean (K)
		S_1	S_2	S_3	S_4	S_5	S_6		
0 Month (P_1)	K_1- 0	0.217	0.217	0.243	0.210	0.213	0.223	0.222	0.217
	K_2 – 1000	0.217	0.217	0.243	0.207	0.213	0.220	0.220	0.217
	K_3 – 2000	0.217	0.220	0.247	0.213	0.213	0.223	0.222	0.219
	Mean	0.217	0.218	0.244	0.210	0.217	0.222	0.221	
2 Month (P_2)	K_1 - 0	0.213	0.217	0.243	0.207	0.213	0.217	0.218	
	K_2 - 1000	0.217	0.217	0.243	0.207	0.213	0.217	0.219	
	K_3 - 2000	0.213	0.217	0.247	0.210	0.213	0.223	0.221	
	Mean	0.214	0.217	0.244	0.208	0.213	0.219	0.219	
4 Month (P_3)	K_1- 0	0.213	0.217	0.233	0.207	0.213	0.217	0.217	
	K_2 - 1000	0.210	0.217	0.233	0.207	0.203	0.217	0.215	
	K_3 - 2000	0.213	0.213	0.237	0.203	0.213	0.220	0.217	
	Mean	0.212	0.216	0.234	0.206	0.210	0.218	0.216	
6 Month (P_4)	K_1 - 0	0.210	0.213	0.233	0.203	0.207	0.217	0.214	
	K_2 - 1000	0.207	0.213	0.233	0.203	0.207	0.217	0.213	
	K_3 - 2000	0.213	0.213	0.237	0.203	0.210	0.220	0.216	
	Mean	0.210	0.213	0.234	0.203	0.208	0.218	0.214	
	Grand Mean (S)	0.213	0.216	0.239	0.207	0.211	0.219		
		K	S	K×S	P	K×P	S×P	K×S×P	
	S.Em±	0.0017	0.0023	0.0041	0.0004	0.0007	0.0009	0.0016	
	CD at 5%	NS	0.0065	NS	0.0011	0.0019	0.0025	0.0044	
	CV%	6.40			1.30				

Table 3: Effect of different treatments on total soluble solids (^{0}B) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	TSS (^{0}B)							
		Sugar /Syrup Treatments, (S)						Mean (K)	Grand
		S_1	S_2	S_3	S_4	S_5	S_6	Mean (P)	Mean (K)
0 Month (P_1)	K_1- 0	70.53	70.39	70.11	70.88	70.55	70.25	70.40	70.67
	K_2 – 1000	70.54	70.44	70.21	71.03	70.58	70.26	70.34	70.74
	K_3 – 2000	70.52	70.35	70.02	70.85	70.55	70.22	70.42	70.61
	Mean	70.53	70.39	70.11	70.59	70.46	70.24	70.39	
2 Month (P_2)	K_1 - 0	70.58	70.56	70.35	70.93	70.84	70.52	70.63	
	K_2 - 1000	70.75	70.57	70.36	71	70.89	70.54	70.69	
	K_3 - 2000	70.58	70.54	70.32	70.92	70.78	70.38	70.59	
	Mean	70.64	70.56	70.34	70.95	70.84	70.48	70.63	
4 Month (P_3)	K_1- 0	70.84	70.69	70.25	71.09	70.89	70.53	70.72	
	K_2 - 1000	70.86	70.74	70.49	71.33	70.99	70.56	70.83	
	K_3 - 2000	70.84	70.57	70.23	70.99	70.86	70.52	70.67	
	Mean	70.85	70.67	70.32	71.14	70.91	70.54	70.74	
6 Month (P_4)	K_1 - 0	70.95	70.91	70.54	71.22	71.03	70.64	70.88	
	K_2 - 1000	70.95	70.91	70.55	71.5	71.07	70.66	70.94	
	K_3 - 2000	70.93	70.78	70.28	71.11	70.98	70.56	70.77	
	Mean	70.94	70.87	70.46	71.28	71.03	70.62	70.86	
	Grand Mean (S)	70.74	70.62	70.31	71.10	70.83	70.47		
		K	S	K×S	P	K×P	S×P	K×S×P	
	S.Em±	0.50	0.71	1.23	0.04	0.07	0.10	0.16	
	CD at 5%	NS	NS	NS	0.106	NS	NS	NS	
	CV%	6.05			0.40				

Table 4: Effect of different treatments on carotene (mg/100 g) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	Carotene (mg/100 g)							
		Sugar /Syrup Treatments, (S)						Mean (K)	Grand
		S_1	S_2	S_3	S_4	S_5	S_6	Mean (P)	Mean (K)
0 Month (P_1)	K_1- 0	55.58	51.58	45.50	60.70	58.72	47.35	53.24	50.80
	K_2 – 1000	57.31	53.55	46.23	60.89	59.28	47.89	54.19	51.75
	K_3 – 2000	54.34	49.69	39.68	59.66	58.21	47.12	51.45	49.16
	Mean	55.74	51.61	43.80	60.42	54.95	47.45	52.96	
2 Month (P_2)	K_1 - 0	52.96	49.54	44.32	59.51	57.14	46.22	51.62	
	K_2 - 1000	53.58	50.56	45.02	59.54	57.20	46.28	52.03	
	K_3 - 2000	51.47	46.36	40.36	58.11	56.47	45.85	49.77	
	Mean	52.67	48.82	43.23	59.05	56.94	46.12	51.14	
4 Month (P_3)	K_1- 0	50.84	48.55	42.01	56.64	54.24	45.00	49.55	
	K_2 - 1000	52.10	50.08	43.87	58.31	55.12	45.84	51.03	
	K_3 - 2000	50.28	46.31	38.31	55.85	54.22	44.28	48.21	
	Mean	51.35	48.31	41.40	56.93	54.52	45.04	49.55	
6 Month (P_4)	K_1 - 0	49.23	47.45	40.45	56.00	54.75	44.89	48.80	
	K_2 - 1000	50.41	47.52	43.87	57.66	55.07	45.02	49.93	
	K_3 - 2000	48.58	45.15	39.63	55.08	50.78	44.05	47.21	
	Mean	49.41	46.71	41.32	56.25	53.53	44.65	48.64	
	Grand Mean (S)	52.22	48.86	42.44	58.16	55.93	45.82		
		K	S	K×S	P	K×P	S×P	K×S×P	
	S.Em±	0.38	0.53	0.92	0.02	0.04	0.06	0.10	
	CD at 5%	1.07	1.52	NS	0.06	0.11	0.17	0.28	
	CV%	6.30			0.34				

Table 5: Effect of different treatments on moisture (%) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	Moisture (%)							
		Sugar /Syrup Treatments, (S)						Mean (K)	Grand
		S_1	S_2	S_3	S_4	S_5	S_6	Mean (P)	Mean (K)
0 Month (P_1)	K_1- 0	12.47	12.02	9.53	14.91	13.25	10.66	11.71	11.55
	K_2 – 1000	12.50	12.11	9.73	15.07	13.28	10.76	12.24	11.75
	K_3 – 2000	12.27	11.31	8.69	14.62	13.01	10.43	11.72	11.06
	Mean	12.41	11.81	9.32	14.87	12.32	10.62	11.89	
2 Month (P_2)	K_1 - 0	12.02	11.22	9.45	15.03	12.71	10.37	11.80	
	K_2 - 1000	12.08	11.34	9.52	15.07	13.21	10.50	11.95	

	K_3 - 2000	11.72	11.22	8.57	13.56	12.14	9.78	11.17
	Mean	11.94	11.26	9.18	14.55	12.69	10.22	11.64
4 Month (P_3)	K_1- 0	11.94	11.22	9.45	14.23	12.19	10.08	11.52
	K_2 - 1000	12.02	11.53	9.50	14.29	13.13	10.46	11.82
	K_3 - 2000	11.68	10.50	8.52	13.42	12.09	9.72	10.99
	Mean	11.88	11.08	9.16	13.98	12.47	10.09	11.44
6 Month (P_4)	K_1 - 0	10.93	10.00	8.43	13.49	12.07	9.53	10.74
	K_2 - 1000	11.07	10.03	8.87	14.03	12.20	9.66	10.98
	K_3 - 2000	10.55	9.91	8.35	12.62	11.64	9.13	10.37
	Mean	10.85	9.98	8.55	13.38	11.97	9.44	10.70
	Grand Mean (S)	11.77	11.03	9.05	14.19	12.57	10.09	
		K	S	K×S	P	K×P	S×P	K×S×P
	S.Em±	0.09	0.13	0.23	0.008	0.01	0.02	0.03
	CD at 5%	0.26	0.37	NS	0.02	0.04	0.06	0.08
	CV%	6.87			0.48			

Table 6: Effect of different treatments on total sugars (%) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	Total sugars (%)							
		Sugar /Syrup Treatments, (S)						Mean (K) Mean (P)	Grand Mean (K)
		S_1	S_2	S_3	S_4	S_5	S_6		
0 Month (P_1)	K_1- 0	55.8	50.17	39.02	64.87	47.61	60.23	50.85	57.43
	K_2 – 1000	57.2	52.34	45.24	65.43	63.37	48.25	55.31	58.93
	K_3 – 2000	55.34	48.29	34.84	64.58	59.09	46.39	51.42	55.51
	Mean	56.11	50.27	39.70	64.96	56.69	47.42	52.52	
2 Month (P_2)	K_1 - 0	59.74	51.17	41.00	68.25	63.78	49.69	55.61	
	K_2 - 1000	59.74	55.89	41.78	69.28	65.27	50.14	57.02	
	K_3 - 2000	58.58	50.84	35.21	66.41	60.12	48.38	53.25	
	Mean	59.35	52.63	39.33	67.98	63.05	49.40	55.29	
4 Month (P_3)	K_1- 0	62.56	57.47	43.57	68.50	65.21	53.94	58.54	
	K_2 - 1000	64.14	58.34	45.05	69.36	66.87	54.78	59.76	
	K_3 - 2000	61.31	55.12	37.26	67.35	64.39	51.32	56.13	
	Mean	62.67	56.98	41.96	68.40	65.49	53.35	58.14	
6 Month (P_4)	K_1 - 0	65.31	61.22	54.37	69.34	66.37	59.17	62.63	
	K_2 - 1000	66.17	61.74	57.27	70.05	67.45	59.20	63.65	
	K_3 - 2000	63.74	60.41	49.37	69.34	66.28	58.20	61.23	
	Mean	65.07	61.12	53.67	69.58	66.70	58.86	62.50	
	Grand Mean (S)	60.80	55.25	43.67	67.73	64.03	52.26		
		K	S	K×S	P	K×P	S×P	K×S×P	
	S.Em±	0.36	0.51	0.88	0.02	0.04	0.05	0.09	
	CD at 5%	1.03	1.46	2.52	0.06	0.11	0.14	0.25	
	CV%	5.33			0.27				

Table 7: Effect of different treatments on reducing sugars (%) of carrot candy during storage period of 6 months

Storage Period (P)	KMS Concentration (K) ppm	Reducing sugars (%)							
		Sugar /Syrup Treatments, (S)						Mean (K) Mean (P)	Grand Mean (K)
		S_1	S_2	S_3	S_4	S_5	S_6		
0 Month (P_1)	K_1- 0	10.65	9.85	8.08	12.24	11.89	8.44	9.62	11.05
	K_2 – 1000	10.95	9.89	8.09	14.95	12.03	9.19	10.85	11.86
	K_3 – 2000	10	9.6	8.02	12.1	11.23	8.29	9.87	10.77
	Mean	10.53	9.78	8.06	12.96	11.72	8.64	10.28	
2 Month (P_2)	K_1 - 0	12.03	10.15	8.36	13.83	12.58	9.1	11.01	
	K_2 - 1000	12.19	11.47	8.4	17.25	12.6	9.89	11.97	
	K_3 - 2000	11.67	9.99	8.36	13.08	12.5	9.06	10.78	
	Mean	11.96	10.54	8.37	14.72	12.56	9.35	11.25	
4 Month (P_3)	K_1- 0	12.03	10.22	8.29	14.58	13.23	9.74	11.35	
	K_2 - 1000	12.66	10.37	8.51	17.10	14.02	10.05	12.12	
	K_3 - 2000	11.74	10.20	7.92	14.03	13.08	9.55	11.09	
	Mean	12.14	10.26	8.24	15.24	13.45	9.78	11.52	
6 Month (P_4)	K_1 - 0	12.19	10.48	8.51	14.59	14.03	9.999	11.63	
	K_2 - 1000	13.45	10.59	8.51	18.57	14.07	10.45	12.61	
	K_3 - 2000	12.04	10.48	8.12	14.13	13.54	9.84	11.36	
	Mean	12.56	10.52	8.38	15.76	13.87	10.10	11.87	
	Grand Mean (S)	11.80	10.27	8.26	14.70	12.89	9.47		
		K	S	K×S	P	K×P	S×P	K×S×P	
	S.Em±	0.07	0.11	0.18	0.01	0.01	0.01	0.02	
	CD at 5%	0.20	0.31	0.51	0.03	0.03	0.03	0.06	
	CV%	5.62			0.37				

Conclusion

From the foregoing discussion, it can be concluded that carrot candy can be prepared by mixing of 1 kg syrup (50^0B) per kg pieces along with 1000 ppm (1g/lit) potassium metabisulphite (KMS) followed by gradual rise (10^0 B) in the syrup strength up to 70^0 B was found better during storage. The carrot candy can be successfully stored for a period of 6 months in polypropylene bags (400 gauge) without much changes in physico-chemical, sensory and microbial quality. Thus, the developed technology can commercially be adopted by food processing industry for the production of quality carrot candy. Therefore, profitable utilization of carrots grown in India for processing can ensures better returns to the growers and processors as well.

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