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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 1568-1578

www.thepharmajournal.com
Received: 11-08-2021
Accepted: 21-09-2021

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Effects of preparation techniques, Pre-treatments and preservatives on quality of carrot juice

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Abstract
Present investigation was caried out to evaluate the nutritional quality of carrot juice during storage. In this investigation a total of 18 treatments were used for juice extraction using different combinations *viz.* preparation techniques as Factor-1 ["Shredding" (T_1) and "Crushing" (T_2)]; microwave pre-treatments as Factor-2 [Control (M_1), Microwave pretreatment 450 W for 30 seconds (M_2) and microwave pretreatment 450 W for 60 seconds (M_3)] and preservatives as Factor-3 [sodium benzoate (P_1), potassium sorbate (P_2) and potassium meta bisulfite (P_3)]. The results of the investigation revealed that acceptable quality carrot juice can be obtained from carrots which was prepared by pre-treating the crushed materials with microwave for 60 seconds followed by preservation with 100 ppm potassium sorbate ($T_2M_3P_2$). The juice obtained from this treatment possess higher yield, β-carotene, and sensory score while lowest reducing sugars and non-enzymatic browning (NEB). The carrot juice which was prepared by pre-treating the crushed materials with microwave for 60 seconds followed by preservation with 100 ppm potassium sorbate ($T_2M_3P_2$) exhibited minimum changes in nutritional as well as sensory attributes during six months storage when packed in glass bottles.

Keywords: Carrot juice, shredding, crushing, microwave, preservatives

1. Introduction
Globally, vegetables are recognized as "protective foods" since they supply adequate quantities of vitamins, minerals, organic acids, folic acids, essential amino acids, dietary fibers, carbohydrates and supplementary amount of proteins. Among major vegetables, carrot (*Daucus carota* L.) belonging to Apiaceae family is the most important root crop grown throughout the world. It is a rich source of β-carotene and contains other vitamins, like thiamine, riboflavin, vitamin B-complex and minerals (Jabbar *et al.*, 2013) [16]. The carrot is consumed in different forms as raw, juice, salads, cooked vegetable and sweet dishes etc. Carrots provide great health benefits to the human body as they are good source of carotenoids, bioactive compounds, vitamins and minerals (Qin *et al.*, 2005) [26]. Due to its good flavor and nutrition, carrot is regarded as very important vegetable owing to its various properties like anticancer, antianemic, antioxidant, sedative and healing which are directly related to human health (Shivhare *et al.*, 2009) [34]. Carotenoids help in preventing heart diseases, improve vision, help in reducing blood sugar and reduce colon cancer. They also act as free-radical scavengers (Bramley, 2000) [6]. The presence of α- and β-carotene in blood has a protective effect against atherosclerosis (D'Odorico *et al.*, 2000) [8]. Due to perishable and seasonal nature of carrot, it is not possible to make fresh carrot available throughout the year. Therefore, consumer demand has increased toward processed foods which have more natural flavour and colour with high nutritional quality and sufficient storage safe for distribution and consumption. This can be achieved by adopting suitable processing methods which inactivate micro-organisms as well as enzymes with little loss of pigments, flavour compounds and vitamins (Dede *et al.*, 2007) [9]. Very limited literature is available on effect of preparation techniques, microwave pre-treatments and preservatives on quality of the juice, besides retention of quality parameters during storage. Thus, there was need to study the effect of preparation techniques, microwave pre-treatments and preservatives to maintain the quality of the carrots juice. Current research was focused for evaluation of different preparation techniques, microwave pre-treatments and preservatives on quality, dry matter and ß-carotene content of carrots juice for their applications in various food preparation. The focus was also to maintain the colour and quality of the juice product during storage.

2. Materials and Methods

Fresh matured but tender, disease and injury free, orange colored carrots (var. *Chantney*) selected and purchased from Morarji yard, APMC, Navsari. The carrots were cleaned and used for further processing into carrot juice. Fresh carrots were analyzed for physico-chemical characteristics and used for juice extraction. A total of 18 treatments were used for juice extraction using combinations of different treatments *viz*. preparation techniques as Factor-1 ["Shredding" (T_1) and "Crushing" (T_2)]; microwave pre-treatments as Factor-2 [Control (M_1), Microwave pretreatment 450 W for 30 seconds (M_2) and microwave pretreatment 450 W for 60 seconds (M_3)] and preservatives as Factor-3 [sodium benzoate (P_1), potassium sorbate (P_2) and potassium meta bisulphite (P_3)]. Various physico-chemical parameters *viz.* TSS, the total soluble solids (TSS) were determined with the help of digital refractometer and expressed as °Brix at 20°C using reference (Ranganna, 1997) [27]. For estimation of total sugars, the filtrate obtained during reducing sugars estimation was used. The method described by Ranganna (1997) [27, 1] was adopted for estimation of titratable acidity. Carotenoids were extracted with acetone and the intensity of colour appeared is measured calorimetrically used spectrophotometer using reference (Ranganna, 1997) [27, 2]. NEB of the processed juice was determined by measuring the optical density of alcoholic extract after 12 hours at 440nm through UV-vis Spectrophotometer using 60 per cent ethanol as blank (Ranganna, 1997) [27, 3] and results were expressed as OD_{440nm}. Total Plate Count (TPC) was recorded aseptically by inoculating 0.1 ml of serially dilute sample in total plate count agar medium prepared according to Ranganna (1997) [27.4]. Experiment was carried out in Completely Randomized Design (CRD) and Completely Randomized Design with factorial concept (FCRD) and experiment repeated thrice.

2.1 Methodology used for extraction of carrot juice

The defective as well as undesirable carrots were removed while sorting. Then carrots were thoroughly washed to remove any adhering dust and dirt particles. After washing, the carrots were cut from end and top to remove undesirable portions with stainless steel (SS) knife. Then cut carrots were shredded or crushed with the help of shredding and crushing machines. The prepared shredded and crushed carrots (Factor-1) were subjected to microwave pre-treatments (Factor-2). After microwave pre-treatments, the samples of extracted juice were preserved using different preservatives (Factor-3). After microwave pretreatment, shreds and crushed materials were pressed for extraction of juice, filtered and heated at 100 ^{0}C for 15 min to inactivate the enzyme and microorganisms, followed by addition of citric acid @ 0.80 g/kg, sugar @ 60.00 g/kg as well as preservatives as per treatments (Factor-3). After juice preparation, the prepared juice was filled in sterilized glass bottles (200 ml), heat processed at 100 ºC for 45 min and stored at ambient temperature to evaluate the nutritional as well as sensory quality of developed products for six months. Principal steps used for extraction and preservation of carrot juice are illustrated in Fig. 1.

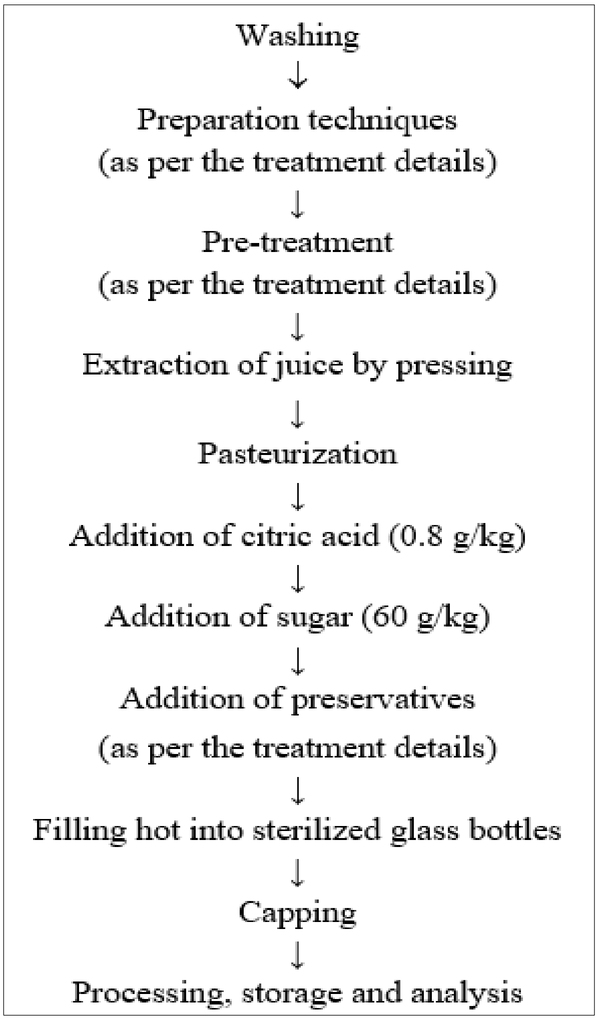

Fig 1: Principal steps used for extraction and preservation of carrot juice

3. Result and Discussion

3.1 Juice recovery

The perusal of data pertaining to effect of different treatments on juice recovery of carrot juice has been presented in Table 1.

3.1.1 Effect of preparation techniques

Among different preparation techniques, the juice recovery (T) of carrot juice varied significantly between 37.50 and 65.67%, with maximum juice recovery (65.67%) in carrot juice which was prepared by giving crushing treatment (T_2) and minimum juice recovery (37.50%) in shredding (T_1). The higher juice recovery in carrot juice which was prepared by giving crushing treatment attributed to immediate release of the moisture and its soluble compounds upon pressing due to more disintegration of the cell structure. Wilczynski *et al.* (2019) also reported higher yield (71.6%) of apple juice of different varieties in screw type of juice extractor due to crushing action of fruit tissues as compared to basket press (61.9%).

3.1.2 Effect of microwave pre-treatment

Data shows that among different microwave pre-treatments grand mean juice recovery (M) of microwave pre-treated carrot juice varied significant between 47.30 and 57.45%, with maximum juice recovery (57.45%) in carrot juice pre-treated with microwave for 60 seconds (M_3) and minimum juice recovery (47.30%) in carrot juice prepared without microwave pre-treatment (M_1). The significant differences of juice recovery value in carrot juice under different microwave pre-treatments might be due to the extraction efficacy of soluble compounds owing to variation in pre-treatment time. The exposure to microwave causes disintegration of the cell structure due to vibration of the water molecules. Gerard and Roberts (2004) [13] reported that Fuji and McIntosh apple mashes heated to bulk temperatures of 60 oC by 2450 MHz microwave oven at 1500 W increased juice yield when mash was treated before pressing. Rayman and Baysal (2011) [28] also reported increase carrot juice yield of 9.70% (50.90 to 55.84%) juice yield due to applications of the electrical methods (electroplasmolysis + microwave). The juice yield was found to vary with the variation of voltage and time of EP application. These treatments affect the cell permeability and make the juice extraction process easier. Similar observations were reported earlier by Sandik (1983) and Okilov (1995) [29] for apple and grape juice.

3.1.3 Effect of treatment interactions

Interaction of preparation technique and microwave pre-treatment (TM) depicted variation in juice yield from 31.60 to 68.00%, with maximum juice yield of 68.00% in crushed carrots which were pre-treated with microwave for 60 seconds T_2M_3 and minimum juice yield of 31.60% in shredded carrots without microwave pre-treatment (T_1M_1). Interaction of preparation technique and microwave pre-treatment (TxM) were found significant.

Table 1: Effect of preparation techniques and microwave pre-treatment on the juice recovery (%) of carrot juice

Preparation techniques (T)	Microwave pre-treatment (M)			
	M_1: control	**M_2:** 30 S	**M_3:** 60 S	**Mean (T)**
T_1: Shredding	31.60	34.00	46.90	37.50
T_2: Crushing	63.00	66.00	68.00	65.67
Mean (M)	47.30	50.00	57.45	
	S.Em. ±		$CD_{0.05}$	
T	0.666		2.053	
M	0.816		2.514	
TxM	1.154		3.555	
CV%	3.87			

3.2 Total soluble solids (TSS)

The perusal of data pertaining to effect of different treatments on TSS content of carrot juice during six months storage period have been presented in Table 2 and Fig. 1.

3.2.1 Effect of preparation techniques

Among different preparation techniques (T), the TSS of carrot juice varied significantly between 16.41 and 16.49 ºBrix, with maximum TSS (16.49 ºBrix) in carrot juice which was prepared by giving crushing treatment (T_2) and minimum TSS (16.41 ºBrix) in shredding (T_1). The higher TSS in carrot juice which was prepared by giving crushing treatment might be attributed to release of more soluble solids upon pressing due to more disintegration of the cell structure. Wilczynski *et al.* (2019) [37] reported higher TSS (13.1, 12.9 and 11.2 ºBrix) in apple juice when extracted from three different apple varieties *viz*, Rubin, Mutsu and Jonaprince using screw type of juice extractor due to crushing action of fruit tissues as compared to basket press (11.9, 12.9 and 11.2 ºBrix), respectively.

3.2.2 Effect of microwave pre-treatment

Data shows that among different microwave pre-treatments grand mean TSS (M) of microwave pre-treated carrot juice depicted variation in TSS from 16.43 to 16.47 ºBrix, with maximum TSS (16.47 ºBrix) in carrot juice pre-treated with microwave for 60 seconds (M_3) and minimum TSS (16.43 ºBrix) in carrot juice prepared without microwave pre-treatment (M_1). The significant differences of TSS value in carrot juice under different microwave pre-treatments might be due to the extraction efficacy of soluble compounds owing to variation in pre-treatment time. Gerard and Roberts (2004) [13, 1] reported that Fuji and McIntosh apple mashes heated to bulk temperatures of 60 oC by 2450 MHz microwave oven at 1500 W increased juice TSS when mash was treated before pressing. Khalil (2017) [20] reported less effect of microwave treatments on TSS of orange juice. The TSS in orange juice reported to vary between 10.5 to 10.8 ºBrix, with minimum TSS in juice treated with microwave for 30 seconds and maximum TSS in juice treated with microwave for 120 and 150 seconds. Variation in TSS of the apple juice was also observed with the application microwave treatment earlier by Canumir *et al.* (2002) [7]. Increase in TSS due to application of microwave treatment compared to fresh juice was observed in pomelo juice earlier by Kumar *et al.* (2017) [21].

3.2.3 Effect of preservatives
Further, it was observed that mean TSS ºBrix (P) of the carrot juice when preserved with different preservatives varied significantly from 16.38 to 16.51 ºBrix, with minimum TSS (16.38 ºBrix) in carrot juice when preserved with 100 ppm potassium sorbate (P_2) and maximum TSS (16.51ºBrix) in carrot juice when preserved with 100 ppm potassium metabisulphite (P_3). Kaur and Aggarwal (2015) [18] reported that KMS treated samples found to retain the maximum TSS. Akinola *et al.* (2018) [3] reported similar variations in TSS of orange juice when preserved with different preservatives using 0.03% of sodium benzoate, sodium metabisulphite, potassium sorbate and their combination. Higher TSS was reported when juice was preserved with the sodium benzoate and sodium metabisulphite. Zakaria *et al.* (2017) [40] reported similar variations in TSS of black mulberry juice when preserved with different preservatives combination like potassium metabisulphite, citric acid, potassium sorbate and sodium benzoate.

3.2.4 Effect of storage
Storage of the carrot juice for six months resulted significant increase in TSS (S) from initial value of 15.79 º Brix to 17.40 ºBrix. The increase in TSS during storage in the present investigation are in line with observation reported by Pal *et al.* (2007) [24] for watermelon nectar, Mingire (2010) [23] for mango nectar and Ahmad (2012) [1] for guava nectar. Rayman and Baysal (2011) [28] reported 1.2% increase in °Brix (7.4 to 8.6%) in carrot juice when given applications of the electrical methods (electro plasmolysis + microwave) during storage.

Table 2: Effect of preparation techniques, microwave pre-treatment and preservatives on the TSS (ºB) of carrot juice during storage

Storage Intervals (S)	Preservatives (P)	Preparation techniques (T)									
		T1: Shredding				T2: Crushing				Grand Mean (S, PS)	Grand Mean (P)
		Microwave pre-treatment (M)				Microwave pre-treatment (M)					
		M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)	M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)		
S_1: Initial	P_1: SB100	15.63	15.70	15.72	15.68	15.85	15.88	15.95	15.89	15.79	16.45
	P_2: PS100	15.63	15.70	15.72	15.68	15.85	15.88	15.95	15.89	15.79	16.38
	P_3:KMS100	15.63	15.70	15.72	15.68	15.85	15.88	15.95	15.89	15.79	16.51
	Mean (TM of S_1)	15.63	15.70	15.72	15.68	15.85	15.88	15.95	15.89	15.79	
S_2:2 Months	P_1: SB100	16.20	16.10	16.10	16.13	16.10	16.20	16.25	16.18	16.16	
	P_2: PS100	16.00	16.20	16.00	16.07	16.00	16.10	16.12	16.07	16.07	
	P_3:KMS100	16.00	16.00	16.30	16.10	16.30	16.35	16.35	16.33	16.22	
	Mean (TM of S_2)	16.07	16.10	16.13	16.10	16.13	16.22	16.24	16.20	16.15	
S_3:4 months	P_1: SB100	16.30	16.50	16.30	16.37	16.45	16.50	16.55	16.50	16.43	
	P_2: PS100	16.25	16.45	16.40	16.37	16.40	16.40	16.35	16.38	16.38	
	P_3:KMS100	16.50	16.20	16.50	16.40	16.65	16.70	16.72	16.69	16.55	
	Mean (TM of S_3)	16.35	16.38	16.40	16.38	16.50	16.53	16.54	16.52	16.45	
S_4:6 months	P_1: SB100	17.10	17.45	17.70	17.42	17.40	17.45	17.42	17.42	17.42	
	P_2: PS100	17.50	17.30	17.25	17.35	17.25	17.20	17.21	17.22	17.29	
	P_3:KMS100	17.90	17.50	17.60	17.67	17.50	17.30	17.25	17.35	17.51	
	Mean (TM of S_4)	17.50	17.42	17.52	17.48	17.38	17.32	17.29	17.33	17.40	
Grand Mean (T, TM)		16.39	16.40	16.44	16.41	16.47	16.49	16.51	16.49		
Grand Mean (M)		16.43	16.44	16.47							
	S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$
T	0.052	0.148	TxP	0.089	NS	S	0.082	0.229	TxMxS	0.199	NS
M	0.063	NS	MxP	0.109	NS	TxS	0.115	NS	TxPxS	0.199	NS
P	0.063	0.181	TxMxP	0.155	NS	MxS	0.141	NS	MxPxS	0.245	NS
TxM	0.089	NS				PxS	0.141	NS	TxMxPxS	0.346	NS
CV%	3.25					CV%	3.64				

3.3 Total sugars
The perusal of data pertaining to effect of different treatments on total sugars of carrot juice during six months storage period has been presented in Table 3.

3.3.1 Effect of preparation techniques
Data shows that among different microwave pre-treatments grand mean total sugars (M) of microwave pre-treated carrot juice varied significantly between 13.89% and 13.98%, with maximum total sugars (13.98%) in carrot juice pre-treated with microwave for 60 seconds (M_3) and minimum (13.89%) in carrot juice pre-treated without microwave pre-treatment (M_1). The higher sugars in carrot juice which was prepared by giving crushing treatment attributed to release of more sugars upon pressing due to more disintegration of the cell structure. Wilczynski *et al*. (2019) [37] reported higher TSS in apple juice when extracted from three different apple varieties *viz*. Rubin, Mutsu and Jonaprince using screw type of juice extractor due to crushing action of fruit tissues as compared to basket press. Higher TSS generally gives indication of the higher sugars.

3.3.2 Effect of microwave pre-treatment
Further, it was observed that mean total sugars (P) of the carrot juice when preserved with different preservatives varied significantly from 13.94 to 13.98%, with maximum total sugars (13.98%) in carrot juice when preserved with 100 ppm potassium metabisulphite (P_3) and minimum total sugars (13.94%) in carrot juice when preserved with 100 ppm potassium sorbate (P_2).The differences of reducing sugars in carrot juice under different microwave pre-treatments might be due to the extraction efficacy of soluble compounds owing to variation in pre-treatment time. Gerard and Roberts (2004) [13, 3] reported that Fuji and McIntosh apple mashes heated to bulk temperatures of 60 oC by 2450 MHz microwave oven at 1500 W increased juice TSS when mash was treated before pressing. Khalil (2017) [20, 1] reported less effect of microwave treatments on reducing sugars of orange juice. The reducing sugars in orange juice reported to vary between 4.80 to

5.00%, with minimum reducing sugars in juice treated with microwave for 30 seconds and maximum reducing sugars in juice treated with microwave for 150 seconds.

3.3.3 Effect of preservatives
Further, it was observed that mean total sugars (P) of the carrot juice when preserved with different preservatives varied significantly from 13.82 to 14.13%, with minimum total sugars (13.82%) in carrot juice when preserved with 100 ppm potassium sorbate (P_2) and maximum total sugars (14.13%) in carrot juice when preserved with 100 ppm sodium benzoate (P_1). Kaur and Aggarwal (2015) [18, 1] reported that KMS treated samples found to retain the maximum TSS. Mehmood *et al*. (2008) [22] reported similar variations in reducing sugars of apple juice when preserved with different concentrations of sodium benzoate, and potassium sorbate. Zakaria *et al*. (2017) [40, 1] reported similar variations in reducing sugars of black mulberry juice when preserved with different preservatives combination like potassium metabisulphite, citric acid, potassium sorbate and sodium benzoate.

3.3.4 Effect of storage
Storage of the carrot juice for six months resulted significant increase in total sugars (S) from initial value of 12.54 to 15. 45%. The increase in total sugars during storage might be due to hydrolysis of polysaccharides into simple soluble sugars. Similar observation were reported by Vijayanand *et al.* (2010) [35] for litchi juice, Sharma *et al.* (2012) [32] for various fruits, Sherpa *et al*. (2014) [33] for plum and Arsad *et al.* (2015) [5] for sugar palm fruit juice. Similar increases in total sugars were earlier reported by Prasad (2015) [25] for water melon nectar.

Table 3: Effect of preparation techniques, microwave pre-treatment and preservatives on the total sugars (%) of carrot juice during storage

Storage Intervals (S)	Preservatives (P)	Preparation techniques (T)									
		T_1: Shredding				T_2: Crushing				Grand Mean (S, PS)	Grand Mean (P)
		Microwave pre-treatment (M)				Microwave pre-treatment (M)					
		M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)	M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)		
S_1: Initial	P_1: SB100	12.50	12.54	12.58	12.54	12.56	12.57	12.58	12.57	12.56	13.89
	P_2: PS100	12.44	12.51	12.55	12.50	12.54	12.56	12.62	12.57	12.54	13.94
	P_3:KMS100	12.48	12.50	12.55	12.51	12.50	12.55	12.63	12.56	12.54	13.98
	Mean (TM of S_1)	12.47	12.52	12.56	12.52	12.53	12.56	12.61	12.57	12.54	
S_2:2 Months	P_1: SB100	13.35	13.42	13.46	13.41	13.40	13.46	13.49	13.45	13.43	
	P_2: PS100	13.33	13.38	13.43	13.38	13.38	13.45	13.50	13.44	13.41	
	P_3:KMS100	13.35	13.40	13.44	13.40	13.39	13.44	13.48	13.44	13.42	
	Mean (TM of S_2)	13.34	13.40	13.44	13.40	13.39	13.45	13.49	13.44	13.42	
S_3:4 months	P_1: SB100	14.13	14.20	14.24	14.19	13.85	13.88	13.93	13.89	14.04	
	P_2: PS100	14.10	14.15	14.25	14.17	14.72	14.78	14.81	14.77	14.47	
	P_3:KMS100	14.12	14.15	14.23	14.17	14.70	14.77	14.82	14.76	14.47	
	Mean (TM of S_3)	14.12	14.17	14.24	14.17	14.42	14.48	14.52	14.47	14.32	
S_4:6 months	P_1: SB100	15.49	15.52	15.55	15.52	15.54	15.55	15.56	15.55	15.54	
	P_2: PS100	15.25	15.31	15.35	15.30	15.35	15.36	15.37	15.36	15.33	
	P_3:KMS100	15.55	15.48	15.52	15.52	15.44	15.45	15.54	15.48	15.50	
	Mean (TM of S_4)	15.43	15.44	15.47	15.45	15.44	15.45	15.49	15.46	15.45	
Grand Mean (T, TM)		13.84	13.88	13.93	13.88	13.95	13.99	14.03	13.99		
Grand Mean (M)		13.89	13.93	13.98							
	S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$
T	0.033	0.096	TxP	0.058	0.166	S	0.054	0.151	TxMxS	0.013	NS
M	0.041	0.118	MxP	0.071	NS	TxS	0.076	0.214	TxPxS	0.132	0.371
P	0.041	0.118	TxMxP	0.100	NS	MxS	0.094	NS	MxPxS	0.162	NS
TxM	0.058	NS				PxS	0.094	0.263	TxMxPxS	0.229	NS
CV%	2.50					CV%	2.85				

3.4 Acidity
The perusal of data pertaining to effect of different treatments on acidity of carrot juice during six months storage period has been presented in Table 3.

3.4.1 Effect of preparation techniques
Among different preparation techniques, the acidity of carrot juice varied significantly between 0.194% and 0.205%, with maximum acidity in carrot juice (0.205%) which was prepared by giving crushing treatment (T_2) and minimum acidity (0.194%) in shredding (T_1). The maximum acidity in carrot juice which was prepared by giving crushing treatment attributed to release of more acid content upon pressing. Wilczynski *et al*. (2019) [37, 1] reported lower pH (3.45, 3.62 and 3.73) which indicate higher acidity in apple juice when extracted from three different apple varieties *viz*. Rubin, Mutsu and Jonaprince using screw type of juice extractor due to crushing action of fruit tissues as compared to basket press (3.61, 3.72 and 3.81); respectively. A probable reason for the higher acidity of the juices from the screw press was increased migration of microelements, organic acids, and secondary plant metabolites such as polyphenols caused by the greater disintegration of membranes and cell walls.

3.4.2 Effect of microwave pre-treatment
Data shows that among different microwave pre-treatments grand mean acidity (M) of microwave pre-treated carrot juice varied significantly between 0.185% and 0.2013%, with maximum acidity (0.213%) in carrot juice pre-treated with microwave for 60 seconds (M_3) and minimum (0.185%) in carrot juice pre-treated without microwave pre-treatment (M_1). The higher acidity in carrot juice which was given microwave pre-treatment might be attributed to release of more organics acids and transfer of ions to the carrot juice. Rayman and Baysal (2011) [28, 2] also reported increase in acidity of juice due to applications of the microwave

treatment from 0.83 to 0.95% and even higher acidity (1.09%) due to electroplasmolysis and microwave heating. Gerard and Roberts (2004) [13, 3] reported that Fuji and McIntosh apple mashes heated to bulk temperatures of 60 oC by 2450 MHz microwave oven at 1500 W increased juice avidity when mash was treated before pressing. Khalil (2017) [20, 3] reported less effect of microwave treatments on pH of orange juice. The pH in orange juice reported to vary between 2.92 to 2.94%, with minimum pH in juice treated with microwave for 30 seconds and maximum pH in juice treated with microwave for 120 and 150 seconds. However, maximum changes during storage were observed in samples treated for less time of 30 seconds. Sharma *et al.* (2009) [31] reported variation in acidity of carrot juice from 0.17 to 0.28% when carrots were subjected to pre-treatments (temperature, time and pH) prior to extraction process. They used temperature variables from 61.50 to 98.50 °C with time variation from 124.55 to 595.45 s and pH variation from 2.31 to 6.6. The best retention of acidity was observed at optimum input variables of 75.26 °C (temperature), 349.89 s (time) and 3.2 (pH). Variation in acidity of the apple juice was also observed with the application microwave treatment earlier by Canumir *et al.* (2002) [7, 2]. Increase in acidity due to application of microwave treatment compared to fresh juice was observed in pomelo juice earlier by Kumar *et al*. (2017) [21, 3].

3.4.3 Effect of preservatives

Further, it was observed that mean acidity% of the carrot juice when preserved with different preservatives (P) varied significantly from 0.195 to 0.205%, with maximum acidity (0.205%) in carrot juice when preserved with 100 ppm potassium sorbate (P_2) and minimum acidity (0.195%) in carrot juice when preserved with 100 ppm sodium benzoate (P_1). Sangani (2021) [30] reported higher acidity in prebiotic carambola guava nectar which were prepared and preserved by using different concentrations of potassium sorbate as compared to KMS. Kaur and Aggarwal (2015) [18.3] reported that KMS treated samples observed variation in acidity of carrot juice from 0.062 to 0.087%. Akinola *et al.* (2018) [3.3] reported similar variations in acidity of orange juice when preserved with different preservatives using 0.03% of sodium benzoate, sodium metabisulphite, potassium sorbate and their combination. Higher acidity was reported when juice was preserved with the combination treatment of sodium benzoate, sodium metabisulphite, potassium sorbate. Mehmood *et al.* (2008) [22, 3] reported similar variations in acidity of apple juice when preserved with different concentrations of sodium benzoate, and potassium sorbate. Zakaria *et al.* (2017) [40, 4] reported similar variations in acidity of black mulberry juice when preserved with different preservatives combination like potassium metabisulphite, citric acid, potassium sorbate and sodium benzoate.

3.4.4 Effect of storage

Storage of the carrot juice for six months resulted significant increase in acidity (S) from initial value of 0.225 to 0.173%. Raymanand Baysal (2011) [28, 4] reported decrease in acidity during storage period of 4 months from 0.95 to 0.67% in carrot juice of variety Nantaise when treated with microwaves. However, Demir *et al.* (2004) and (2007) [10&11] observed increase in acidity of carrot juice during storage. Yu and Rupasinghe (2012) [39] conducted an experiment to study the effect of acidification on acidity of carrot juice. They compared the effects of different acidification methods for processing carrot juice: blanching of carrot with 20 and 40 g L^{-1} of citric acid, 20 and 40 g L^{-1} of lactic acid and blending carrot juice with cranberry juice in 80:20 and 70:30 ratio. They reported that titratable acidity values were much more stable for all acidified juices than for water-blanched juice and titratable acidity increased during storage.

Table 4: Effect of preparation techniques, microwave pre-treatment and preservatives on the acidity (%) of carrot juice during storage

Storage Intervals (S)	Preservatives (P)	Preparation techniques (T)									
		T_1: Shredding				T_2: Crushing				Grand Mean (S, PS)	Grand Mean (P)
		Microwave pre-treatment (M)				Microwave pre-treatment (M)					
		M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)	M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)		
S_1: Initial	$P_{1: SB100}$	0.210	0.220	0.230	0.220	0.220	0.230	0.240	0.230	0.225	0.195
	$P_{2: PS100}$	0.210	0.220	0.230	0.220	0.220	0.230	0.240	0.230	0.225	0.205
	$P_{3:KMS100}$	0.210	0.220	0.230	0.220	0.220	0.230	0.240	0.230	0.225	0.198
	Mean (TM of S_1)	0.210	0.220	0.230	0.220	0.220	0.230	0.240	0.230	0.225	
S_2:2 Months	$P_{1: SB100}$	0.173	0.216	0.229	0.206	0.206	0.214	0.234	0.218	0.212	
	$P_{2: PS100}$	0.193	0.226	0.233	0.217	0.213	0.215	0.243	0.224	0.221	
	$P_{3:KMS100}$	0.193	0.203	0.213	0.203	0.203	0.214	0.224	0.214	0.208	
	Mean (TM of S_2)	0.186	0.215	0.225	0.209	0.207	0.214	0.234	0.218	0.214	
S_3:4 months	$P_{1: SB100}$	0.138	0.181	0.194	0.171	0.171	0.179	0.199	0.183	0.177	
	$P_{2: PS100}$	0.158	0.191	0.208	0.186	0.188	0.200	0.208	0.199	0.192	
	$P_{3:KMS100}$	0.168	0.194	0.204	0.189	0.188	0.182	0.193	0.188	0.188	
	Mean (TM of S_3)	0.155	0.189	0.202	0.182	0.182	0.187	0.200	0.190	0.186	
S_4:6 months	$P_{1: SB100}$	0.137	0.164	0.172	0.158	0.164	0.172	0.192	0.176	0.167	
	$P_{2: PS100}$	0.152	0.179	0.189	0.173	0.178	0.187	0.201	0.189	0.181	
	$P_{3:KMS100}$	0.136	0.171	0.181	0.163	0.171	0.175	0.186	0.177	0.170	
	Mean (TM of S_4)	0.142	0.171	0.181	0.165	0.171	0.178	0.193	0.181	0.173	
Grand Mean (T, TM)		0.173	0.199	0.209	0.194	0.195	0.202	0.217	0.205		
Grand Mean (M)		0.184	0.201	0.213							
	S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$
T	0.001	0.002	TxP	0.001	0.003	S	0.001	0.003	TxMxS	0.003	0.007
M	0.001	0.002	MxP	0.001	0.004	TxS	0.001	0.004	TxPxS	0.003	0.007
P	0.001	0.002	TxMxP	0.002	0.006	MxS	0.002	0.005	MxPxS	0.003	0.008
TxM	0.0011	0.003				PxS	0.002	0.005	TxMxPxS	0.005	0.012
CV%	3.75					CV%	3.70				

3.5 β-carotene

The perusal of data pertaining to effect of different treatments on beta carotene of carrot juice during six months storage period has been presented in Table 5.

3.5.1 Effect of preparation techniques

Among different preparation techniques, the beta carotene of carrot juice varied significantly between 21.57 and 24.98 mg/100g, with maximum beta carotene in carrot juice (24.98 mg/100g) which was prepared by giving crushing treatment (T_2) and minimum beta carotene (21.57 mg/100g) in shredding (T_1). The higher beta carotene in carrot juice which was prepared by giving crushing treatment attributed to release of more beta carotene upon pressing due to more disintegration of the cell structure. Wilczynski *et al*. (2019) [37.4] reported higher phenolics and anti-oxidant capacity in apple juice when extracted from three different apple varieties *viz*. Rubin, Mutsu and Jonaprince using screw type of juice extractor as compared to basket press. The juices from the screw press were statistically significantly richer in polyphenols than the juices from the basket press. The higher content of polyphenols in the juice from the screw press was related to the higher percentage of solid particles and probably better grinding of apple tissue, especially skin. Heinmaa *et al*. (2017) [14] reported that antioxidant capacity was highest in juices extracted on water press, followed by those extracted on belt press and rack-and-frame press. Their results also showed that the degrees of correlation between individual polyphenols and antioxidant activity were different. Variations in beta-carotene, phenolics and ascorbic acid contents of juice of pineapple, carrot, red dragon fruit and white dragon fruits were reported due to extraction methods by Khaksar *et al*. (2019) [19]. Sharma *et al.* (2009) [31.2] conducted an experiment to study the effect of pre-treatment conditions on beta carotene of carrot juice. Carrot juice obtained by hydraulic press with wooden set-up was subjected to pre-treatments (temperature, time and pH) prior to extraction process. They used temperature variables from 61.50 to 98.50 °C with time variation from 124.55 to 595.45 s and pH variation from 2.31 to 6.6. They reported variation in beta-carotene in the range of 3750 to 7250 (µg/100 g) and stated that significant increase in extraction upto (52.9%) with these pre-treatments in comparison to control samples. The best retention (83.8%) of beta carotene was observed at optimum input variables of 75.26 °C (temperature), 349.89 s (time) and 3.2 (pH).

3.5.2 Effect of microwave pre-treatment

Data shows that among different microwave pre-treatments grand mean beta carotene (M) of microwave pre-treated carrot juice varied significantly between 21.82 and 24.81mg/100g, with maximum beta carotene (24.81 mg/100g) in carrot juice pre-treated with microwave for 60 seconds (M_3) and minimum (21.82 mg/100g) in carrot juice without microwave pre-treatment (M_1). Rayman and Baysal (2011) [28, 5] also reported increase in beta carotene contents of juice from 253.38 to 444.46 mg/l due to applications of the electrical methods (electroplasmolysis + microwave). Similar observations were reported earlier by Sandik (1983) and Okilov (1995) [29, 2] for apple and grape juice. Zang and Zang (2014) [41] reported increase in total flavonoids and polyphenols of apple juices when raw materials were treated with different microwave powers for different times. The exposure time of 75 seconds resulted 115% increase in total flavonoids and polyphenols of apple juices as compared to control samples. Gerard and Roberts (2004) [13, 4] reported that Fuji and McIntosh apple mashes heated to bulk temperatures of 60 oC by 2450 MHz microwave oven at 1500 W increased juice phenolics and flavonoids when mash was treated before pressing. Elik *et al.* (2020) [12] reported higher carotenoids extraction from carrot juice processing waste by application of microwave treatment using flaxseed oil as solvent.

3.5.3 Effect of preservatives

Further, it was observed that mean beta carotene (P) of the carrot juice when preserved with different preservatives varied significantly from 23.01 to 23.48 mg/100g, with maximum beta carotene (23.48 mg/100g) in carrot juice when preserved with 100 ppm potassium sorbate (P_2) and minimum beta carotene (23.01 mg/100g) in carrot juice when preserved with 100 ppm sodium benzoate (P_1).

3.5.4 Effect of storage

Storage of the carrot juice for six months resulted significant decrease in beta carotene (S) from initial value of 25.80 to 19.93 mg/100g. Yu and Rupasinghe (2012) [39, 3] reported variation in beta-carotene content in the range of 14.77 to 55.49 and after 21 days 13.04 to 26.26 (mg L^{-1}) at 4˚C. They further stated highest beta-carotene value 40 g L^{-1} in blanched juice acidified with lactic acid. Amanyunose *et al.* (2017) [4] reported lowest vitamin A value 3150.10 µg/100g at 4 ºC in the fifth day while the highest value 520.20 µg/100 recorded in treated samples. The vitamin A content of the juice decreased after the five days of storage for the samples stored 4 and 27±2 ˚C. The values for the carrot juices were higher after preparation but reduced greatly during storage. Ahmad (2017) [2] significant decrease in carotenoids content of mango nectar during storage from 0.350mg/100g to 0.395mg/100g.

Table 5: Effect of preparation techniques, microwave pre-treatment and preservatives on the β-carotene (mg/100g) of carrot juice during storage

Storage Intervals (S)	Preservatives (P)	Preparation techniques (T)									
		T_1: Shredding				T_2: Crushing				Grand Mean (S, PS)	Grand Mean (P)
		Microwave pre-treatment (M)				Microwave pre-treatment (M)					
		M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)	M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)		
S_1: Initial	P_1: SB100	24.12	24.40	24.50	24.34	26.84	27.45	27.50	27.26	25.80	23.01
	P_2: PS100	24.15	24.35	24.45	24.32	26.75	27.35	27.65	27.25	25.78	23.48
	P_3:KMS100	24.30	24.40	24.60	24.43	26.95	27.15	27.50	27.20	25.82	23.33
	Mean (TM of S_1)	24.19	24.38	24.52	24.36	26.85	27.32	27.55	27.24	25.80	
S_2:2 Months	P_1: SB100	21.84	22.54	23.15	22.51	25.34	26.04	26.25	25.88	24.19	
	P_2: PS100	20.65	22.89	24.12	22.55	24.15	26.89	27.15	26.06	24.31	
	P_3:KMS100	21.91	23.13	23.23	22.76	25.41	26.23	26.33	25.99	24.37	
	Mean (TM of S_2)	21.47	22.85	23.50	22.61	24.97	26.39	26.58	25.98	24.29	
S_3:4 months	P_1: SB100	19.29	19.99	23.59	20.96	22.79	23.49	27.09	24.46	22.71	

	$P_{2:}$ PS100	18.10	20.34	24.36	20.93	21.60	27.34	27.90	25.61	23.27	
	$P_{3:}$KMS100	19.36	21.14	24.68	21.73	22.86	24.68	26.78	24.77	23.25	
	Mean (TM of S_3)	18.92	20.49	24.21	21.21	22.42	25.17	27.26	24.95	23.08	
S_4:6 months	$P_{1:}$ SB100	15.93	16.63	20.23	17.60	19.43	20.13	23.73	21.10	19.35	
	$P_{2:}$ PS100	16.74	16.98	21.44	18.39	19.64	23.98	24.54	22.72	20.55	
	$P_{3:}$KMS100	16.00	17.78	21.32	18.37	19.50	21.32	23.42	21.41	19.89	
	Mean (TM of S_4)	16.22	17.13	21.00	18.12	19.52	21.81	23.90	21.74	19.93	
Grand Mean (T, TM)		20.20	21.21	23.31	21.57	23.44	25.17	26.32	24.98		
Grand Mean (M)		21.82	23.19	24.81							
	S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$
T	0.102	0.292	TxP	0.176	0.506	S	0.133	0.372	TxMxS	0.325	0.910
M	0.125	0.358	MxP	0.216	0.619	TxS	0.188	0.526	TxPxS	0.325	NS
P	0.125	0.358	TxMxP	0.305	0.856	MxS	0.230	0.644	MxPxS	0.398	1.115
TxM	0.176	0.506		0.176	0.506	PxS	0.230	0.644	TxMxPxS	0.563	NS
CV%	4.54					CV%	4.19				

3.6 Non-enzymatic browning (NEB)

The perusal of data pertaining to effect of different treatments on NEB of carrot juice during six months storage period have been presented in Table 6.

3.6.1 Effect of preparation techniques

Among different preparation techniques, the NEB of carrot juice varied significantly between 0.016 and 0.017 OD_{440nm}, with minimum NEB (0.016 OD_{440nm}) in carrot juice which was prepared by giving crushing treatment (T_2) and maximum NEB (0.017 OD_{440nm}) in shredding treatment (T_1). The lower NEB in carrot juice which was prepared by giving crushing treatment attributed to release of more anti-oxidants upon pressing because anti-oxidants in juices are responsible to influence the colour as reported earlier by Heinmma *et al.* (2017) [14, 3]. Wilczynski *et al.* (2019) [37, 5] reported higher anti-oxidant capacity in apple juice when extracted from three different apple varieties *viz.* Rubin, Mutsu and Jonaprince using screw type of juice extractor as compared to basket press.

3.6.2 Effect of microwave pre-treatment

Data shows that among different microwave pre-treatments grand mean NEB (M) of microwave pre-treated carrot juice varied significantly between 0.014 and 0.021 OD_{440nm}, with minimum NEB (0.014 OD_{440nm}) in carrot juice pre-treated with microwave for 60 seconds (M_3) and maximum NEB (0.021 OD_{440nm}) in carrot juice without microwave pre-treatment (M_1). The lower NEB in carrot juice which was prepared by giving microwave pre-treatment attributed to release of more anti-oxidants during juice extraction because anti-oxidants in juices are responsible to influence the colour as reported earlier by Heinmma *et al.* (2017) [14, 4]. Rayman and Baysal (2011) [28, 6] also reported increase in beta carotene contents and anti-oxidant activity of juice due to applications of the electrical methods (electroplasmolysis + microwave). The lower NEB in carrot juice which was given microwave pre-treatment might also be attributed to higher ΔE value of carrot juice based on L, a and b values. Rayman and Baysal (2011) [28, 7] reported higher ΔE value of carrot juice due to applications of the microwave (ΔE 10.63) heating as compared to thermal treatment (ΔE 10.30). A higher value of ΔE depicts less colour change during processing. In contrast to this, browning index of the orange juice increased with increase in the time of microwave exposure which was attributed to degradation of the higher ascorbic acid with higher exposure time.

3.6.3 Effect of preservatives

Further, it was observed that mean NEB (P) of the carrot juice when preserved with different preservatives varied significantly from 0.014 and 0.020 OD_{440nm}, with minimum NEB (0.014 OD_{440nm}) in carrot juice when preserved with 100 ppm potassium sorbate (P_2) and maximum NEB (0.020 OD_{440nm}) in carrot juice when preserved with 100 ppm sodium benzoate (P_1). Sangani (2021) [30, 3] reported variations in NEB of nectar prepared by adding different KMS and potassium sorbate concentrations.

3.6.4 Effect of storage

Storage of the carrot juice for six months resulted significant increase in NEB (S) from initial value of 0.011 to 0.022 OD_{440nm}. The increase in the NEB during storage might be attributed to degradation of the ascorbic acid. Ibarz *et al.* (1990) [15] reported that the ascorbic acid degradation is one of the vital browning colour production in fruits juices. Even Maillard reaction are responsible for the increase in the NEB of the juices during storage. Wang *et al.* (2006) [36] conducted the experiment to study the Effect of storage temperature, storage time and total soluble solid (TSS) on the browning degree (BD) in carrot juice concentrate (CJC) stored at −18, 0, 25 and 37 ˚C. Finally, they reported that higher temperature at 25 and 37 ˚C had a significant effect on BD, while lower temperature at 0 and−18 ˚C had less effect, and the storage time and the soluble solid of CJC stored at 25 and 37 ˚C also had a significant effect on BD. Sangani (2021) [30, 4] reported increased in mean NEB during six months from initial value of 0.058 OD_{440nm} to 0.214 OD_{440nm} in carambola-guava blended nectar. Similar results increase in NEB were observes by Jangir *et al.* (2017) [17] for mango pulp and Yadav *et al.* (2017) [38] for guava pulp.

Table 6: Effect of preparation techniques, microwave pre-treatment and preservatives on the NEB ($OD_{440\ nm}$) of carrot juice during storage

Storage Intervals (S)	Preservatives (P)	Preparation techniques (T)									
		T_1: Shredding				T_2: Crushing				Grand Mean (S, PS)	Grand Mean (P)
		Microwave pre-treatment (M)				Microwave pre-treatment (M)					
		M_1:control	$M_{2:}$ 30 S	$M_{3:}$ 60 S	Mean (TS, TPS)	M_1:control	$M_{2:}$ 30 S	$M_{3:}$ 60 S	Mean (TS, TPS)		
S_1: Initial	$P_{1:}$ SB100	0.012	0.011	0.010	0.011	0.021	0.005	0.011	0.012	0.012	0.020

	$P_{2: PS100}$	0.008	0.003	0.002	0.004	0.012	0.011	0.010	0.011	0.008	0.014
	$P_{3:KMS100}$	0.022	0.019	0.011	0.017	0.006	0.009	0.013	0.009	0.013	0.016
	Mean (TM of S_1)	0.014	0.011	0.008	0.011	0.013	0.008	0.011	0.011	0.011	
S_2:2 Months	$P_{1: SB100}$	0.028	0.015	0.021	0.021	0.024	0.019	0.013	0.019	0.020	
	$P_{2: PS100}$	0.020	0.007	0.004	0.010	0.015	0.018	0.011	0.015	0.012	
	$P_{3:KMS100}$	0.022	0.016	0.014	0.017	0.009	0.019	0.019	0.016	0.016	
	Mean (TM of S_2)	0.023	0.013	0.013	0.016	0.016	0.019	0.014	0.016	0.016	
S_3:4 months	$P_{1: SB100}$	0.031	0.018	0.023	0.024	0.028	0.021	0.016	0.022	0.023	
	$P_{2: PS100}$	0.023	0.008	0.014	0.015	0.017	0.021	0.010	0.016	0.016	
	$P_{3:KMS100}$	0.023	0.024	0.015	0.021	0.012	0.015	0.011	0.013	0.017	
	Mean (TM of S_3)	0.026	0.017	0.017	0.020	0.019	0.019	0.012	0.017	0.018	
S_4:6 months	$P_{1: SB100}$	0.034	0.023	0.022	0.026	0.035	0.019	0.021	0.025	0.026	
	$P_{2: PS100}$	0.031	0.012	0.011	0.018	0.024	0.021	0.020	0.022	0.020	
	$P_{3:KMS100}$	0.025	0.018	0.017	0.020	0.014	0.019	0.024	0.019	0.020	
	Mean (TM of S_4)	0.030	0.018	0.017	0.021	0.024	0.020	0.022	0.022	0.022	
Grand Mean (T, TM)		0.023	0.014	0.014	0.017	0.018	0.016	0.015	0.016		
Grand Mean (M)		0.021	0.015	0.014							
	S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$		S.Em. ±	$CD_{0.05}$
T	0.0002	0.0006	TxP	0.0003	0.0009	S	0.0001	0.0003	TxMxS	0.0003	0.0008
M	0.0002	0.0006	MxP	0.0004	0.0011	TxS	0.0002	0.0006	TxPxS	0.0003	0.0008
P	0.0002	0.0006	TxMxP	0.0006	0.0017	MxS	0.0002	0.0006	MxPxS	0.0003	0.0008
TxM	0.0003	0.0009				PxS	0.0002	0.0006	TxMxPxS	0.0005	0.0014
CV%	4.85					CV%	4.78				

3.7 Total plate count

The perusal of data pertaining to total plate count of carrot juice prepared using different microwave pre-treatment with different preservatives were free from microbial contamination upto two months storage and detected negligible TPC (CFU/ml) during six months of storage. Thus, all juice samples were safe for consumption during six months storage (Table 7). Thus, juice samples were safe for consumption upto six months storage when juice was prepared by pretreating the crushed materials with microwave for 60 seconds followed by preservation with 100 ppm potassium sorbate ($T_2M_3P_2S_4$) having minimum TPC (CFU/ml). Similar observations were recorded by Yadav *et al.* (2017) [39, 2] for guava pulp and Akinola *et al.* (2018) [3, 4] for orange juice and Sangani (2021) [30, 5] for carambola-guava blended nectar.

Table 7: Effect of preparation techniques, microwave pre-treatment and preservatives on the total plate count (x 10^2cfu/g) of carrot juice during storage

Storage Intervals(S)	Preservatives (P)	Preparation techniques (T)							
		T_1: Shredding				T_2: Crushing			
		Microwave pre-treatment (M)				Microwave pre-treatment (M)			
		M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)	M_1:control	M_2: 30 S	M_3: 60 S	Mean (TS, TPS)
S_1: Initial	$P_{1: SB100}$	-	-	-	-	-	-	-	-
	$P_{2: PS100}$	-	-	-	-	-	-	-	-
	$P_{3:KMS100}$	-	-	-	-	-	-	-	-
	Mean (T, M of S_1)	-	-	-	-	-	-	-	-
S_2:2 Months	$P_{1: SB100}$	-	-	-	-	-	-	-	-
	$P_{2: PS100}$	-	-	-	-	-	-	-	-
	$P_{3:KMS100}$	-	-	-	-	-	-	-	-
	Mean (T, M of S_2)	-	-	-	-	-	-	-	-
S_3:4 months	$P_{1: SB100}$	-	-	-	-	-	-	-	-
	$P_{2: PS100}$	-	-	-	-	-	-	-	-
	$P_{3:KMS100}$	-	-	-	-	-	-	-	-
	Mean (T, M of S_3)	-	-	-	-	-	-	-	-
S_4:6 months	$P_{1: SB100}$	0.90	0.55	0.23	0.56	0.82	0.54	0.18	0.51
	$P_{2: PS100}$	0.70	0.48	0.15	0.44	0.70	0.46	0.12	0.43
	$P_{3:KMS100}$	0.80	0.52	0.21	0.51	0.75	0.50	0.20	0.48
	Mean (T, M of S_4)	0.80	0.52	0.20		0.76	0.50	0.17	

4. Conclusions

Overall, from the findings of investigation it can be concluded that single strength carrot juice can be extracted by pre-treating the crushed materials with microwave for 60 seconds followed by pressing and preservation with 100 ppm potassium sorbate followed by processing at 96 ºC for 30 min by maintaining 0.20% acidity and 15.0 ºBrix TSS. The prepared juice can successfully be stored for six months in glass bottles with minimum changes in chemical and microbial quality. Thus, the developed technologies can commercially be explored by food processing industry for the production of carrot juice. Therefore, profitable utilization of carrot grown in India and Afghanistan by processing can ensure better returns to the growers, processors and consumers.

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