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Development of intermediate moisture product from carrot pulp

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Abstract

Carrots (var. Nantes) were used to develop intermediate moisture product from carrot pulp in the moisture range 15-50%. Intermediate moisture product from carrot pulp was prepared using sugar (20, 30, 40 and 50%), citric acid (0.5, 0.7, 1 and 1.5%), gums viz.,pectin(0.5, 0.75 and 1%), carboxy methyl cellulose (0.1, 0.25 and 0.5%) and sodium alginate (0.1, 0.25 and 0.5%) and preservatives (potassium sorbate, potassium metabisulphite and combination). The final product for storage was prepared using sugar 40%, citric acid 1% and pectin 0.75%, standardized on the basis of sensory evaluation on nine point hedonic scale. More losses of ascorbic acid and carotenoids were found in the product packed in polyethylene as compared to laminate. Room temperature storage had a significant effect on the moisture, water activity, total sugar, reducing sugars, TSS and colour of the product. Organoleptically, it was found acceptable at room (13-35°C) and refrigerated temperature (5°C) storage of four months.

Keywords: Carrot, Pulp, Post-harvest

Introduction

Carrot (*Daucus carota* L.) is one of the most important root vegetables grown extensively in various countries particularly during winter season. The carotenoids are in the group of bioactive compounds that are believed to play a significant role for the health-promoting properties of carrots. Carotenoids are the precursor of vitamin A which is an essential component of the visual pigments in the retina and their deficiency leads to xeropthalmia and night blindness in human beings. Vitamin A is known to have anti-tumour activity (Chawla *et al* 2005). Carrots are used in the preparation of stews, soups, curries, salads and various sweet meats. They are also processed into products such as canned, dehydrated, juice, beverages, candy, preserves and pickles. Carrot juice is the only carrot product which is marketed, either stand-alone or blended with fruits and other vegetables. In a juice industry more than 50% of carrot goes waste after extraction of juice, This waste juice residue has a lot of nutrients like carbohydrates, carotenes, thiamine, riboflavin, niacin, phosphorous, fiber and other minerals. If whole of the vegetable could be used for making the product which is shelf stable and ready to use as it is or in the form of a juice or beverage after reconstitution, the problem of waste disposal will also be solved along with saving of nutrient waste. Therefore, the current study was undertaken to develop an intermediate moisture product from carrot pulp.

The principle behind the development of intermediate moisture products is that one needs not to dehydrate foods to 5-10% moisture level dictated by microorganisms stability. There will be substantial reduction in drying and reconstitution time and better retention of original flavour and texture compared to conventional hot air dried or heat processed (canned) foods if the food is dehydrated to an intermediate moisture level (Jayaraman *et al* 1974).

Materials and Methods

Fresh carrots were procured in lots from the local market at Ludhiana. Other ingredients like sugar were also purchased from the local market of Ludhiana and chemicals like fructose, glucose and pectin were procured from Chemical Corporation, Ludhiana.

Method of preparation: Carrots were washed and peeled manually with a sharp knife. Then the carrot was cut into small pieces and boiled in water for 10 minutes to enable softness of the carrot pieces for pulping. The pieces were then made into fine pulp with the help of electric grinder. The fine pulp was cooked with different concentrations of sugar (20, 30, 40 and 50%) along with different levels of acid (0.5, 0.7,1 and 1.5%). Different gums with different concentrations i.e. pectin (0.5, 0.75 and 1%), sodium alginate (0.1, 0.25 and 0.5

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Table 1. Physicochemical* characteristics of fresh carrot pulp

Parameters	Carrot pulp
Moisture(%)	90.3
TSS(°B)	5.8
Acidity (%)	0.05
Ascorbic acid(mg/100g)	2.0
Total sugars (%)	4.2
Reducing sugars (%)	1.2
Total carotenoids (mg/100g)	32.4
β-carotene(mg/100g)	10.9
Ash (%)	0.8
Pectin (%)	0.3

*mean of three readings

%) and carboxy methyl cellulose (0.1, 0.25 and 0.5 %) were added in the pulp to give it a binding effect. The pulp with sugar, gum and acid was cooked until it gets the optimum consistency. After cooking, the pulp was allowed to cool followed by even spreading on the aluminium trays and dried for 4 hours at temperature of 55°C.

The prepared product was then cut into sheets of square pieces and thickness (0.5 cm) which was maintained by double layering the product followed by packing in polyethylene (200 gauge) and laminated pouches and stored at refrigeration (5°C) and room temperature (13-35°C) for storage studies.

Physico-chemical and organoleptic analysis: Carrot pulp was analysed for its moisture, TSS, acidity, ascorbic acid, reducing and total sugars, total carotenoids and beta carotene, pH, colour, pectin, water activity and ash content as per methods described by Ranganna (1995). The samples i.e. control and with preservatives, were analyzed for organoleptically by a semi-trained panel using a 9-point Hedonic scale (Ranganna, 1995).

Statistical analysis: All the data from various parameters was analyzed for analysis of variance using factorial experiments using LSD (Least standard deviation) (Anonymous 1991).

Results and Discussion

Physico-chemical characteristics of carrot pulp: Carrot pulp was found to have moisture 90.3%, TSS 5.8°B, acidity 0.05%, ascorbic acid 2.0 mg/100g, total sugars 4.2%, reducing sugars 1.2%, total carotenoids 32.4 mg/100g, â-carotene 10.9 mg/100g, ash 0.8 % and pectin 0.3 %.

Intermediate moisture product (IMP) from carrot pulp

Effect of various levels of sugar (sucrose) on chemical and organoleptic parameters of IMP from carrot pulp: The average scores for appearance, texture, taste and overall acceptability showed an increase from sugar level of 20% to 40 % but a decrease from 40% to 50%, apparently due to more sweet taste of the product (Table 2). Gowda *et al* (1995) also used 20% sugar in the preparation of mango fruit bar.

Effect of various levels of acid on the chemical and organoleptic parameters of IMP from carrot pulp: Table 3 shows effect of various levels of citric acid (0.5, 0.7, 1 and 1.5%) on the sensory attributes of intermediate moisture carrot product from pulp. Citric acid was used to prevent crystallization of the sugar and to provide good mouth feel, optimum sugar: acid ratio and to increase the acidity of the product to have better preservation effect. The mean values for appearance, taste, texture and overall acceptability increased with increase of percent of acid from 0.5 to 1%, but showed a downfall when the acid level was increased from 1 % to 1.5%. Hence, an acid level of 1% was finalized to be used in the preparation of product for storage studies.

Effect of different concentrations of gums (pectin, CMC and Sod. alginate) on the chemical and organoleptic parameters of intermediate moisture carrot product from

Table 2: Effect of various levels of sugar (sucrose) on chemical* and organoleptic**parameters of IMP from carrot pulp

	Sugar concentrations (%)				
Parameters	20	30	40	50	LSD (0.05)
Moisture (%)	24.81	24.62	24.89	24.74	0.654
Acidity (%)	0.55	0.55	0.55	0.55	0.754
TSS(°B)	33.30	50	66.5	83	0.600
Organoleptic parameters					
Appearance	4.69	6.00	8.19	7.62	0.990
Texture	3.38	5.25	8.18	7.69	0.690
Taste	3.06	5.75	8.31	7.56	0.582
Overall Acceptability	3.71	5.67	8.23	7.62	0.478

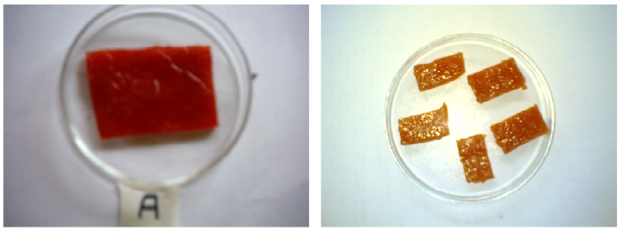
* mean of three readings
** mean of eight observations

Table 3: Effect of various levels of acid on the chemical* and organoleptic** parameters of IMP from carrot pulp

	Citric acid level (%)				
Parameters	0.5	0.7	1	1.5	LSD (0.05)
Moisture (%)	24.88	24.82	24.84	24.87	0.632
TSS (°B)	67	67	67	67	0.719
Organoleptic parameters					
Appearance	6.5	7.38	8.38	7.18	0.984
Texture	6.87	7.5	8.25	7.06	1.45
Taste	6.38	7.13	7.63	6.81	1.92
Overall acceptability	6.58	7.50	8.08	7.01	1.23

* Mean of three readings
** Mean of eight readings

pulp: Table 4 shows the effect of various levels of gums (pectin, CMC and sod. alginate) on the organoleptic acceptability of intermediate moisture carrot product from pulp. Pectin was primarily added to give a proper binding effect to the leather so that a sheet like final product is obtained. The mean values for appearance, flavor, texture and overall acceptability increased with an increase in pectin concentration (0.5 and 0.75%) but decreased slightly when the pectin level was increased from 0.75% to 1%. So, a pectin concentration of 0.75% was found to be the most acceptable (Fig 1.).



Control Pectin (0.75%)

Fig 1. Intermediate moisture product from carrot pulp

Carboxy methyl cellulose and sodium alginate were also added for the same purpose i.e. binding effect, as pectin. The mean values of appearance, flavour, texture and overall acceptability increased with an increase in CMC concentration from 0.1 to 0.25% but decreased when the concentration from 0.25 to 0.5%. So, CMC concentrations of 0.1 and 0.25% were found to be equally good and product with the minimum CMC concentration i.e. 0.1% was selected. Sodium alginate also performed the function of providing a binding effect to the product. The mean scores of appearance, flavour, texture and overall acceptability increased with a concentration of sodium alginate from 0.1 to 0.25%. With further increase in sodium alginate level from 0.25 to 0.5%, there was a slight decrease in mean values of sensory scores. So, the product with sodium alginate concentrations of 0.1 and 0.25% were found to be equally good. However, minimum concentration of sodium alginate i.e. 0.1% was finalized out of all concentrations used. Gill *et al* (2004) also prepared mango bar using sodium alginate (0, 0.5 and 1%) out of which 0.5% gum level was found to be highly acceptable.

Out of the three gum concentrations selected (pectin 0.75%, CMC 0.1% and Sod. Alginate 0.1%), the mean sensory scores were the highest for the product prepared with 0.75% pectin due to the efficient texture provided by the binding effect of the pectin gum. So, the final storage sample was prepared using 0.75% pectin with 40% sugar and 1% acid (Table 4). Aruna *et al.* (1999) kept the acidity of pulp at 0.7% with TSS at 30°Brix in the preparation of papaya fruit bar. Hemakar *et al.* (2000) blended the mango leather with 0.5% pectin to prepare mango-guava sheets.

Drying rate of intermediate moisture carrot product from pulp: During dehydration of the product, there was a loss in weight of the product with drying time. The weight loss was rapid in the first hour of drying followed by slow decrease in weight in the subsequent hours. There was 27.7% loss in weight in the 1st hour, 4.3 % loss in weight in the 2nd hour, 3% loss in weight in the 3rd hour and only 2.3 % loss in weight in the 4th hour of drying as shown in the drying curve in Fig 2.

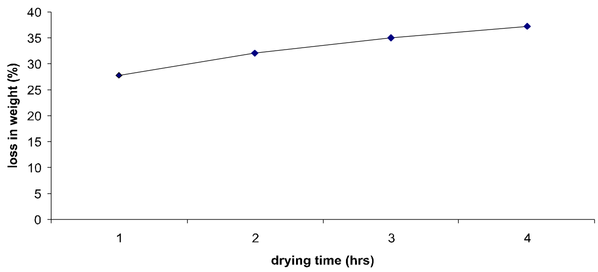


Fig 2. Drying curve for intermediate moisture product from carrot pulp.

Effect of storage on the physico-chemical parameters of intermediate moisture product

Moisture content: There was a decreasing trend in moisture content during the storage period, being relatively higher at room temperature as compared to

Table 4. Effect of different gums on the chemical* and organoleptic** parameters of intermediate moisture carrot product from pulp.

	Pectin (%)			CMC (%)			Sod. alginate (%)			
Parameters	0.5	0.75	1	0.1	0.25	0.5	0.1	0.25	0.5	LSD (0.05)
Moisture(%)	21.23	21.28	21.47	21.25	21.30	21.30	21.25	21.30	21.29	0.428
TSS(°B)	67	67	67	67	67	67	67	67	67	0.600
Acidity (%)	0.54	0.54	0.54	0.55	0.55	0.55	0.55	0.55	0.5	0.719
Organoleptic parameters										
Appearance	6.81	8.69	8.50	7.75	7.63	7.44	7.81	7.81	7.25	1.09
Texture	6.81	8.5	7.93	8.06	7.94	6.94	8.12	8.06	7.56	1.53
Flavour	7.06	8.31	8.25	7.75	7.75	7.00	8.06	7.81	7.69	1.56
Overall acceptability	6.89	8.5	8.23	7.85	7.77	7.12	7.99	7.89	7.50	1.53

* Mean of three readings ** Mean of eight readings

refrigeration. The decrease in moisture seemed due to the natural dehydration of the product during storage. The average per cent moisture loss was observed to be 19.36 and 18.57 at room temperature and refrigerated temperature respectively for all the samples. Also, the loss of moisture was non-significantly (P=0.05) different in the different packaging materials used i.e polythene and laminated pouches (200 gauge) at different temperatures (Table 5). Roy *et al* (1980) reported a decrease in moisture content of mango sheets during the storage period of 3 months. Gowda *et al* (1995) also observed a decreasing trend in moisture content during the storage of mango fruit bar.

Water activity: Decreasing trend in water activity of the samples of intermediate moisture product was observed (table 5) with more decrease at room temperature than at refrigeration temperature. This decline in the water activity values were apparently due to the loss of moisture due to the dehydration of the product at high temperature(37°C) conditions at room temperature. However, there was a non-significant affect (P=0.05) of the preservatives on the water activity of the samples. Slight significant change was found in the different packaging materials, with slightly more loss in polyethylene as compared to laminated bags.

Total soluble solids (TSS): Increasing trend with storage was noticed in total soluble solids of sample.The increase was 4.5 and 3.75% at room and refrigeration for both polyethylene pouches and laminated pouches. This increase seemed to be the result of moisture loss resulting in concentration effect on the product during storage period. The rate of increase (3.76%) was less at refrigeration temperature (4.50%) as compared to room temperature. The storage time and packaging material had a non-significant (P=0.05) effect on the total soluble solids of the intermediate moisture product from pulp (Table 6). Kumar and Manimegalai (2002) observed an increase in TSS of fruit bar from sapota during the storage of 6 months.

Ascorbic acid: The residual ascorbic acid showed a decreasing trend in all the samples. Slight significant change was found due to the effect of temperature, storage, packaging material. The decrease in ascorbic acid content was found to be lesser in laminate pouches (62.25%) as compared to the polyethylene pouches (63.2%) mainly due to the absence of penetration of light in laminate pouches (Table 6). Sharma et al (2000) reported a decrease in the ascorbic acid content of osmo-air dehydrated apricot fruits during storage of six months. Krishanaveni *et al* (1999) reported a decrease in ascorbic acid content during storage in sapota fruit bar and jackfruit bar respectively.

Acidity: A decreasing trend was observed in the acidity values for all the samples. This decrease in acidity was in conformity with Mir and Nath (1993).The decrease in acid content was 31.48% and 25.92% at room and refrigerated temperature in polyethylene pouches whereas it was 31.48% and 24.07% for room and referigerated pouches in laminated pouches. There was a non-significant (P=0.05) effect of preservatives on the acid content of the product. The continuous decrease in acidity values was apparently due to the reaction of acids with basic minerals in the product or due to the loss of ascorbic acid. There was a significant (P=0.05) effect of storage but packaging material and temperature had no effect on the samples (Table 7). A slight decrease

Table 5. Effect of storage and packaging on the moisture(%) and water activity ofthe IMP from carrot pulp.

		Moisture (%)				Water activity			
Sample	Storage time, months	Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	21.15	21.15	21.15	21.15	0.851	0.852	0.852	0.852
	1	19.55	20.45	20.52	20.67	0.823	0.825	0.825	0.825
	2	18.75	19.22	19.45	19.89	0.781	0.782	0.782	0.782
	3	17.43	18.54	18.87	18.90	0.677	0.678	0.678	0.678
	4	16.88	17.21	17.23	17.55	0.667	0.668	0.669	0.669
LSD (0.05)		0.857	0.857	0.857	0.857	0.165	0.165	0.165	0.165

Table 6. Effect of storage and packaging on the TSS(°B) and ascorbic acid(mg/100g) content of the IMP from carrot pulp.

		TSS(°B)				Ascorbic acid(mg/100g)			
Sample	Storage time, months	Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	66.5	66.5	66.5	66.5	2.04	2.04	2.04	2.04
	1	67.5	67.0	67.5	67.0	1.97	1.97	1.97	1.98
	2	68.0	67.5	68.0	67.5	0.91	0.92	0.91	0.92
	3	69.0	68.0	69.0	68.0	0.88	0.89	0.89	0.89
	4	69.5	69.0	69.5	69.0	0.75	0.77	0.77	0.77
LSD(0.05)		0.544	0.544	0.544	0.544	0.610	0.610	0.610	0.610

Table 7. Effect of storage and packaging on the acidity (%) and pH of the IMP from carrot pulp.

		Acidity (%)				pH			
Sample	Storage time, months	Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	0.54	0.54	0.54	0.54	3.02	3.02	3.02	3.02
	1	0.49	0.50	0.49	0.50	3.09	3.07	3.10	3.07
	2	0.45	0.48	0.45	0.49	3.15	3.11	3.15	3.11
	3	0.40	0.45	0.40	0.46	3.25	3.24	3.40	3.19
	4	0.37	0.40	0.37	0.41	4.12	4.09	4.11	4.10
LSD(0.05)		0.610	0.610	0.610	0.610	0.445	0.445	0.445	0.445

in acidity was reported by Hemakar *et al* (2000) in mango guava sheet.

pH: The pH values of the product showed an increase during the storage period of 4 months as shown in Table 7. The increase in pH values were 3.03 to 4.12 (room) and 3.02 to 4.09 (refrigeration) in polyethylene pouches wheras it was 3.02 to 4.11 (room) and 3.02 to 4.10 (refrigeration) in laminate pouches. This is mainly attributed to the continuous decrease in acidity of the product during the storage period. The packaging materials, temperatures and storage period had non-significant (P<0.05) effect on the values of pH of four samples of intermediate moisture carrot product from pulp.

Ash: Non-significant change (P<0.05) was found in ash content between the two temperatures as well as among the different samples along with the two packaging materials during the storage of the product (Table 8). Aruna *et al* (1999) also reported no change in total ash during storage of papaya fruit bar.

Pectin: Pectin content showed a non-significant cahnge during the storage period of the product which may be due to the conversion of protopectin into pectinic acid, pectic acid and further to D-galatuyonic acid (Kapoor *et al* 1983). There was a non-significant change (P=0.05) with respect to the effect of packaging materials and different storage temperatures on the change in the pectin content of the intermediate moisture product from pulp (Table 8). Aruna *et al* (2000) reported a non-significant decrease in pectin content of papaya leather during storage of nine months.

Sugars: There was a significant (P=0.05) increase in both the total and reducing sugars of with increasing storage period of all the samples at all temperatures and packaging materials (Table 9). The per cent increase in total sugars was found to be 18.94 and 19.21 at room and refrigeration temperature respectively, in polyethylene pouches whereas, in laminated pouches the increase in total sugars at room and refrigeration temperature was 20.63 and 20.77 respectively. Similarly, the per cent increase in reducing sugars at room and refrigeration temperature were found to be 17.74 and 16.88 (polyethylene) and 15.88 and 14.86 (laminate). The increase was found to be higher at room temperature than at refrigeration temperature. The different packaging materials i.e. polyethylene and laminate pouches also had a non-significant (P=0.05) effect on the total as well as reducing sugars of the intermediate moisture product from carrot pulp during the storage period. The

Table 8. Effect of storage and packaging on the ash (%) and pectin content(%) of the IMP from carrot pulp.

		Ash (%)				Pectin (%)			
Sample	Storage time, months	Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	0.33	0.33	0.33	0.33	2.92	2.92	2.92	2.92
	1	0.33	0.33	0.33	0.33	2.81	2.81	2.82	2.82
	2	0.34	0.34	0.35	0.35	2.82	2.82	2.83	2.83
	3	0.34	0.34	0.35	0.35	2.82	2.82	2.82	2.82
	4	0.33	0.33	0.31	0.31	2.81	2.81	2.81	2.81
LSD(0.05)		0.363	0.363	0.363	0.363	0.724	0.724	0.724	0.724

Table 9. Effect of storage and packaging on the total sugars (%) and reducing sugars(%) of the IMP from carrot pulp.

		Total sugars(%)				Reducing sugars(%)			
Sample	Storage time, months	Polythene		Laminate		polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	37.84	37.84	37.84	37.84	12.85	12.85	12.85	12.85
	1	40.62	40.23	40.62	40.33	12.98	12.57	12.90	12.96
	2	42.29	42.55	42.33	42.50	13.73	13.54	13.67	13.22
	3	44.56	44.78	44.67	44.78	14.59	14.37	14.43	14.17
	4	45.01	45.11	45.65	45.70	15.13	15.02	14.89	14.76
LSD(0.05)		0.576	0.576	0.576	0.576	0.659	0.659	0.659	0.659

increase in reducing sugars was mainly due to the inversion of non-reducing sugars by acid present in the product. On the other hand, the increase in total sugars may be due to the loss of moisture from the product with time. However, there was a significant effect of storage period on the total sugar and reducing sugar content of the intermediate moisture carrot product from pulp. A similar increasing trend was reported by Roy *et al* (1980) in total sugars and reducing sugars content of mango sheets with the increasing time of storage. Kumar and Manimegalai (2002) also reported an increase in reducing sugars in sapota fruit bar during storage. Nominal increase in reducing sugars was found in mango-guava sheet by Hemakar *et al* (2000).

Carotenoids: There was a significant decrease in both the total carotenoids and â-carotene, with a more decrease at room temperature as compared to the refrigeration temperature. Also, the packaging material had a significant (P?0.05) effect on the total carotenoids as well as the â-carotene levels of the intermediate moisture product from pulp. The per cent decrease in total carotenoids at room and refrigeration temperature were found to be 24.82 and 18.20 (polyethylene) and 14.93 and 14.06 (laminate) respectively. Similarly, the per cent decrease in beta-carotene was found to be 41.79 and 41.87 at room and refrigeration temperature respectively, in polyethylene pouches whereas it was 30.77 and 30.50 (Table 10) at room and refrigeration temperature respectively, in laminated pouches. Hence, the loss was more in polythene pouches as compared to the laminated pouches due to the more exposure to light in the former type of packaging material. Aruna *et al* (1999) reported 46% loss in total carotenes and 43% loss in beta-carotene in papaya fruit bar. Rao *et al* (1980) reported a decrease in the carotenoid pigments with the increasing storage time of mango sheets.

Colour: Change in 'L', 'a' and 'b' values were observed during the four months of storage (Table 11). 'L' and 'b' values were found to increase whereas the 'a' were found to decrease in all the samples of intermediate moisture carrot product from pulp. There was a significant ($P<0.05$) decrease in brightness of colour stored at room temperature as compared to the refrigeration temperature. However, there was a non-significant ($P=0.05$) effect of different preservatives on the colour readings of the product. During the storage period, an increase in whiteness of the slices was observed due to the accumulation of sugar on the surface of candies. Increase in 'b' values indicated an increase in the yellowness in the colour of the carrot slices. Decline in 'a' values indicated a decrease in redness of the product stored at room temperature.

The increase in 'L' values were found to be 46.77 to 49.79 and 46.77 to 49.54 at room and refrigeration temperature in polyethylene pouches. In laminated pouches, these values were found to be as 46.77 to 50.58 and 46.77 to 49.51 at room and refrigeration temperature respectively. Decrease in 'a' values were noted as 16.83 to 14.09 and 16.83 to 14.10 for room and refrigeration temperatures in polyethylene pouches whereas, it was 16.83 to 14.18 and 16.83 to 14.05 respectively in laminated pouches. The increase in 'b' values were found to be as 11.17 to 14.09 (room) and 16.83 to 14.10 (refrigeration) in polyethylene pouches but it was 11.16 to 14.18 (room) and 11.17 to 12.98

Table 10. Effect of storage and packaging on the total carotenoids(mg/100g) and â-carotene (mg/100g) of the IMP from carrot pulp.

		Total carotenoids (mg/100g)				Beta-carotene (mg/100g)			
Sample	Storage time, months	Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.
Control	0	24.17	24.17	24.17	24.17	12.25	12.25	12.25	12.25
	1	22.23	23.43	23.69	23.76	10.36	11.32	11.86	11.90
	2	20.21	21.57	22.29	22.68	10.15	10.47	10.81	10.98
	3	19.55	20.87	21.66	21.89	9.81	9.97	10.63	10.88
	4	18.17	19.45	20.56	20.55	9.13	9.34	10.48	10.57
LSD (0.05)		0.412	0.412	0.412	0.412	0.494	0.494	0.494	0.494

Table 11. Effect of storage and packaging on the colour of IMP from carrot pulp.

		Polythene						Laminate					
		R.T.			Ref.			R.T.			Ref.		
	Storage time, months	L	a	b	L	a	b	L	a	b	L	a	b
Control	0	46.77	16.83	11.17	46.77	16.83	11.17	46.77	16.83	11.16	46.77	16.83	11.17
	1	47.98	16.45	12.13	47.78	16.45	12.21	48.01	16.45	12.12	47.01	16.31	12.11
	2	48.74	15.91	12.48	48.7	15.92	12.67	48.88	15.93	12.51	47.98	15.91	12.23
	3	49.25	15.17	12.55	49.19	15.16	12.89	50.07	15.20	12.67	49.11	15.11	12.48
	4	49.79	14.09	14.09	49.54	14.10	13.88	50.58	14.18	13.13	49.51	14.05	12.98
LSD(0.05)		0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329	0.329

Table 12. Effect of storage and packaging on the sensory characteristics of the intermediate moisture carrot product from pulp.

	Storage time, months	Appearance				Texture				Flavour				Overall acceptability			
		Polythene		Laminate		Polythene		Laminate		Polythene		Laminate		Polythene		Laminate	
		R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T.	Ref.	R.T	Ref.
Control	0	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75	8.75
	1	8.19	8.25	8.19	8.25	8.50	8.56	8.44	8.56	8.56	8.63	8.50	8.56	8.42	8.48	8.40	8.44
	2	7.94	8.00	7.94	8.00	8.31	8.34	8.25	8.31	8.19	8.25	8.13	8.19	8.15	8.21	8.08	8.18
	3	7.25	7.34	7.25	7.34	7.88	8.00	7.81	7.93	8.06	8.13	8.06	8.13	7.73	7.83	7.63	7.68
	4	7.10	7.13	7.10	7.13	7.69	7.81	7.63	7.81	7.81	7.87	7.75	7.81	7.50	7.60	7.48	7.58
LSD(0.05)		0.66	0.66	0.66	0.66	0.31	0.31	0.31	0.31	0.53	0.53	0.53	0.53	0.41	0.41	0.41	0.41

(refrigeration) in laminated pouches. The storage time and packaging materials also had a significant (P=0.05) effect on the colour changes during the storage period of four months.

Appearance: The samples of intermediate moisture carrot product from pulp were found to have good appearance at the end of four months. The samples on an average scored 8.75 at the start which decreased to 8.10 at the end of storage. The appearance of the product prepared from carrot pulp hardly changed up till two months of storage but in the third month slight crystallization of sugar was seen in some of the samples. Hence, the appearance scores showed a decline during storage. However, at refrigeration, there was no visual effect on the appearance of the product (Table 12). Aruna *et al* (1999) reported a decrease in colour and appearance scores of papaya fruit bar during storage.

Texture: Among the samples prepared from intermediate moisture carrot product from pulp, all the samples hardly differed in texture, with an average score of 8.75. With time, all the samples showed slight hardness in texture due to the loss of moisture with time of storage, more at room temperature as compared to refrigeration temperature (Table 12). This led to a decline in the texture scores during the storage. The refrigerated samples scored better (7.81) as compared to that kept at room temperature (7.69) at the end of storage. Aruna *et al* (1999) reported a decrease in texture of papaya fruit bar due to development of stickiness and hardness during storage at 5°C and 25°C and above.

Flavour: The samples of intermediate moisture product prepared from pulp, all the samples were equally good in taste at room temperature, scoring 8.75 at the start of storage but decreasing to 7.81 at the end of four months.The flavour of the refrigerated samples was unaffected in both the packaging materials. However, in some of the samples at room temperature, slight crystallization of sugar was observed which gave sweet sugary taste to the product (Table 12). This led to a slight decrease in the flavour scores of the product during storage but retaining most of it. However, the refrigerated samples scored better (7.87) than room temperature (7.81) at the end of storage period.

Overall acceptability: Amongst the samples of the intermediate moisture carrot product prepared from pulp, all the samples had almost equal overall acceptability. The score 8.75 decreased to 7.54 at the end of storage. The storage at room temperature affected the overall acceptability scores due to greater loss of moisture at room temperature as compared to refrigeration temperature. The product stored at refrigeration temperature was found to be acceptable even after four months (Table 12). There was slight difference amongst the packaging material. Sensory scores of papaya fruit leather decreased during storage as reported by Aruna *et al* (1999).

From the present investigation, it was concluded that the Intermediate moisture product prepared from carrot pulp by using 0.75% pectin, 40% sugar concentration and 1% acid was found to have the best organoleptic characteristics. The moisture content of the product from pulp was optimized at 21-22%, for longer shelf life of the product. The product can be stored at room temperature without the addition of class II preservatives keeping in view the cost of production and health safety.

सारांश

गाजर (प्रजाति नैन्टस) के गूदे का उपयोग मध्यम नमीं उत्पाद जिसकी औसम नमीं 15–50 प्रतिशत हो, को विकसित किया गया। मध्यम नमी उत्पाद विकसित करने के लिए शर्करा (20, 30, 40 एवं 50 प्रतिशत), साइट्रिक अम्ल (0.5, 0.7, 1 एवं 1.5 प्रतिशत), गोंद यानि पेक्टिन (0.5, 0.75 एवं 1 प्रतिशत), कार्बोक्सी मिथाइल सेलूलोज (0.1, 0.25 एवं 0.5 प्रतिशत) तथा सोडियम अल्गीनेट (0.1, 0.25 तथा 0.5 प्रतिशत) एवं परिरक्षक (पोटैशियम सारबेट, पोटैशियम मेटाबाईसल्फाइट एवं इनके मेल) का प्रयोग किया गया। भण्डारण के लिए अंतिम उत्पाद की शर्करा (40 प्रतिशत), साइट्रिक एसिड (1 प्रतिशत) एवं पेक्टीन (0.75 प्रतिशत) से तैयार कर मापन ग्रहणशील मूल्यांकन 9 विन्दुओं हेडोनिक स्केल पर किया गया। एस्कार्बिक एसिड तथा कैरोटिनायड का नुकसान लैमिनेट की तुलना में सबसे अधिक पालीइथीलीन पैक में पाया गया। कमरे के तापमान पर भण्डारण का सार्थक प्रभाव नमी, जल प्रक्रिया, कुल शर्करा, शर्करा घटाव, कुल विलेय ठोस तथा उत्पाद के रंग पर पाया गया। मुखीय

ग्रहणशीलता के आधार पर कमरे के तापक्रम (13–35 डिग्री सेन्टीग्रेड) एवं रेफ्रीजेरेशन तापक्रम (5 डिग्री सेन्टीग्रेड) पर चार महीने तक उत्तम पाया गया।

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