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Quality of Dehydrated Carrot Shreds as Affected by Partial Juice Extraction through Hydraulic Press

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Abstract

Carrot (Daucus carota) is a major carotene rich root vegetable of Apiaceae, previously known as Umbelliferae. India is the second largest producer of fruits and vegetables and is ranked thirteenth in the production of carrot. Carrot is a potent source of the bioactive compounds like β- carotene and phyto-chemicals that provide it the various functional properties. It is utilized as fresh, cooked or processed into different value added products. The improper harvesting, handling, storage and transportation result in the significant losses due to perishable nature of the root crop. The supplementation of the carrot pomace in the processed food products can help to fulfill the requirements of vitamin-A at a very low cost. The edible part of carrot consists of two portions cortex and core, the former being rich in juice and the latter rich in the fiber. It was found that in the carrot variety Pusa Kesar, the cortex core ratio decreases as the maturity increases and ranges from 6.36±0.92 and 4.12±4.12 for maturity group one and four with length of the root 12.06±0.27 cm and 21.60±1.76 cm, respectively. The cortex core ratio after dehydration of carrots ranged from 7.05±0.95 and 5.00±0.17, respectively. The juice extraction behavior as affected by the hydraulic press showed an increasing pattern with the increase in the pressure. The juice yield increased from near 25 to 62% with the increase in pressure to 14.061×10^5 kg/m^2. The extreme juice recovery on applying higher pressure resulted in a residue less appealing whereas a pressure nearly half of the extreme pressure as 5.624×10^5 kg/m^2 yielded comparable juice yield with an attractive and nutritionally acceptable dehydrated carrot pomace with least color loss.

Keywords: Carrot; juice; carotene; extraction; color.

1. Introduction

Carrot (*Daucus carota*) is a temperate, biannual and conical root crop of Apiaceae family that grows well in the cool regions of the world. Carrot is a unique and only root crop rich in carotenoids (Rodriguez-Amaya, 2001). Cortex core ratio decreases on growth provides an indication about quality (Northolt et al, 2004). Carrot juice as a popular α- and β- carotene rich (Chen et al, 1995; Chen and Tang, 1998) natural, healthy and nutritional drink is gaining importance due to its significant health promoting properties.

Juice extraction of fruits or vegetable is achieved by juice extractor viz. centrifugal basket, centrifugal pulp-ejecting, twin gear, hydraulic press and mastication juice extractors (Donaldson, 1998). The conventional carrot juice extractors results in poor juice yield due to the harder texture of the root, that can be increased by enzymes or heat processing to soften the tissue (Tingtin et al, 2013) but can decrease the quality of the juice by imparting off flavor (Siliha, 1995; Furui et al, 1995). Moreover, presences of insoluble matters make the juice cloudy on conventional juice extraction and thus pose solid liquid separation with storage problems and thus affected the acceptability (Giacomo and Taglieri, 2009). The hydraulic pressed juice is almost clear juice with minimum insoluble solids that prevents the sedimentation problems (Bazhal et al, 2001) resulting the increased cloud stability (Sinchaipanit et al, 2007). Extraction of the juice using a hydraulic press has a potent advantage of controlled extraction and thus can be employed for the development of value added products with designer components. Considering these points, the present study was planned to get the valuable information about the effect of carrot physical properties with different maturity groups and variable pressure on the juice extraction behavior and quality of the dehydrated carrot shreds for further valuable uses in food and allied fields.

2. Materials and Methods

Carrot (*Daucus carota*) of variety Pusa Kesar was procured from the local market Longowal, Punjab. The procured carrot was sorted in different maturity groups, washed and peeled manually to remove undesirable matter if any. The washed and sorted carrot was studied for the physical properties and the shredded carrot for the extraction and dehydration behavior.

2.1 Physico-chemical Properties

A vernier caliper with a least count 0.01 mm and a digital balance were used for measuring size and weight, respectively. True density is the ratio between the mass of sample and volume determined using the water displacement method (Mohsenin, 1970). Cortex core ratio and the dehydration ratio were obtained from the weight of fresh samples to that of dehydrated samples. Moisture content of the shreds was

determined following AOAC method (AOAC, 1980) using hot air oven method. The soluble solids in juice were determined using refracto meter, while the insoluble solid was examined by adding the known amount of shreds in the distilled water and stirring continuously for 10 minutes followed by extracting under the hydraulic press and weighing. The process was repeated until there was no more decrease in the weight after pressing by the hydraulic press. The final weight was regarded as the insoluble matter that was subtracted from the total solids to obtain the soluble solids.

2.2 Juice Extraction by Hydraulic Pressing

Known amount of carrot shreds was placed in the developed experimental setup for juice extraction having base plate with plunger on it before subjecting for hydraulic press pressing (Fig. 1) at different pressures for five minutes (Table 3). The extracted juice and carrot pomace as residue were analyzed for different characteristics.

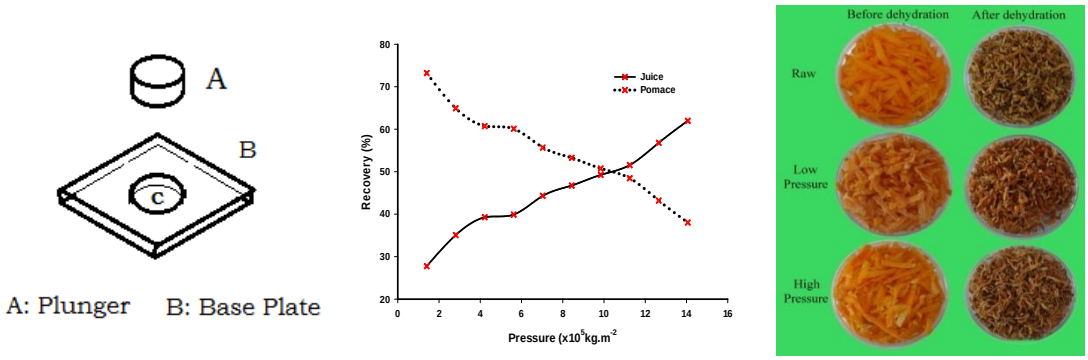

Figure 1: Developed experimental Setup, extraction process with carrot shreds before and after dehydration.

3. Results and Discussion

3.1 Physico-chemical Properties

Carrot of different maturity groups were studied for the size, cortex to core ratio in a portions of head, middle and lower parts (Table 1 & 2). The average length and weight of carrots increased considerably ranging from 12.06 to 21.60 cm and 17.25 to 97.67 gm, respectively for the maturity group I to IV. The increase in the growth showed increase in diameter of head part followed by the lower. The middle portion remained almost constant in diameter after I and II maturity group. The proportion of the head, middle and lower parts remained almost constant for the first three maturity groups while as in the fourth there was a gradual decrease and increase in the head and lower proportion. As the maturity proceeds the cortex to core ratio showed a decreasing trend (Table 2 and Figure 2), which is an indication of quality (Northolt et al, 2004). The cortex to core ratio increased after dehydration as compared to that of fresh carrots but

both showed a decreasing trend in the ratio as the root matures. The decreasing cortex to core ratio gave an indication of increase in the fiber content of the root as the core is rich in fibrous portion, while as the cortex decreased resulting in decrease of the juice content. The cortex to core ratio from 6.36 to 4.12 was found to have changed to 7.05 to 5.00 on dehydration (Table 1). The decrease in true density further supports the findings for the change in the cortex to core ratio (Table 2). The moisture content of shreds was found to be decreased considerably from 88.8% in carrot to 31.78% in pomace on increasing the pressure to 14.061×10^5 kg/m^2.

Table 1: Effect of maturity groups on the cortex core ratio and dimensions of Daucus carota var. Pusa kesar before and after drying.

Maturity group	**Length (cm)**	**Diameter (cm)**			**Cortex core ratio**	
		Head part	**Middle part**	**Lower part**	**Before Drying**	**After Drying**
First (I)	12.06 ± 0.27	1.88 ± 0.15	1.48 ± 0.13	0.88 ± 0.32	6.36 ± 0.92	7.05 ± 0.95
Second (II)	14.04 ± 1.52	2.30 ± 0.32	2.24 ± 0.29	1.54 ± 0.32	5.40 ± 0.65	5.96 ± 0.78
Third (III)	17.54 ± 1.41	3.08 ± 0.27	2.74 ± 0.38	2.04 ± 0.22	4.28 ± 0.14	5.52 ± 0.11
Fourth (IV)	21.60 ± 1.76	3.04 ± 0.37	2.74 ± 0.30	2.00 ± 0.19	4.12 ± 0.16	5.00 ± 0.17

Table 2: Effect of maturity groups on the percentage of head, middle and lower parts of Daucus carota var. Pusa kesar along with their true density.

Maturity group	**Weight of carrot (gm)**		**Portion (%)**		**True Density (kg/m^3)**
		Head part	**Middle part**	**Lower part**	
First (I)	17.25 ± 1.73	43.41 ± 0.33	33.10 ± 0.07	23.48 ± 0.34	1069.19 ± 51.34
Second (II)	34.84 ± 2.17	42.94 ± 2.45	32.61 ± 2.40	24.45 ± 0.51	1098.78 ± 40.76
Third (III)	63.62 ± 4.29	44.55 ± 4.40	30.71 ± 1.36	24.74 ± 3.47	975.01 ± 18.97
Fourth (IV)	97.67 ± 2.42	38.79 ± 0.57	32.50 ± 0.62	28.72 ± 0.90	946.85 ± 37.32

Table 3: Juice extraction characteristics of Daucus carota var. Pusa kesar shreds.

Pressure (kg/m^2)	**Recovery (%)**		**Soluble Solids**		**Dehydration ratio**
	Juice	**Pomace**	**Juice**	**Pomace**	
1.406×10^5	27.75±2.49	73.22±2.49	2.22±0.08	4.53±0.08	7.61±0.19
2.812×10^5	35.08±2.25	64.92±2.25	2.81±0.18	3.94±0.19	7.26±0.06
4.218×10^5	39.28±1.18	60.72±1.18	3.14±0.09	3.60±0.10	7.12±0.19
5.624×10^5	39.90±1.71	60.10±1.71	3.19±0.14	3.55±0.15	7.18±0.22
7.030×10^5	44.33±1.97	55.67±1.97	3.55±0.16	3.20±0.18	6.91±0.22
8.437×10^5	46.73±1.21	53.27±1.21	3.74±0.10	3.01±0.11	6.83±0.14
9.843×10^5	49.25±1.38	50.75±1.38	3.94±0.11	2.81±0.13	6.64±0.18
11.249×10^5	51.54±0.65	48.46±0.65	4.12±0.05	2.62±0.06	6.58±0.09
12.655×10^5	56.80±2.60	43.20±2.60	4.54±0.21	2.20±0.26	6.46±0.08
14.061×10^5	61.98±2.58	38.02±2.58	4.96±0.21	1.79±0.26	6.16±0.08

3.2 Juice Extraction Characteristics and Quality of Dehydrated Shreds

The juice extraction under the hydraulic press resulted in the increase of the juice and decrease in pomace content on increasing the pressure (Figure 3). Up to 61.98% juice recovery was noticed. The dehydrated carrot shreds without juice extraction were studied for the total solids, water soluble and insoluble solids found to be 11.2, 6.75 and 4.45%, respectively (Table 3). It was found the total soluble solids in the juice increased from 2.22 to 4.96 % with the increase in the pressure from 1.406 to 14.061×10^5 kg/m^2 and may be as a result of extensive breakage of tissues resulting in leaching of more soluble solids into the juice. The insoluble solids of the dehydrated shreds remained constant while as the soluble solids varied from 4.53 to 1.79% with increasing pressure. The extensive use of the pressure resulted in the formation of less nutritive pomace while the intermediate pressure of 5.624×10^5 kg/m^2 yielded a pomace with good nutritional, attractive colour (Fig. 1) with more acceptable quality.

4. Conclusion

Maturity of carrot affects the quality of carrot as per cortex to core ratio, juice yield and dehydrated carrot shreds quality. Intermediate pressure of 5.624×10^5 kg/m^2 in hydraulic press for juice extraction yield a pomace of good nutritional and appealing characteristic and dehydrated product quality for finding the applications food and allied purposes.

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