Preparation and Quality Evaluation of Carrot Powder

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Abstract- The purpose of this research is to produce dehydrated carrot powder by using oven drying method under various drying conditions. The characteristics and nutritional value of fresh carrot were examined. Sound ripe, bright orange colour carrots were selected that are free from diseases and damage. After peeling and cutting, carrots were boiled with water for 30 minutes. Then, they were blending in juice blender. The carrot paste was dried using different temperatures of 55, 60, 65, 70 and 75°C. Then, the effect of drying temperature and drying time on the moisture content, yield percent and sensory evaluation of dehydrated carrot powder were studied. The physico-chemical properties and nutritional values of dehydrated carrot powder were also determined. The most favourable conditions of carrot powder were 65°C drying temperature and 9 hours drying time by using hot air oven.

Keywords – Fresh carrot, dehydrated carrot powder, hot air oven

I. INTRODUCTION

Vegetables are an important item of human diet and they are plant or parts of plant that are used as food. Vegetables are important in improving the acceptability of the meal, due to their innumerable shades of colour, flavour and texture they contribute. Fruits and vegetables provide most of the carotenoids in the human diet and carrot (*Daucus carota* L.) has the highest carotenoids content among food products. They are indispensable sources of essential dietary nutrients, such as β-carotene and vitamin B complex, organic acids, fiber, pectin, and mineral compounds (Zielinska, M.; et.al 2006 [1] and Zadernowski, R.; Oszmianski, J. 1994 [2]). Carrot is one of the most commonly used vegetables for human nutrition, the excellent source of β-Carotene to prevent cancer and presents the highest carotenoids content among food products (Magdalena and Markowski [3]). Carrots also possess vitamin A and potassium, and contain cholesterol-lowering pectin, vitamin C, vitamin B6, thiamine, folic acid, and magnesium (Desobry, et al. [4]). Thus, carrots provide health benefits including strong antiseptic qualities, which can be used as a laxative, poultice and for the treatment of liver conditions (Erenturk and Erenturk [5]).

Drying is one of the most useful and challenging processes of food industry, since a great number of food products are subjected to at least one drying step during its production. Dehydration or drying of foods is a process that involves thermal removal of volatile substances to obtain a dry solid (Wankhade P,Sapkal R,Sapkal, V 2013) [6]. The main purposes of drying crops are to increase its shelf life, to better its quality, to simplify the handling, storage and transport of the products and also to prepare the product to subsequent processes. Drying of Agricultural crops is done in most farms by sun-drying which is contaminated by insects and dust. So, there is need to introduce the use of mechanical dryers provided that the nutritional characteristics would be retained better than using sun-drying method (Lsisi D, Balogun LA, Nasiruteen AR, Ogunsola FO, 2013) [7]. Being seasonal, as well as perishable due to high moisture content, carrots are available in plenty only at a particular period of the years. During the peak season, the selling price carrots becomes too low because of abundant supply, leading to heavy losses to the growers. To preserve the carrots over a period of long time for use during off-seasons, dehydration is one of the most important methods, because it lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product (Singh B, Panesar PS, Kennedy JF 2001) [8].

II. MATERIALS AND METHODS

2.1 Raw Materials

The mature carrots (Shan State) used for the preparation of dehydrated carrots powder were purchased from local market.

2.2 Preparation of Dehydrated Carrot Powder

The mature carrots were washed in a washing tank and selected that are free from diseases and damage. After peeling and cutting, 600g of the carrot slices were placed to steel pot containing 1L water at about 95° C and 30 minutes. Then they are poured into the blender and obtained extracted paste.

The carrot pastes were spread on the trays to produce dry leather. These trays were dried in the hot air oven at the various drying temperature (55, 60, 65, 70, 75°C). At the end of drying, the carrot leathers were scrapped, ground with grinder to obtain carrot powder. The carrot powders were screened with 120 mesh sieve. The powders were collected, weighed and put into the polyethylene plastic bag and sealed for the quality determination.

2.3 Methods of Analysis

Physico-chemical properties of fresh carrot and dehydrated carrot powder such as moisture content, ash content, protein content, fiber content, fat content, and carbohydrate content (AOAC-Method, 2000) [9] were determined. The microorganisms were determined by Aerobic Plant Counts by petrifilm method (AOAC-990.12), and Yeast & Mould by FDA-BAM (Food and Drug Administration-Bacteriological Analytical Manual) (Online Manual April 2001) method, respectively.

2.3.1 Determination of Moisture Content

3 g of sample was weighed in a petri dish and dried for 4 hours at 110°C in hot air oven and it was cooled in desiccators and weighed. The process of heating, cooling and weighing was repeated. Moisture content was calculated as follows: [9]

$$\text{Moisture}\ (\%) = \frac{W_1 - W_2}{W_1}$$

Where, W_1= weight (g) of sample before drying,
W_2= weight (g) of sample after drying

2.3.2. Determination of Ash Content

Accurately weighed 1 g of sample was introduced into the porcelain crucible. The crucible and sample were carefully ignited over hot plate and heated until the sample was thoroughly charred. Then, it was placed in the muffle furnace at 550°C for 5 hours until residue was free from carbon. The crucible and ash were then cooled in the desiccator and weighed. The weighing, heating in the furnace and cooling were repeated until the constant weight was obtained. The ash content of sample was calculated as follows: [9]

$$\text{Ash}\ (\%) = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

2.3.3. Determination of Protein Content

2 g of sample was transferred to a digestion flask followed by the addition of 3 g of catalyst mixture (K_2SO_4:$CuSO_4$:SeO_2 in 100:20:2.5) and 20 ml of concentrated sulfuric acid. The content was then digested till transparent liquid was obtained. The volume of digested material was made up to 100 ml with distilled water. Carry out a blank digestion without the sample and make the digested to 100ml. Measured a liquor of digested material was distilled with excess of 40% NaOH solution and the liberated ammonia was collected in 20 ml of 2% boric acid solution containing 2-3 drops of mixed indicator (10 ml of 0.1 percent bromocresol green + 2 ml of 0.1 percent methyl red indicator in 95 percent alcohol). The entrapped ammonia was titrated against 0.01 N of hydrochloric acid. A reagent blank was similarly digested and distilled. Nitrogen content in the sample was calculated as follows and a factor of 6.25 was used to convert nitrogen to protein [9].

$$N_2\ (\%) = \frac{\text{Sample titre} - \text{Blank titre} \times \text{Normality of HCl} \times 14 \quad \text{vol. made of digest} \times 100}{\text{Aliquot of the digest taken} \times \text{Weight of sample} \times 1000}$$

$$\text{Protein content} = \%\ \text{Nitrogen} \times 6.25$$

2.3.4. Determination of Crude Fiber Content

2 g of sample was weighed into 500 ml of beaker and 200 ml of boiling 0.255 N of sulfuric acid (1.25 percent w/v) was added. The mixture was boiled for 30 min keeping the volume constant by the addition of hot water at frequent intervals (a glass rod stirred in the beaker helps smooth boiling). At the end of this period, the mixture was filtered through a muslin cloth and the residue washed with hot water till free from acid. The material was then transferred to the same beaker and 200 ml of boiling 0.313 N of NaOH (1.25 percent w/v) was added. After boiling for 30 min., the mixture was filtered to a crucible, dried overnight at 80-100°C and weighed (W_2). The crucible was kept at in a muffle furnace at 550°C for 3 hours. Then it was cooled in desiccators and weighed again (W_3). The difference in residue weights and ash represents the weight of crude fiber [9].

$$\text{Crude fiber content }(\%) = \frac{(W_2 - W_3)}{W_1} \times 100$$

where, W_1= Weight of sample, (g), W_2= Weight of insoluble matter, (g) and W_3= Weight of ash, (g).

2.3.5. Determination of Fat Content

Accurately weighed 5 g of sample was introduced inside the thimble and a piece of cotton was placed at the open and of the thimble. The thimble containing the sample was kept inside Soxhlet apparatus fixed with round bottom flask (500 ml) containing petroleum ether (B. P 40-60°C) 250 ml. The extraction flask was heated on the heating mantle for 14 hours at the boiling point of petroleum ether. After the extraction was completed, the ether dissolving oil was transferred into the beaker. Then, the ether was removed by evaporation. Fat content was calculated as follows: [9]

$$\text{Fat }(\%) = \frac{\text{Fat weight}}{\text{Sample weight}} \times 100$$

2.3.6. Determination of Carbohydrate Content

Carbohydrate value of the sample was determined by using the following formula:

Carbohydrate(%) = 100 – (moisture + ash + protein + fiber + fat)

2.7.7. Statistical Analysis

All measurements were made in triplicate for each sample; statistical analysis for physico-chemical properties of all samples were calculated using a one way ANOVA and the significant difference between the samples were determined using LSD test at $p < 0.05$.

For sensory evaluation, the organoleptic properties of product were determined on the basis of 9 point Hedonic scale-rating, where 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, 1 = dislike extremely) by a panel of 10 semi-trained judges. The results were analyzed using Analysis of Variance (ANOVA). The overall acceptability of the results were compared using Turkey's test. All tests were conducted at the 5% significance level.

III. Results and discussions

3.1 Proximate Composition of Raw Materials

From Table (1), although the moisture content, pH and total soluble solid of fresh carrot were close agreement with the literature value, other constituents such as total fiber, ash, protein and carbohydrate content were quite different with literature value because of the cultivated conditions, the climate and the nature of soil.

Table 1. Physico-Chemical Characteristics and Nutritional Value of Fresh Carrots

Sample No.	Characteristics	Experimental Value	*Literature Value
1	Moisture (%)	85.8±0.2	86
2	Ash (%)	1.5±0.2	1.1
3	Crude Protein (%)	0.96±0.3	0.9
4	Crude Fiber (%)	1.5±0.1	1.2

5	Crude Fat (%)	0.6±0.2	0.5
6	Carbohydrate (%)	9.94±0.3	10.6
7	pH Value	7.3±0.2	7.2
8	Total soluble solid(°Brix)	4.6±0.03	4.64

*Source: Nutritive Value of Indian Foods, National Institute of Nutrition, Indian council of Medical Research, Hyderabad. India 1984.

3.2 Effect of Temperature on Drying Time, Yield Percent, Moisture Content and Sensory Score of Dehydrated Carrot Powder

The dehydrated carrot powder was prepared by hot air oven drying process with different temperatures. The results from Table (2) display the effect of temperature on drying time, yield percent, moisture content and sensory score of dehydrated carrot powder. The results showed that moisture content decreased with the increase in temperature as there is more evaporation of the moisture at higher temperature. From these result the most favourable temperature was 65°C because of high yield percent and highest sensory score of dehydrated carrot powder.

Table 2. Effect of Temperature on Drying Time, Yield Percent, Moisture Content and Sensory Evaluation of Dehydrated Carrot Powder

Sample No.	Temperature (°C)	Time (hour)	Moisture (%w/w)	Yield Percent (%w/w)	Overall Acceptability
1	55	13	10.5	7.53	6.5
2	60	11	10.8	7.78	6.7
*3	65	9	11.8	8.15	8.5
4	70	8	9.13	7.35	5.4
5	75	7	8.24	6.98	4.2

3.3 Effect of Drying Temperature on Rehydration Ratio of Carrot Powder

The effect of drying temperature on rehydration ratio of carrot powder is shown in Table 3. After the 30 min, the rehydration ratios of dehydrated carrots were found to be 7.23, 7.29, 7.53, 7.42 and 7.51 respectively. After the 60 min, the rehydration ratio was found to be slight increased i.e., 7.27, 7.34, 7.59, and 7.54 respectively. The increase in the rehydration ratio was due to the absorption of water by the dehydrated carrot powder.

Table 3. Effect of Temperature on Rehydration Ratio of Dehydrated Carrot Powder

Sr. No.	Temperature (°C)	Rehydration Ratio (%w/w)		
		After 30 minutes	After 60 minutes	Mean
1	55	7.23	7.27	7.25
2	60	7.29	7.34	7.315
*3	65	7.53	7.59	7.56
4	70	7.42	7.46	7.44
5	75	7.51	7.54	7.525

3.4 Effect of Temperature on Moisture Content of Dehydrated Carrot Powder during Storage Period

The product was prepared by processing it by different temperatures followed by storage at ambient temperature. Moisture content was calculated on the 0th day. The effect of storage condition on the moisture content was evaluated after every 10 days during a period of one month. The results showed that moisture content decreased with the increase in temperature as there is more evaporation of the moisture at higher temperature. The moisture content was increased during the storage period because of the ingress of moisture through the packaging material. The results obtained are shown in Table 4, the highest moisture content for carrot was 11.8% present in sample dehydrated at 65°C and lowest i.e., 8.24% was recorded in the sample dehydrated at 75°C.

Table 4. Effect of Temperature on Moisture Content of Dehydrated Carrot Powder during Storage Period

Sr. No.	Temperature (°C)	Moisture Content (%w/w)			
		0 Day	10 Days	20 Days	30 Days
1	55	10.5	10.6	10.72	10.9
2	60	10.8	10.8	10.85	10.92
*3	65	11.8	11.8	11.82	11.85
4	70	9.13	9.13	9.24	9.6
5	75	8.24	8.24	8.82	9.1

3.5 Physico-chemical Properties of and Nutritional Value of Dehydrated Carrot Powder

Physico-chemical properties of and nutritional value of dehydrated carrot powder was determined in Table 5. Dehydrated carrot powder was characterized by protein content 7.2±0.3 % and high content in fiber, 7.53±0.4% and in ash, 4.38±0.2 %. The carbohydrate level was substantially increased to 63.56±0.1% due to decrease of moisture content. It was found that the water activity (a_w) content is 0.47 of freshly prepared dehydrated carrot powder. According to the literature, water activity (a_w) content 0.51 and less than 0.51 that is not contaminated to food and microorganisms cannot grow at that time.

Table 5. Physico-Chemical Characteristics and Nutritional Value of Dehydrated Carrot Powder

Sample No.	Characteristics	Experimental Value
1	Moisture (%w/w)	11.71±0.3
2	Ash (%w/w)	4.38±0.2
3	Crude Protein (%w/w)	7.2±0.3
4	Crude Fiber (%w/w)	7.53±0.4
5	Crude Fat (%w/w)	5.62±0.2
6	Carbohydrate (%w/w)	63.56±0.1
7	pH	5.3±0.1
8	a_w	0.47±0.2

3.6 Elemental Compositions of Dehydrated Carrot Powder

The elemental compositions of dehydrated carrot powder were analyzed by XRF. The data are shown in Table 6. It shows chlorine, phosphorus, calcium, magnesium, iron and potassium. These minerals can effectively contribute towards the daily recommended allowances [10] for all groups. It was observed that dehydrated carrot powder can fulfill the micro nutrients deficiency as well.

Table 6. Determination of Elements in Dehydrated Carrot Powder by X-ray Fluorescence Spectrometry (XRF)

Sr. No	Elements	Experimental Values (% by weight)
1	Magnesium (Mg)	0.96±0.02
2	Potassium (K)	16.8±0.03
3	Calcium (Ca)	10.4±0.01
4	Iron (Fe)	0.24±0.02
5	Phosphorus (P)	3.2±0.03
6	Chlorine (Cl)	8.1±0.02

IV.CONCLUSION

From the results of this study it is concluded that the quality evaluation at different drying temperatures for carrot slices showed similar trend or nature towards the storage conditions that were provided after packing in the LDPE for 30 days to observe the shelf life of dehydrated carrot powder. The temperatures were the most pronounced factors affecting moisture content, rehydration ratio of dehydrated carrot during oven drying. The most suitable condition for dehydrated carrot powder is drying temperature 65°C for nine hours. The dehydrated carrot powder contained enough amounts of protein, fat, fiber and carbohydrate due to provide the human health. The dehydrated carrot powder had low moisture content and water activity (a_w) content, so it might show the stability of the product during storage. The dehydrated products will be of great use particularly in off season of carrot. No mould growth was observed during storage period. On the basis of quality attributes, and sensory attributes especially colour and appearance of the products were acceptable. However, there was difference in the overall acceptability of the product.

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