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Effect of Heat Treatments on Some Quality Parameters of Carrot (*Dascus carota* L.) Juice

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Abstract: Effect of pasteurization treatment in water bath with different time periods (10 min and 20 min) at temperature of 100°C on the vitamin contents, microbiological and sensory evaluation in the treated and untreated carrot juice was studied. The values of ascorbic acid and beta-carotene decreased from 4.5 mg/100g and 9 mg/100g in fresh carrot juice to 3.8 mg/100g and 8.2 mg/100g at 10 min pasteurization (P1) in treated carrot juice and respectively pasteurization (P2) at 20min. Whereas the effect was significant for microbiological analysis such as total plate count (TPC, 1500 cfu/ml), coliform (+ive) and yeast and mould (1755) in fresh juice while the level of treated juice was (TPC, 15 cfu/ml), E-coli (-ive), yeast (-ive) and mould (-ive). However, the overall acceptability scores for both 10min and 20 min at temperature 100°C on carrot juice remained within the acceptable range (> 5.0). Although, sensory evaluation of the 20 min pasteurization treatment was preferred over 10 min pasteurization treatment, due to the stability of colour and a good taste. It is also concluded in this study that 10 min treatment was good for the retention of ascorbic acid and β-carotene but it was not significant to kill all microorganisms in carrot juice.

Key words: Carrot Juice · Heat Effect · Ascorbic Acid · Beta-Carotene And Microbiological Analysis

INTRODUCTION

Carrot (*Dascus carota L.*) is one of the most commonly used vegetables of human nutrition. It is rich in β-carotene, ascorbic acid and tocopherols and is classified as vitaminzed food [1]. High carotenoids intake is associated with lowering risk of many cancers, especially the prostate cancer. Moreover, vitamin A is an antioxidant that is key to the growth and repair of tissues and helps the body to fight with infections, keep eyes healthy and nourish epithelial tissues in the lungs, as well as of the skin. Therefore, maximum retention of beta-carotene is of utmost importance for the preservation of the attractive appearance and dietary value of the product [2]. Fruits and vegetables can be kept fresher and longer by the help of pasteurization. The process of pasteurization of bottled juice involves heating to a specific temperature for a determined period. Some forms of pasteurization are flash, high-pressure and In-pack pasteurization [3].The in-pack pasteurization is more economic as compared to others in which the bottled product is immersed into a tank filled with hot water at the temperature 70°C for about 20 min. Nowadays flash and high-pressure pasteurization methods are mostly used n industrial scale. These methods appear to be expensive and beyond the approach of small and medium enterprises for the preservation of fruit and vegetable juice. The quality of carrot juice is affected by various factors like heat, light and oxygen exposure. These factors have detrimental effects on the vitamins content. In these factors heating is one of the most important methods used to extend the shelf life of foods which results in the elimination of Total plate counts (TPC), coliform, yeast and moulds and always sharply reduced. Thermal processes such as blanching and pasteurization increase storage life of food products and minimize food-borne

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diseases [4]. It was reported that 15% to 20% of ascorbic acid was lost during blanching, [5]. The objective of the present study was to investigate the effect of pasteurization on β-carotene, ascorbic acid, color, pathogenic organisms and sensory evaluation. Moreover, the effect of different heat treatments on the quality of carrot juice was also observed.

MATERIALS AND METHODS

Carrot Juice Preparation: Fresh carrots were procured from food pilot of Food Technology Center of PCSIR Peshawar Pakistan. Carrot was washed, peeled, chopped and blanched at 80°C for 10 minutes. The pulp was ground by blender before filtration to obtain carrot juice. Total soluble solids and pH of the juice were controlled at 8° brix and 4 respectively. The juice was then homogenized at 11,000 rpm min^{-1} for 5 minutes, followed by pasteurization at 70 °C for 10 and 20 minutes. The flow sheet of the carrot juice processing as shown in the Figure 1.

Fig. 1: Carrot Juice Processing

Heat Treatment: Carrot juice was pasteurized in a water bath at 70°C for 20 and 30 minutes. Immediately after pressurization, the bottle juice was removed and cooled in an ice bath. Unpasteurised carrot juice (raw juice) was used as control sample.

Methods

Screening Method for β-Carotene Determination: The screening method used for β-carotene determination according to described methods [6, 7] with a minor modification for carrot juice.

Extraction: About 5-10 ml of carrot juice was weighed in the extraction tube. The sample was homogenized with 50 mL of cold acetone for 1 min and then filtered with suction through a Buchner funnel with filter paper.

Partition to Petroleum Ether: 20 ml petroleum ether (PE) was put in a 500 ml separatory funnel with Teflon stop-cock and the acetone or methanol: THF extract was added. 300 ml distilled water was added, letting it flow along the walls of the funnel. To avoid formation of an emulsion shaking was avoided. (Once formed, an emulsion can be broken by adding saturated sodium chloride solution. When an emulsion is difficult to break, it is better to start the analysis over rather than proceed with an analysis that may give an erroneous result.) The two phases were let to separate and lower aqueous phase was discarded. The petroleum ether phase was washed 3-4 times with distilled water (200 ml each time) to remove residual acetone or methanol: THF. In the last washing, it was made sure to discard the lower phase as completely as possible, without discarding any of the upper phases. The petroleum ether phase was collected in a volumetric flask (30 ml for carrot juice), which made the solution pass through a small funnel containing anhydrous sodium sulfate (~15 g) to remove residual water (A glass wool plug was put to hold the sodium sulfate). The separatory funnel was washed with petroleum ether, collecting the washings in the volumetric flask by passing through the funnel with sodium sulfate. Alternatively, before transferring to a volumetric flask, the PE phase could be collected in a flask and anhydrous sodium sulfate was added until some crystals remain loose.

Spectrophotometer Reading and Calculation: The volume of the sample was made up with petroleum ether and the absorbance was taken at 450 nm. It may be necessary to concentrate or dilute the carotenoids solution (the absorbance should be between 0.2 and 0.8). Calculate the total carotenoids content using the following formula:

$$\text{Total carotenoid content (mg/100g)} = \frac{A \times \text{volume (ml)} \times 10\,4}{A1\%1\text{cm} \times \text{sample weight (g)}}$$

Where A= absorbance; volume = total volume of extract (50 or 25 mL); A1%1cm = absorption coefficient of β-carotene in PE (2592). Multiply by 100 to give the carotenoid content in mg/100 g.

Ascorbic Acid: Ascorbic acid was determined by using 2, 6-dichlorophenol indophenol titrimetric method [8]. Color Analysis.

A Tintometer (Lovibond, PFX 195) was used to analyze color of the samples. Three grams of carrot juice were weighed and placed in a curvet. The samples were analyzed for L*, a* and b* values. Where a* refers to the redness or greenness and b* refers to the yellowness or blueness [9].

Microbiological Analysis: Microbiological analyses were used for the microbial assessment of fresh fruits juices by methods [8].

Sensory Evaluation: Sensory evaluation of the tested carrot juice was carried out using the hedonic scale method [10] by ten staff members, food technology center of PCSIR Labs Complex for color, taste, odor and overall acceptability. The overall acceptability was calculated from the total scores of the tested attributes. The juice samples (treated juices) were presented in glasses with a capacity of 250 ml. The judges rated the preferred sample in comparison with the untreated juice control (Freshly prepared juice).

RESULTS AND DISCUSSION

Effect of heat treatments (pasteurization technique) at a temperature of 100°C for 10 and 20 minutes on parameters such as ascorbic acid, carotene and color measurements of carrot juice as data shown in Table 1. The values of ascorbic acid, β-carotene and *a *b *L were 4.5, 9 and 12.9, 30.8, 43.8 in fresh juice. Ascorbic acid and β-carotene was reduced from 3.8 to 3 and 8.2 to 7.5 by heat treatments such as p_1 and p_2 respectively. Carotenoids are relatively stable as compared to other vitamins but carotenoids possess a series of conjugated double bonds which make them highly susceptible to oxidation and oxidation is accelerated by oxygen, uv/vis light, heavy metals and high temperature. It was investigated [11] that exposure of carotenoids to light, oxygen and/or thermal processing will cause a significant loss and destroyed through processing because of extreme time-temperature processing involved in a typical pasteurization. It was also reported [12] that Processing and cooking conditions cause variable losses of vitamins. The most labile vitamins during culinary processes are retinol (vegetable boiling, 33% retention) and vitamin C. Similar results were found by [13] that canning (121 °C, 30 min) resulted in the highest destruction of carotenoids, Carrot juice color turned from orange to yellow with intensive treatment.

Table 1: Effect of Pasteurization Treatments on Vitamin Contents.

Sample	Ascorbic acid (mg/100g)	Beta-carotene (mg/100g)	a*	b*	L*
Fresh juice	4.5	9	12.9	30.8	43.8
*P1	3.8	8.2	12.1	31.8	44.7
P2	3	7.5	11.8	32.6	45.7

*L= lightness, a+= red direction, b+= yellow direction, *P1= Pasteurization 1 for 10 minutes, P2 = Pasteurization 2 for 20 minutes.

Table 2: Effect of Pasteurization Treatments on Microbiological Contents.

Sample	Total plates counts (cfu/ml)	*E. coli*	Yeast & mould (cfu/ml)
Fresh juice	1.5×10^3	+	1.7×10^3
*P1	$1.5 \times 10°$	-	-
*P2	-	-	-

*P1= Pasteurization 1 for 10 minutes, P= Pasteurization 2 for 20 minutes, +: Detected

- : Not detected

Microbiological Analysis: The effects of heat treatments on the total viable plates (TVP), *E. coli* and yeast and mould in carrot juice are shown in Table 2. TVP in the fresh juice were about 1.5×10^3 cfu/ ml but the treated sample at 100°C for 10 minutes showed viable cell growth of the organisms as $1.5 \times 10°$ cfu/ml and not detected by P2. *E. coli* was found in fresh carrot juice while in samples treated by p1 and p2 E. coli was not-detected. Without pasteurization fresh carrot juice, the mould count and yeast were 1.7×10^3 while in samples treated by p_1 and p_2 the mould count and yeast was not detected.

It was reported [14] that without pasteurization the total amount of mesophilic aerobes was approximately 10^6 cfu/ml. This number is much higher than the results (3-10^3 cfu/ml). It was found [15] that also found that Sulphate-reducing clostridia were below the detection limit (10^2 cfu/ml). Cell concentration of enterobacteria, coliforms, pseudomonas, lactic acid bacteria and yeast was varied in the range from 10^3 cfu/ml to 10^5 cfu/ml. The mould count was less than 10^3 cfu/ml. Among all investigated contaminant microbes, only some mesophilic aerobes and coliforms were detected when the carrot juice was pasteurized at 80°C for 15 min. When the duration of pasteurization was increased to 20 min (at 80°C), the cell count of all investigated contaminant microbes decreased

Table 3: The recommended microbial standards for any fruit juices sold in Gulf region, in all figure per ml juice are consumed.

Standards	Total colony count	Coliforms	Yeast and moulds
Maximum count anticipated	5.0×10^3	100	10
Maximum count permitted	1.0×10^4	1.0×10^3	100

Table 4: Effect of Pasteurization Treatments on Sensory Evaluation.

Sample	Color	Taste	Odor	Overall acceptability
Fresh juice	6.2	6.5	6.3	6.5
*P1	6.6	6.8	6.6	6.7
P2	6.5	6.6	6.4	6.6

* 7-point hedonic scale rating 7- like very much 1 - dislike very much, *P1= Pasteurization 1 for 10 minutes, *P1= Pasteurization 2 for 20 minutes.

below the detection limit (10^2 cfu/ml). It was also investigated [16] that Pasteurization reduced the colony count in all cases but due to the different flora and to minor variations in the heating process much irregularity was observed. Reductions in count to 1/50 or 1/100 of the count on raw juice were usual.

Sensory Analysis: The effect of heat treatment on sensory characteristic such as color, taste, odor and overall acceptability is presented in Table 3. On the basis of the average scores given by the judges, the overall acceptability (color, taste and odor) of the treated samples were more accepted (higher scores) than those of the untreated sample (raw juice). Similar findings were observed [17] by that all juice samples pasteurized at 90°C recorded higher overall acceptability. Furthermore, fast degradation was observed concerning the stored black carrot juice compared with the fresh one (at zero time) with significant differences for color, taste and appearance attributes. The results of anthocyanins and ascorbic acid coincide with our findings. These results are also in agreement with [18, 19] who revealed that the high csensory quality of pulse-electric field treated orange juice as compared with thermally processed juice.

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Conflict of Interest: The authors declare that they have no conflicts of interest.

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