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The Β-Carotene Level Increases During Stir Frying And Decreases During Boiling Of Carrot: An Experimental Case Study

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Abstract

Aim: *Vitamin A is essential for normal growth, reproduction, and proper function of the immune system with great antioxidant activity. The β-carotene is the most active and abundant precursor for vitamin A among the members of carotenoid family in carrot. Hence, the aim of the study was to estimate the β-carotene content in different forms of carrots (raw, boiled and fried) to find out which form of carrot would be most valuable for dietary intake with respect to the level of β-carotene.* ***Material and Method:*** *The raw, boiled and fried forms of carrot in equal amount (2g) were then subjected to solvent extraction using solvent hexane. The β-carotene levels in all these 3 samples were estimated from the absorbance values obtained from colorimetric reading. The experiment was done in triplicates to validate the levels.* ***Results and Conclusion:*** *The mean β-carotene concentrations in raw, boiled and fried carrots showed significant difference. There was a significant ($P\leq0.05$) increase in the amount of β-carotene content in fried carrots when compared with raw carrots, whereas a significant decrease ($P\leq0.05$) was observed in boiled carrots. We conclude from our study results that the boiling process leads to heat disruption of β-carotene, whereas the oil fry enhanced the extraction release of β-carotene in low flame condition.*

Keywords: *Carrot, Boiling, Oil fry, β-Carotene, Vitamin A precursor, Hexane extraction.*

Introduction

The components in the plant having health promoting metabolites are called phytonutrients [1]. Carotenoids are naturally occurring pigments, richly colored molecules (yellow, orange, and red colors) which are synthesized by plants, algae, and photosynthetic bacteria. Fruits and vegetables provide 40 to 50 carotenoids which are beneficial to human diet. The phytochemicals such as α-Carotene, β-carotene, β-cryptoxanthin, lutein, zeaxanthin and lycopene are the most common dietary carotenoids. Among which β-carotene is the most abundant form of provitamin A in fruits and vegetables [2]. The other two carotenoids with vitamin A activity such as alpha-carotene and beta-cryptoxanthin, are not prevalent in foods. β-carotene is an effective source of vitamin A in both conventional foods and vitamin supplements, and generally safe to consume [3]. Carotenoids are with huge C40 polyenes, orchestrates by all photosynthetic organisms, few fungi and bacteria and are reported to be essential for the photosynthesis mechanism in plants [4]. Industries are synthetically preparing the major carotenoids like β-carotene, canthaxanthin, zeaxanthin, lycopene and astaxanthin in large scale for vitamin supplements, health products and food additives [5]. β-carotene and other carotenoids exhibit free radical scavenging activity (Antioxidant) in addition to its precursors role for vitamin A and hence it can be easily taken in our daily diet [6]. Free radicals are the compounds, which causes numerous diseases, ranging up to cancer. [7]. Intake of antioxidants rich diet can give protection against free radicals and it is proven to decline the diseases and increase the human life quality [8]. When compared with the other colored vegetables carrot is having more antioxidants and it's called as gold mine of antioxidants.

It is reported that carrot juice extract have anti-carcinogenic effect on myeloid and lymphoid leukemia cell lines [9]. Besides anti-carcinogenic property it reduces inflammation and modulate immune response [10]. The bioavailability of the carotenoids and other contents varies when the vegetables are processed. There have been quite distinct variations in the carotenoid content, especially β-carotene, of raw, cooked, blanched and fried vegetables. A study done by[11] Mosha has shown that the conventional blanching and cooking processes resulted in a significant increase in the concentration of carotenoids in the cowpea, peanut and pumpkin leaves while in amaranth and sweet potato greens, the thermal

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processing resulted in a significant decrease in the concentration of these nutrients. This means that the carotenoid retention is different for different vegetables and also dependent on the method of processing of the vegetables. Comparing to other vegetables, carrots can provide significant amount of vitamin A in the human diet, due to the high bioavailability of carotenoids. By considering the significance of carrot and its common use as a vital source of β- carotene or pro-vitamin A for humans, it is worthwhile to analyze the effective way of intake of carrot to achieve maximum level of carotenoid and to minimize loss of β-carotene. In this study, we have analyzed the level of β-carotene in differently processed carrots such as boiled carrot and oil fried carrot and compared with raw carrot.

Material and methods

Chemicals

Standard β-carotene was purchased from sigma and all other chemicals used for this experiments were of analytical grade and purchased from Hi-Media.

Sample Preparations

Experiment was conducted in three different ways for the carrots, Sample 1: raw carrot (2g) sample 2: boiled carrot (2g) and sample: 3 fried carrot (2g). The extraction of the β-carotene was repeated thrice with all three sample types in order to check for concordant results.

Extraction of β-carotene from different samples

Sample 1: Raw carrot

Carrots were washed under running tap water and dried. Sufficient amount of the carrot sample was scraped and 2gms of scraped sample was placed inside the mortar and 10 mL of acetone was added into it. The sample was ground well using the pestle and the semi liquid paste was collected in a separating funnel.

Sample 2: Boiled carrot

Carrots were washed under running tap water and after drying 2gms of sample was placed in a small vessel using induction cooker in minimal amount of water for 3-4 mins. After boiling the carrot sample was placed inside the mortar and 10 mL of acetone was added into it. The sample was ground well using the pestle, transferred in a separating funnel.

Sample 3: Fried carrot

Carrots were washed, dried and was scraped. Then 2gms of scraped sample was kept in a small pan 4-5 drops of cooking oil. Sample was cooked by stir fry for 10-15min using induction stove. Then the sample was transferred in the mortar. The oil used for frying was also taken to ensure minimal loss of any beta carotene. The sample was then ground with 10ml of acetone well using the pestle. The pasty liquid was collected in a separating funnel

All the three samples were then processed as follows:

20 mL of hexane (solvent) was added for the extraction of carotenoid pigments. The extraction was kept undisturbed for 5 mins and then washed with 40 mL of NaCl (0.9%) solution. The bottom aqueous layer was discarded and the top hexane layer was collected in a beaker. The volume was made up to 25 mL using hexane and the absorbance was measured at 470 nm for the β-carotene for all the three samples [12].

Colorimetric Analysis of Standard β-Carotene

Stock solution of 100 ppm was prepared by dissolving 20 mg standard β-carotene in 20 mL of hexane. A working standard of 10 ppm was prepared by taking 10 mL of stock solution and making it up to 100 mL using hexane. Further dilutions of 2 ppm, 4 ppm, 6 ppm, 8 ppm and 10 ppm were made from the working standard. The absorbance values of all the dilutions were noted and a standard curve was plotted to calculate the β-carotene level present in the test samples. [13]

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Statistical Analysis

Single factor Analysis of Variance was employed to analyze the difference in β-carotene levels present in boiled and fried carrots with that present in raw carrots. The level of significance was taken as p value less than or equal to 0.05 in comparison.

Results

Standard Graph of β-Carotene

The β-carotene values were obtained using colorimetric method and a linear curve was obtained. The linear equation as well as the regression value was found out as shown in figure 1. Using this linear equation, we found out the amount of β-carotene content in the test samples. The amount of β-carotene content in the test samples were estimated from the standard graph

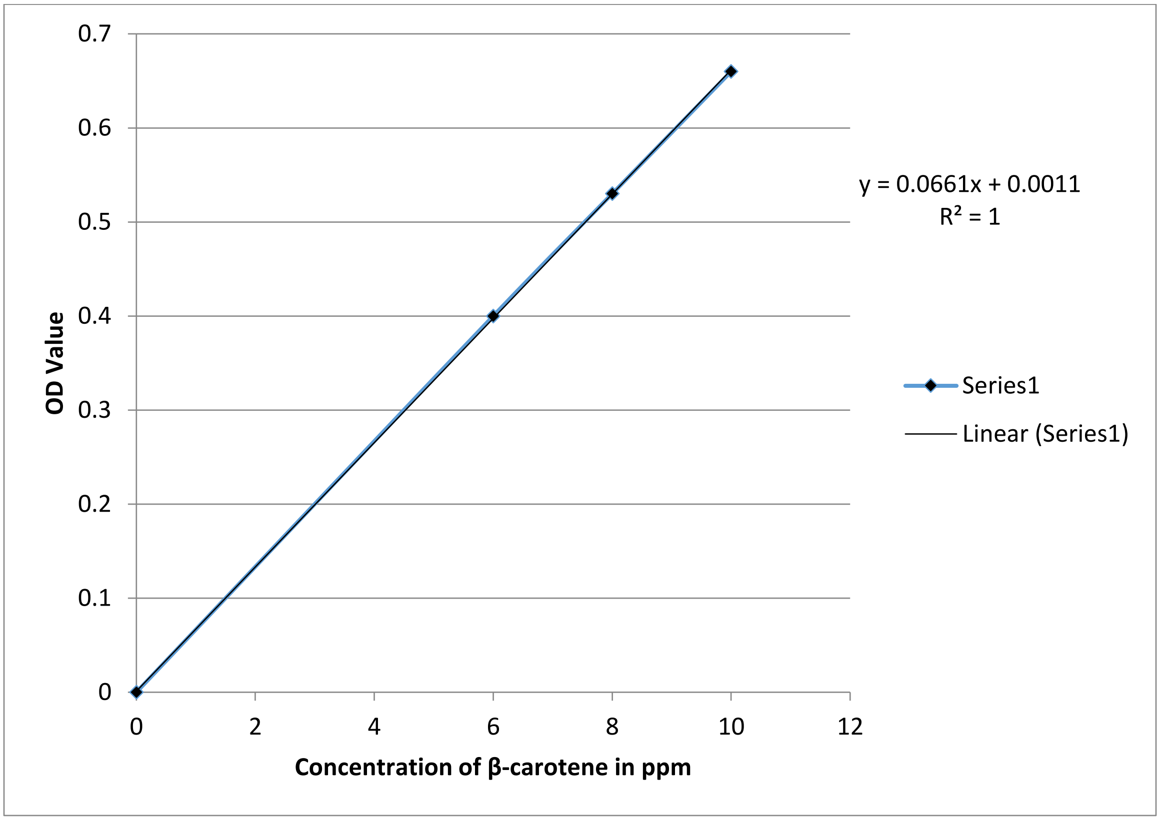

Fig 1: Linear equation as well as the regression value of the β-carotene standard using Colorimetric method.

Level of β-Carotene in Test Samples

The amount of β-carotene present in boiled and fried samples of carrot was compared with that of in raw carrot. The level of significance ($p \leq 0.05$) is shown with (*) symbol. A significant decrease in level of β-carotene was observed in both boiled carrot 6.388 ±2.015 when compared with raw carrot. Surprisingly the fried carrot showed significant increase in β-carotene level compared to raw carrot as shown in table 1 and figure 2.

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Table 1: Level of β-carotene estimated in carrot samples

Sl. No.	Samples (2g)	β-carotene in ppm (x)
1	Raw Carrot	13.549 ± 0.531
2	Boiled Carrot	6.388 ±2.015 a*
3	Fried Carrot	15.364 ±1.287 b*

a – Raw carrot compared with boiled carrot
b – Raw carrot compared with fried carrot
(*) – Level of significance ($p \leq 0.05$)

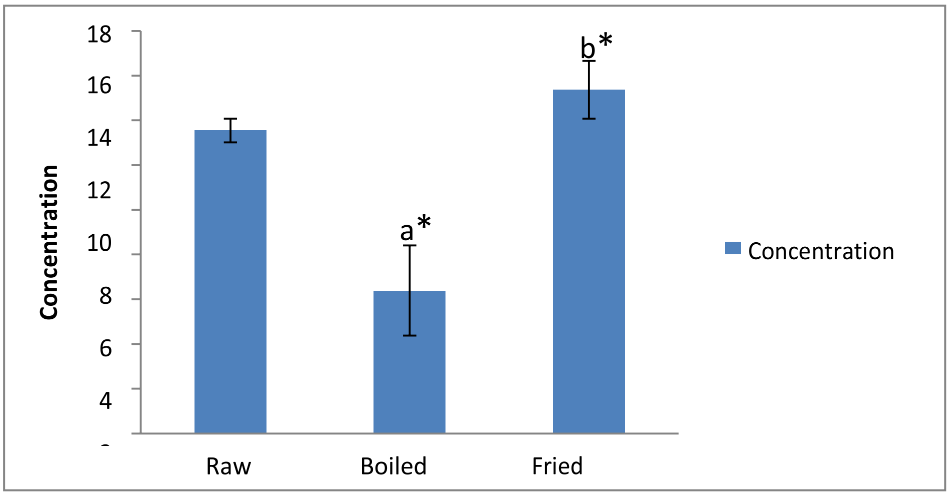

Fig 2: Bar graph depicting the mean concentrations of β-carotene content in different carrot sample

The values of experiment are given in mean ± SE of triplicate values. The values of boiled and fried samples were compared with Raw carrot, ie., a – Raw carrot compared with boiled carrot; b – Raw carrot compared with fried carrot.

(*) – Level of significance ($p \leq 0.05$)

Discussion

Vegetables and fruits will increase the biological mechanism of human life in positive way. The early stage of diseases, cancer initiation and the free radicals will be reduced by an increased consumption of fruits and vegetables [14]. The public, medical community and health organization are having unparalleled interest on their safe and protective health through food supplements. The availability of the Vitamins and antioxidants in fruits and vegetables is altered by various processing methods like heating, boiling and maceration, such major alteration will happens in vitamin C, vitamin A and phenolic antioxidant contents. Processing of the carotenoid containing vegetables may increase or decrease the availability of the β-carotene [15]. β-carotene and α-carotene are natural phytochemical with rich antioxidants and both are gaining much interest for research due to their provitamin- A nature. Carotenes exhibit wide range of antioxidant activity [16] with anticancer properties [17] and it is found that 2.4mg of β-carotene can supplement vitamin A need. It is already reported that after cooking, the antioxidant activity will increases or remains unchanged [18]. The heat treatment in *Phaseolus vulgaris* affected the antioxidant properties i.e the antioxidant content was decreased when compared to the raw *Phaseolus vulgaris* after cooking. Boiling has reduced the initial antioxidant capacity till 30% in the yellow variety and also reduced (43%) the phenolic content in green variety, whereas the biogenic amines were significantly increased in both the varieties after boiling [19].

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The carotenes content also differed after cooking although the mechanism is unknown. In a previous study carotene content in raw carrot was 29% and by adding olive oil to carrot during cooking the carotenes content again drastically increased to 80%. They concluded that the addition of oil during cooking increased the carotenoid extraction [20]. In our current investigation also it is proven that the amount of β-carotene is altered during different cooking process when compared with that of in the raw carrot. However, in our study the concentration of β-carotene declined in the boiled carrot when compared with the raw and it was increased in the fried carrot when compared with the raw carrot. Both alterations showed a significant difference ($p < 0.05$) in statistical comparison. Another study has shown a decrease in β-carotene content heating process and this decrease in the β-carotene values is suggested to be due to the disruption in the cellular matrix caused by thermal exposure [21]. The duration of boiling also acts as a factor of loss in the β-carotene values as shown in another study done on β-carotene content in tomatoes. As the time of boiling increases, the stability of the molecule was affected, suggesting that β-carotene is a heat labile compound [22]

In our study, on contrary to the decreasing effect of boiling process on β-carotene content, the oil fry has significantly ($P \leq 0.05$) increased the β-carotene level when compared with raw carrot. A previous study has estimated the carotenoid accessibility in carrots and they observed a significant raise of accessible β-carotene amount in the homogenized sample with the addition of gram oil [23] suggesting the role of oil in enhancing β-carotene extraction. Ingestion of fat along with carotenoids is thought to be crucial in the absorption process [24]. Dietary fat provides a hydrophobic environment for the released carotenoids that would be dissolved into small lipid droplets and is facilitated by mechanical mixing. Public sector, food industry people and health care are showing keen interest in the carotenoid contents mainly β-carotene due to its wide range of health benefits. Industrialists are also showing interest to find out an enhanced availability of β-carotene in different food sources to make it as commercial product for the human benefit.

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Conflict of Interest

The author declares that there is no conflict of interest.

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