Factors Affecting Carotenoids in Carrots (Daucus Carota)

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Abstract:

Carrot is the first source of carotene. It is the most important source of vitamin A. Carrots contains carotenoids such as α-, β-, γ- ζ-carotene, lutein, β-zeaxarotene and lycopene.

Carotenoids are not only color pigments in the eyes but also bioactive substances which have a positive effect on human health.

Epidemiological studies show that carotenoid-rich fruit and vegetable consumption reduces the risk of tumor formation, lung, stomach and bladder cancers, cardiovascular diseases, eye diseases (cataracts, age-related macular disorders), and strengthens the immune system. Carrots are rich in vitamins, minerals, pulp, antioxidants and carotenoids and are an important vegetable species in terms of health.

However, carotenoids in carrots vary in many ways. For this reason, factors affecting the carotenoid content in carrots (species, varieties, climatic factors, growing conditions, light-dark / glossy-mat formation of carrot color, postharvest preservation conditions, drying for fresh, frozen and functional food etc.) Literature studies will be tried to be conveyed.

Key words: *Daucus carota L., Carotenoids, Beta carotene, Vitamin A*

1. Introduction

Carrot is a kind of umbrella flowers (Umbelliferae, Apiaceae) family (Daucuscarota L.). Despite being the homeland of Afghanistan and Pakistan, the carrot is a vegetable produced and consumed everywhere in the world [1], [2].

Nowadays, the importance of healthy nutrition and the positive effects of vegetables on human health have been determined, and therefore the importance of carrot plants containing antioxidant substances such as beta carotene and vitamin A is increasing.

Experts have reported that carotenoids reduce the risk of lung, bladder and stomach cancer due to its antioxidant properties [3]. Recently results have been obtained in which carotenoid pigments inhibit tumor growth or slow the development of carotenoids [4]. Carotenoids strengthen the immune system and protect the surrounding tissues and are also reported to have a strong association between carotenoid ingestion and some diseases such as cardiovascular disease, bone calcification, and neurological disorders, as well as the reduction of risk for many cancer types [5]. Lutein and zeaxanthin in the retina protect eye-free radicals and harmful effects of light [6]. It prevents the formation of eye diseases like

cataracts and age-related macular disorders [7].

Excessive intake of vitamin A, also known as hypervitaminosis A, manifests itself as an acute (short-term) or chronic (long-lasting) toxic effect. Hipovitaminosis, known as vitamin A deficiency, is a common disease, especially in developing countries, and is a serious disease that causes rather common and distressing consequences. Vitamin A is given as retinol equivalent and the vitamins required to be taken on a daily basis are given in (Table 1).

Table 1: Reliable limit values for Vitamin A. [4]

Yaş	Yaş	RE*/gün (µg)
Bebek ve çocuklar (kız ve erkek)	0-1	350
	1-6	400
	6-10	400
	12-15	600
Gençler		
Erkek	15-18	600
Kız	15-18	500
Erişkinler		
Erkek	18+	600
Kadın	18+	500
Hamileler		600
Süt emziren kadınlar		850

*RE: Retinol eşdeğeri

2. Carotenoids

It is one of the most important pigment groups in nature with its wide dispersions, structural differences, various effects and functions. Carotenoids, which are the main source of yellow, red and orange plant pigments, are commonly found in fruits and vegetables. They can not be synthesized by any mammal species, including humans. There are about 600 carotenoids identified from natural sources. It is insoluble in water, soluble in organic solvents and some in oils. Carotenoids have high boiling points and range from 130 to 220 ° C. Carotenoids show maximum absorbance at wavelengths of about 430-480 nm [9].

Carotenoids also determine biological functions such as absorbing light during photosynthesis in plants, energy transfer and protecting cells from harmful effects of light [10]. In addition, some of the carotenoids found in roots and the leaves, foliage are abscisic acid precursor which is a chemical carrier and growth regulator compound [9].

Since carotenoids are lipophilic compounds, they are soluble in oil, organic solvents such as chloroform, benzene, petroleum ether, carbon disulfide and are not soluble in alcohol. Carotenoids, which have a polyunsaturated structure, undergo isomerization during processing and storage with stability to heat.

2.1. Digestive Absorption and Storage of Carotenoids

Carotenoids liberated from food dissolve during the digestion by turning into smaller lipid emulsion particles. Soluble carotenoids are transported from the midair to the duodenum, the first part of the small intestine. The digestion of carotenoids in the duodenum is effected by the pancreatic lipase enzyme and bile salts [11].

Many factors affect the absorption of vitamin A and carotenoids. These are the amount of fat, protein and antioxidant found in food and the permeability of pancreatic enzymes, bile acid and mucosal cells in the intestinal lumen. The absorption rate of vitamin A on diet is 80-90%. Conversely, the rate of absorption of beta-carotene is 40-60%. While 90% of Vitamin A is stored in the liver, 10% is stored in other tissues. Deficiency of zinc or vitamin E disrupts vitamin A metabolism. Because,

these two vitamins play an important role in the absorption and transport of vitamins.

Carotenes can be stored in fat, liver, adrenal glands, testes, overdoses and deep. Deep deposits give the skin a yellowish color. It's called carotenoderm. This is a harmless situation. Carotenodermia has nothing to do with daily intake or nutritional support. However, zinc, thyroid hormones, vitamin C, protein, such as the lack of essential factors may show.

2.2. Bioavailability of carotenoids

Where the carotenoids are present in the plant (eg whether they are complexed with protein in cell chloroplasts or in crystal form in chromoplasts) affects bioavailability [12]. Cooking, shredding and purifying vegetables makes the carotenoids more useful during the absorption of the scaffold, causing particle sizes to shrink and the plant cell wall to break down [13]. While boiling increases utility, boiling reduces pro-vitamin activity and bioavailability by causing oxidation and isomerization of carotenoids [14].

3. Material and Method

As a research material, factors that affect carotenoid amounts in different carrot cultivars were tried to be brought together.

In the doctoral studies on mini carrots in Ege University Institute of Science, the carotenoid quantities in baby carrots were determined spectrophotometrically because of the ease of application.

3.1. Quantification of Total Carotenoid Substance

Carrots were made using a modification of the method recommended by [15], the total amount of carotenoids. According to this; 25 g Hexane: Acetone (7: 3) mixture containing 0.01% BHT is added to 0.5 g ground dry carrot sample and mixed on a 30 min shaker. The mixture is filtered through Buchner funnel using Whatman No: 1 filter paper. Extraction 20 ml Hexane: Repeat once with acetone solution. Distilled water is added to the phases collected in the separation funnel to remove the acetone. Na2SO4 is added onto the hexane phase. After filtration through coarse, it is completed in 50ml with hexane. The total amount of carotenoid is determined by reading the absorbance at 450 nm in the spectrophotometer.

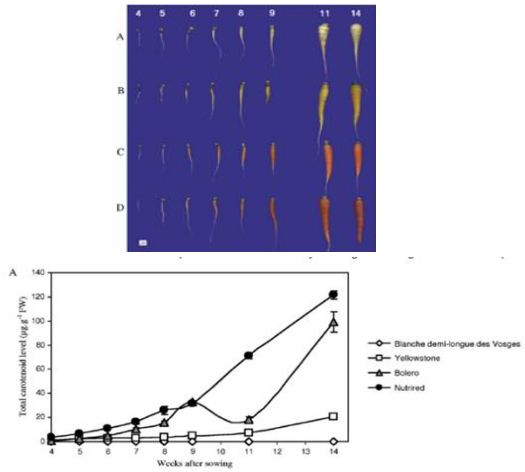
4. Factors Affecting Carotenoid Content in Carrots

4.1. Variety

It has been reported that the amounts of carotenoids in fruits and vegetables vary in different varieties of the same species [16]. Carotenoid amounts in different parts of the solution may vary. Generally, the amount of carotenoid is higher in the crust than in the woody core.

4.2. Maturity and Color

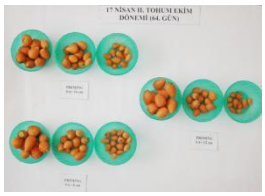
Maturation level on the carotenoid content in plants is affected and carotenoids increase during maturity. In the first stage of carrot development, transversal growth takes place at the progressive stage of longitudinal extension and the color reaches a shiny dark orange color. In a study by Clotault, J., et al. 2008 [17], developmental stages were classified in different carrot cultivars, and after 9th stage, total carotenoid levels increased with maturity (Figure 1.).



Şekil 1: The effects of carotenoids on maturity in carrots

In a doctoral study in Ege University, Faculty of Agriculture, Horticulture Graduates [18]; every month, mini carrot seeds were sown to determine the correct harvesting time and the change between total carotenoid amounts, similar results were obtained with previous studies. In mini carrots, it was determined that total carotenoid amounts were low due to the short production period in spring and summer and high carotenoid amounts due to the length of the time between sowing and harvest in autumn and winter months.


Baby carrot



4.3. Temperature

It has a positive effect on color formation in carrots. During the cold and rainy season, light carrots are obtained. On the harvest period, the color that occurs at temperatures of 10 ° C is not satisfactory. The temperature is directly influenced by root formation and the carrot length is short at high temperatures. At low temperatures, the carrot size varieties feature, but this time the color and the carrot diameter grows worse. Longer, light-colored carrots come to the water. It is seen that a significant part of the plants in the spring production made in the hot regions flow through generative phase without forming enough carrots.

4.4. Fertilization

Studies show that plants are more tolerant to disease and harmfulness by feeding with ideal N, P, K, root development and health values are high. Tenant, S., et al. the effects of different microbial fertilizers on carrot quality characteristics of different dosing applications were investigated and it was determined that carrot had a positive effect on beta carotene content [19].

4.5. Training Conditions and Time

Soil pH is important for carrot breeding. Carrots are susceptible to high acidity. Deeply sandy-clay soils with pH values between 6-6.5 are ideal soil for carrot growing. It has been reported that the amount of carotene is increased as the growing season in the carrot grows longer [20]. B-carotene content (26-55 mg / kg), which is low in summer (June-August), has been determined to reach the highest level in winter (46-77 mg / kg) [20], [21]. In mini carrots, total carotenoid amounts were found to be low due to the short production period in spring and summer time and to be high in autumn and winter months, due to the length of the time between sowing and harvest [18].

4.6. Processing Technology

Carotenoid losses occur during processing such as shredding, grinding ([22] scalding,

cooking [23], drying, freezing [24], irradiation [25] storage [26]) applied to foodstuffs for various purposes. Oxidation is prevented by air removal during canning process, but the content of carotene is decreased due to applied heat treatment and isomerization.

İf canned pickles are made, it was determined that salt treatment and acetic acid in addition to heat treatment were effective on carotenoids, and salt concentration negatively affected the stability of carotenoids [27].

4.7. Storage

Morais et al. 2001 found that the rate of deterioration of carotenoid pigments depend on storage time, oxygen and light availability, while the oxygen effect was the lowest, the storage period was the most effective factor [28].

After harvesting, some quality defects such as carotenoids and loss of flavor and bitterness can occur in carrots. To reduce the loss of quality, carrots are recommended to be stored at 0 ° C and 93-98% relative humidity at the ideal temperature.

5. Result

Carotenoid compounds are of great importance in terms of human health in the treatment of some diseases before the formation of many diseases. The varieties of red and dark orange carrots are richer in carotenoid than the other varieties of carrots. When the carrots are in full color, they must be harvested at the right time and optimum temperature requirements must be met. As it is a cool climate vegetable, its carotenoid content is higher in winter months than in summer months. In suitable climatic conditions sandy-clay, deep, rich in nutrients, pH 6-6,5 soil should be grown by applying an ideal nutrition program. The heat treatment applied in terms of processing technology, grade, duration, cooking method, applied pre-treatments etc. causing carotenoid defects in varying proportions. Storage at different temperatures for different times also causes significant loss of life. Long-term storage causes a decrease in carotenoid amounts even if kept fresh on ideal conditions. Drying and powdering cause carotenoid losses at a certain rate. The extent to which carotenoids can be preserved in carrots can be used more effectively and profitably in the preparation of different types of functional products.

6. References

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