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Processing and value addition of carrot

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Abstract

The advancement of vegetable products is always significant as it contributes to the longevity of vegetables and enhances their quality through the addition of value. This document involves the processing and enhancement of carrot value. In India, numerous types of under-utilized vegetables exist, yet they are not being properly utilized despite their high nutritional value. These crops possess great potential for ensuring sustainability regarding the nation's economy. Carrots are undervalued regarding their processing capability, despite having a high processing capacity. This review provides insights into the processing of carrots and the various value-added products derived from them.

Keywords: Value addition, processing, carrot

1. Introduction

The carrot (*Daucus carota* subsp. *sativus*) is a root vegetable commonly red or orange, but there are also purple, black, white, and yellow varieties. The part of a carrot that is most frequently consumed is the taproot, although the greens are occasionally eaten too. It is a cultivated version of the wild carrot *Daucus carota*, indigenous to Europe and southwestern Asia. The cultivated carrot has been selectively developed for its significantly larger and tastier, less fibrous edible taproot (Kalra *et al.*, 1987)^[16].

Carrots are cultivated from seeds and may require up to 120 days reaching maturity, although numerous varieties can mature in 70 to 80 days when conditions are optimal. They thrive in full sunlight but can endure partial shade. The best temperature range is 16 to 21 °C. The preferred soil type is deep, loose, and well-drained, either sandy or loamy, with a pH between 6.3 and 6.8. Fertilizers need to be applied based on soil type since the crop needs low nitrogen levels, moderate phosphate, and high potash. Avoid rich or rocky soils, as they can lead to hairy and/or misshapen roots (Rubatzky *et al.*, 1999)^[24]. Irrigation is utilized as required to maintain moisture in the soil. Once the crop has sprouted, it is ultimately thinned to a distance of 8 to 10 cm and weeded to inhibit competition below the soil (CSIR, 2010). It is primarily a root vegetable featuring innately decompounds leaves and clusters of tiny white or yellow blooms. The edible part of a carrot is its taproot, consumed either raw or cooked (Simon and Wolff, 1987)^[26].

Carrots can be found year-round, but locally cultivated ones are in season during summer and fall when they taste best and are freshest. Carrots are part of the Umbelliferae family, which is named for the umbrella-shaped flower clusters that these plants create (CSIR, 2010). Therefore, carrots are connected to parsnips, fennel, parsley, anise, caraway, cumin, and dill. Carrots may measure as short as two inches or as long as three feet, with diameters varying from half an inch to more than two inches (Gill and Kataria, 1974)^[12]. Carrot roots possess a crisp consistency and a sweet, minty fragrant flavor, whereas the greens offer a fresh flavor with a hint of bitterness. Although we commonly link carrots to shades of red and orange, they can also be discovered in various other hues such as white, yellow, purple, or black. Indeed, purple, yellow, and red carrots were the sole color variations grown before the 15th or 16th century (Grassmann *et al.*, 2007)^[13].

The bright red or orange hue of the carrot is attributed to β -carotene, along with smaller quantities of α -carotene, γ -carotene, lutein, and zeaxanthin. Both α - and β -carotenes are partially converted into vitamin A, supplying over 100% of the Daily Value (DV) in a 100 g portion of carrots (Simon and Wolff, 1987)^[26]. Carrots provide a decent amount of vitamin K (13% DV) and vitamin B6 (11% DV) (Krinsky, 1989)^[17], but their levels of other necessary nutrients are relatively low.

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Carrot dietary fiber primarily consists of cellulose, along with lesser amounts of hemi-cellulose, lignin, and starch (Davidson-Hunt, 2006)^[8]. Carrots contain free sugars such as sucrose, glucose, and fructose (Fu *et al.*, 2009)^[11]. Carrots can be kept for several months in the refrigerator or throughout the winter in a cool, moist location. For extended storage, unwashed carrots can be stored in a bucket layered with sand, a 50/50 blend of sand and wood shavings, or within soil. A temperature range between 0 and 5 °C is optimal (CSIR, 2010). Wild carrots possess a woody core that is less appealing, leading cultivation to gradually eliminate that trait, resulting in the familiar variety of carrots we recognize today. Carrots are enjoyed by both adults and children due to their crisp texture and sweet flavor, making them a worthwhile vegetable for parents and kids alike (Byers and Perry, 1992). Although people commonly recognize carrots as orange root vegetables, a stunning range of colors exists globally for this type of vegetable. All of these color variations, nevertheless, still fall under the same genus and species of plant, *Daucus carota* (Simon and Wolff, 1987; Kalra *et al.*, 1987)^[26, 16].

Processing and Value addition of Carrot

Canned carrot

Tiny carrots are typically utilized in canning operations. Canning can occur in various ways, including diced, halved, quartered, or whole. The ideal temperature for the blanching process is 71 °C for 6 to 8 minutes, leading to improved quality of the canned product. To enhance the color and quality, carrots underwent thermal treatment, resulting in a rise in the carotenoid content in the products (De Sa and Rodriguez-Amaya, 2004)^[2]. Multiple studies indicated that the leaching of soluble solids during blanching is the primary factor contributing to the rise of carotenoids (Sulaeman *et al.*, 2001)^[28] and (Puuponen-Pimia *et al.*, 2003)^[20].

Dehydrated carrot

Blanched pre-treated dried carrot is said to have more β -carotene and less ascorbic acid compared to unblanched dried carrot. The blanching process also inhibits the nonenzymatic browning of carrots (Negi and Roy, 2001)^[19]. Extended drying periods and excessive heating of the product caused a brown hue, diminished flavor, and reduced rehydration capacity (Giri and Prasad, 2007)^[14]. Pre-treating shredded carrot with a 5% sugar solution while blanching before dehydration was found to improve the retention of color and flavor; according to Alam *et al.* (2013)^[2], convective drying of citric acid blanched carrot at 65 °C was superior to solar drying, sun drying, and convective drying methods. Freeze drying has proven to be an outstanding method for preserving not just carotenoids (96-98%) but also the flavor and color of carrots (Rodriguez-Amaya, 1997)^[23]. The use of vacuum and microwave drying reduces shrinkage while drying, leading to less damage to the physical structure and increased porosity (Béttega *et al.*, 2014)^[4]. Ultrasonic technology for drying is an energy-efficient method

Carrot pickle

NaCl (sodium chloride) brine or potassium metabisulfite is utilized for the industrial manufacturing of pickles. It also prevents the carrot from softening since it serves as a

preservative (Fernads, 2000)^[10]. The application of lactic acid assists in the fermentation processes of carrot pickles. According to reports, pickles serve as a great appetizer and enhance the flavor of a meal (Sultana *et al.*, 2014)^[29].

Carrot juice

Carrot juice is typically blended with other juices like orange juice and pineapple juice, which are quite popular in non-alcoholic drinks, and it is also utilized in the fermentation of yogurt. The juice extract from blanched carrots was observed to exceed that of cold-pressed juice, and blanched carrots also contain a higher quantity of carotenoids. Grinding carrots to a particle size of 6-2 mm increased yield by 0.7% per millimeter and enhanced the juice color for blanched and macerated carrots (Bin-Lim and Kyung-Jwa, 1996)^[5]. Carrot juice is a high source of α and β carotene.

Carrot juice helps to lessen the bitterness of kinnow and mandarin juice. (Salwa *et al.*, 2004)^[25] included carrot juice at a concentration of 5-20% in milk to produce high-quality carrot yogurt. To maintain the juice for a longer duration, various modern methods such as ozone processing, ultrasound treatment (US), high pressure (HP), and ultraviolet treatments are utilized (Adiamo *et al.*, 2018)^[1]. According to reports, the shelf life of UV treated carrot juice was extended by as much as 12 days without any notable changes in the physicochemical and sensory properties of the juice kept at 4 °C (Riganakos *et al.*, 2017)^[22].

Carrot candy

It is a confection made from carrots by soaking them in sugar syrup, then removing excess syrup and drying to achieve a stable condition (Haq Raees-ul and Prasad, 2015)^[15]. It has been noted that the total soluble solid content of the carrot candy must be 70-75°B (Beerh *et al.*, 1984)^[3]. The carrot candies stored in glass and LDPE materials possess enhanced sensory qualities

Carrot jam

The pulp is boiled with a specific amount of sugar and pectin until it takes on a jelly-like consistency. While jam is typically made from fruits, researchers have effectively adapted the process to certain vegetables, including tomato, cucumber, pumpkin, sweet potato, and carrot (Haq Raees-ul and Prasad, 2015)^[15]. Currently, during the making of jam, carrot juice is mixed with citrus juice to prevent the oxidation of carotene.

The mixed ingredients are heated with sugar and lemon juice along with pectin to create a suitable gel. This method is highly favored because it preserves a majority of the original compounds such as phenolics, carotene, and potassium, along with their color characteristics (Renna *et al.*, 2013)^[21]. Black carrot juice has been utilized as a dye in the production of strawberry jam (Kirca *et al.*, 2007). Ultrasound-assisted vacuum drying has advantages over traditional drying techniques (Chen *et al.*, 2016)^[6].

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