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Effect of citric acid, calcium lactate and low temperature prefreezing treatment on the quality of frozen strawberry



Magdy Abd-Elhady

Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

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Abstract Texture degradation and color fading of frozen strawberries consider to be a serious problem affect their quality. Therefore, in the present study the fresh strawberry immersed in various concentrations of citric acid and calcium lactate alone or in combination for 5 min. and kept at low temperature (5 °C) for overnight before freezing or frozen directly for controlling these defects. The obtained results declared that pretreatment with citric acid dip obviously enhanced the retention of ascorbic acid and total anthocyanins content and lowered the browning index while Calcium lactate maintained the texture by reducing the drip loss and increasing the firmness after thawing. The precooling treatment did not show any enhancer affect in the quality indices of frozen berries. Compared to the other treatments, the use of 0.4% citric acid – 1% Ca lactate combination dip achieved better quality attributes, including reduction in drip loss and enhancement of firmness, retention of ascorbic acid and anthocyanin content in addition to improving in color attributes.

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Introduction

The strawberry belongs to the family Rosaceae, genus *Fragaria*, and is among the most widely consumed fruits throughout the world. Strawberries are a good source of Folate and Potassium, and a very good source of Dietary Fiber, Vitamin C, Manganese and antioxidants (Garcia et al., 1998).

The annual world production of strawberries according to FAO (2011) reached to 4,308,179 metric tonnes. Egypt occupies fourth order in the world production with quantity

reached to 240,254 tonnes produced from 5628 Hectares' (about 13,400 Feddan) represented 5.57% of the global production of strawberries and exported about 74,976 tonnes, equivalent to 58.721 million US \$ (FAO, 2011).

Strawberries are consumed mainly as fresh fruit. In addition, many other strawberry products such as juice, nectar, puree, and juice concentrate as well as jam are commercially available. Due to the highly fragile structure of strawberry fruit and their high rates of respiration, their postharvest life is relatively short (Tucker, 1993). Freezing, a simple and fast method of strawberry preservation, maintains their natural color, and nutritional value. The main components, upon which the nutritional value of foodstuff depends, are preserved best in frozen foodstuffs (Cesnauskas et al., 1998). Freezing

E-mail address: sidky1234rehab@hotmail.com

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strawberries is known as a good method for increasing shelf-life, but this berry undergoes quality changes throughout the whole frozen food chain. i.e. freezing, subsequent frozen storage and thawing (Kmiciek et al., 2000).

Inevitably, the freezing process and the frozen storage have negative impacts on food quality. The main physical changes that occur during frozen storage are moisture migration and ice recrystallization (Van Buggenhout et al., 2006). Both phenomena are related to the stability of products (frozen water) which affects the vegetable texture and loss of nutrients and weight if thawing drip loss takes place (Pukszta and Palich, 2007). Moreover, chemical changes in frozen vegetables are related with onset of off-odor and off-flavors (especially if vegetables were not blanched) (Nielsen et al., 2003), pigment and color degradation (Lisiewska et al., 2004) and chemical oxidation e.g. of vitamin C (Serpen et al., 2007).

It is well known that calcium plays a major role in maintaining the quality of fruit and vegetables. Increasing the calcium content in the cell wall of fruit tissue can help to delay softening and mold growth and decrease the incidence of physiological disorders (Poovaiah, 1986). Calcium dips have been employed to improve firmness and extend the postharvest shelf-life of a wide range of fruit and vegetables. With regard to strawberries, several authors have reported that CaCl_2 dips in combination with heat treatment or modified atmosphere storage and refrigeration increase calcium content and fruit firmness and delay postharvest decay (Rosen and Kader, 1989 and Garcia et al., 1996). Although CaCl_2 exerts a beneficial effect on fruit texture it has been reported to impart bitterness (Monsalve-Gonzalez et al., 1993). Organic calcium salts are an alternative calcium source and calcium lactate has been described in the literature as a firming agent for several fruit (La Cerda et al., 1999). According to Lawless et al. (2003), the bitter and salty tastes associated with calcium chloride are largely suppressed when calcium is combined with larger organic ions such as lactate, gluconate or glycerophosphate. In addition, organic acid salts of calcium such as citrate, lactate and gluconate are more bioavailable than the inorganic salts and enhance the nutritional value of foods (Labin Goldscher and Edelstein, 1996).

Besides texture and economic considerations, color is one of the most important attributes affecting consumer acceptance of food. Color stability of strawberry products, particularly after heat and light exposure, remains a challenge (Carle et al., 2001). In general, several factors are believed to affect the color and stability of strawberry anthocyanins include structure and concentration, pH, temperature, light, presence of co pigments, self association, metallic ions, enzymes, oxygen, ascorbic acid, sugar and their degradation products, proteins and sulfur dioxide (Mazza and Miniati, 1993 and Rhim, 2002). The stability of anthocyanin and phenolic content was influenced by several factors (Jiang, 2000). Among them, polyphenoloxidase plays an important role in the degradation of anthocyanin and phenolic content. Citric acid has been used extensively for the inhibitory activity on polyphenoloxidase and the anti-browning activity in minimally processed fruits and vegetables. Citric acid extracts have a double inhibitory effect by chelating copper at lower pH (Altunkaya and Gokmen, 2009). Sistrunk and Moore (1979) mentioned that bright red color of strawberry is related to acidity. High acidity and low pH stabilize strawberry color by inhibiting polyphenoloxidase during frozen storage and thawing.

Therefore, the aim of this study was to investigate the possibility of reducing the undesirable changes in color and texture of frozen strawberry by prefreezing treatments of citric acid and Ca lactate either frozen directly or after cooling for overnight at 5 °C before freezing.

Materials and methods

Materials

- Strawberries (*Fragaria ananassa*) of season (2012) used in this study were purchased from the local market in Giza governorate, Egypt.
- Chemicals used in this study were of analytical grade and purchased from El-Gomhoria Co.
- The anthocyanin standards from Carl Roth GmbH (D-76185 Karlsruhe, Germany).

Methods

Fresh strawberries were uncapped and sorted to select those full red color, being of uniform size and free of physical damage and fungal infection then washed by tap water. A mount of 1000 g berries were used for each treatment and dipped for 5 min at room temperature ~ 25 °C in various concentrations of citric acid and Calcium lactate solutions as follows:

- Citric acid solutions with concentration of 0.2%, 0.4% and 0.6%.
- Calcium lactate solutions with concentration of 0.5%, 1.0% and 1.5%.
- 0.4% citric acid solution contained either 0.5%, 1.0% or 1.5% Calcium lactate.
- Untreated sample dipped in tap water for 5 min.

Each treatment was divided into two equal portions, the first one was held overnight at 5 °C before freezing and the other portion was frozen directly. All treatments were frozen by individual quick freezing (IQF) technique in a flow freeze air blast unit at -40 °C through 20 min. Each 500 g of frozen treatments were packaged in polyethylene bags and tightly sealed. All frozen samples were stored at -18 °C for 12 month according to Egyptian Standard (ES 2368/2008). Physicochemical analysis of the frozen samples was conducted in a three replications after 24 h of thawing at 5 °C.

Analytical methods

- Total soluble solids, total titratable acidity, pH values and ascorbic acid were determined according to AOAC (2005).
- Browning index was determined according to the method of Meydev et al. (1977), as its light absorbance at 420 nm.
- Determination of Firmness (N)*: Firmness (N) measurements were performed with a universal testing machine (Comietech, Type B, Taiwan) equipped with a 2000 N load cell and operated at a crosshead speed of 20 mm/min. The force needed to compress the disk to 15 mm with a flat-plate probe (25 mm diameter) was registered. All measurements were performed at 25 °C as reported by Susana and Almeida (2008).

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