International Food Research Journal 23(Suppl): S119-S123 (December 2016)
Journal homepage: *http://www.ifrj.upm.edu.my*

Influence of temperature and blanching duration on quality of minimally-processed carrot (*Daucus carota*, l.) during freeze storage

*Santosa, Mislaini, Hasan, A. and Umam, K..

Department of Agricultural Engineering, Faculty of Agricultural Technology Andalas University, Limau Manis, Padang, Indonesia 25163

Article history

Received: 20 November 2016
Received in revised form: 5 December 2016
Accepted: 6 December 2016

Keywords

Carrot
Temperature
Blanching
Minimally-processed carrot
Freezing storagee

Abstract

The objective of this study is to identify the quality of minimally-processed carrot during freezing storage toward temperature and blanching time. The result of research shows that minimmally-processed carrot at freezing storage could maintain its good quality till 14 days. Damaging of tissue and the loss of turgor pressure in carrot slice occur after 14 days. Meanwhile, in the prevailing condition, the blanched carrot could maintain till 2 days only. It is indicated by the soft-slice, rotten smell, and decay of slice. The best hardness obtained on sample for 14-day stored at 70°C, in 2 minutes and 4 minutes viz. 130.234 kPa. The best condition for maintaining amount of vitamin C content of carrot was found at 70°C as long as 4 minutes viz. 0.022%. The treatment of temperature and blanching time during the freezing storage gave the effect toward weight loss, diameter-shrink but not giving the effect on the water level, hardness, and vitamin C.

© All Rights Reserved

Introduction

Carrot (*Daucus carota*, L.) is one of the renowned vegetables in Indonesia with high pro-vitamin A, Vitamin B, vitamin C, and healthy consumed (Kumalaningsih *et al*., 2005). Generally, people prefer to consume fresh vegetable due to its valuable benefits. However, consumers may not provide their own needs of fresh vegetables because their time is limited. Then, consumers will choose the ready vegetables to be consumed.To provide the needs of human being regarding the fresh vegetables, then minimally-processing technique can be used. The goal of minimally processing of horticulture products is to maintain the freshness of the product without any reduction on its nutrient content and extend the self-life of the product (Antara, 2007).

According to King and Bolin (1989), fruits and vegetables which is processed by minimally-processing are the fruits and vegetables that prepared for easiness to be consumed and distribution. Carrot is one of the commodities that prone to get damage and it needs to have proper handling after harvesting to ensure its quality till reaching the consumer (Samadi, 2014). The damage is caused by the enzyme activities and micro-organism infestations. To inhibit enzyme activities and microorganism infestation, then the blanching process conducted. Blanching is a process which subjected to food by dipping into hot water in short time (Fellow, 1997).The aim of thi process is to reduce and stop the enzyme activities in products (Muchtadi, 2010). Blanching process may be solution for reducing use of chemical in fruit and vegetables processing. Freezing process may control growth of microorganism and enzyme activity. Packaging also play important role in prevent the decaying process. The packaging aims to evade the physical and chemical damaged. Based on discussion above, it then needs a research to know the quality of minimally processed carrot (*Daucus carota*, L.) during its freezing storage in differrent of temperature and blanching time. The result of this research will contribute as a source of information and a reference for industrial society or the researcher.

Materials and Methods

Place and time

This research has been conducted in September to November 2014 at laboratory of Food Processing and Agricultural Product, laboratory of Technology and Engineer of Agricultural Product of Technology, Faculty of Agricultural Technology, and laboratory of Nutrient Non-Ruminants', Faculty of Animal Husbandry, Andalas University, Padang.

*Corresponding author.
Email:*santosa764@yahoo.co.id*

Plant material and instruments

The material used in this study was a fresh carrot which bought from the farmer field. The tool used were water bath with type H-SWB-50 L, freezer, digital force gauge with type FGS-5S to measure its firmness, thermometer, thermometer infrared with type TM-908, vernier caliper, oven, and digital scale with type ABJ 320-ANM.

Research implementation

The first step of this research was blanching process, where carrot was put in water bath type H-SWB-50 L, then the device operated at 60°C, 70°C and without blanching treatment for 2 minutes and 4 minutes. The temperature of freezing storage was -18°C and at room temperature 29°C. Then carrot was blanched, and washed in cool water at temperature 5°C for 3 minutes. The carrot then was sliced for 5 minutes to reduce water level and packed with plastic polypropylene (PP). Temperature of freezing storage at -18°C was set for collecting data. Carrot put at outside at ambient temperature as control.

Observation

The observation was done for both blanched carrot and without blanching. The observation did at room temperature 29°C and -18°C. The observation was conducted until carrot not accepted by the consumer which indicated by its texture. It was brown color of peel, soft flesh, rotten smell, damaged texture. Parameter have been conducted for ; weight shrinkage, diameter shrinkage, hardness, water content and vitamin C.

Results and Discussion

Freezing is one way to anticipate deteroration of the food and prolong its shelf-life. This technology is quite simple and less time consuming. It can inhibit growth of bacterias, molds, and yeasts on the food that can accelerate decaying process. Frozen carrots will be more durable because the microbial activity stops and enzyme activity as well. Inhibition of growth of microorganisms in food caused by water was no longer available. While inhibition rate of chemical reaction caused by the system has turned into a solid solution so that the water no longer serves as a solvent. Minimally processed of carrots at freezing condition after thawing has different characteristics againts fresh carrots. The minimally processed of carrot have a softer texture and chewy. It caused by treatment of low temperatures, which can cause physical damage indicating the occurrence of tissue damage and loss of turgor pressure in the sliced carrots. Other damage occurs as a part of the outbreak of sliced carrots and uneven texture can give effect to the quality of minimally processed carrot during storage.

Weight loss

Figure 1 shows increasing of weight loss of blanched minimally-processed carrots from day 0 until carrots cannot be consumed. The weight loss occurred at temperature 60°C for 2 minutes was 36.14%, temperature 60°C for 4 minutes was 38.57%, temperature of 70°C for 2 minutes was 39.70%, temperature of 70°C for 4 minutes was 41.79% and without treatment (control) was 36.53%. The highest weight loss occures at 70°C with a time of 4 minutes was 41.79% and the lowest weight losses found in carrots minimally processed without treatment blanching (control) was 36.14%. Weight losses caused by water content inside the carot was out and become ice crystals. This process occurs because the ice crystals have a lower vapour pressure than the pressure for the cell, so water inside cells will lead to be crystal and lose during the thawing process done.

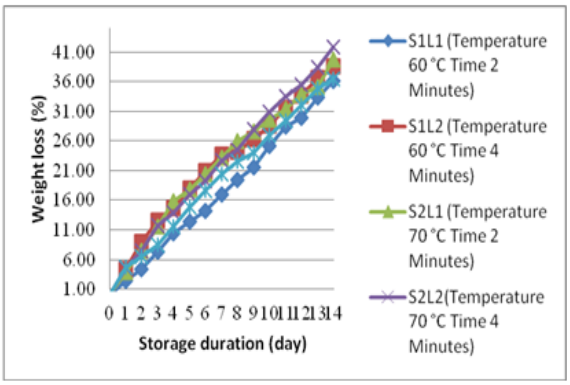

Figure 1. Weight loss of minimally processed of carrot during freezing storage

Loss of water content will cause the turgidity decreasing, weight reducing. It caused by evaporation. The evaporation occurs due to store in cold temperature i.e -18°C. It is caused by air inside the chamber too dry (low RH), and water inside carrots evaporate to achieve the balance. Consequence of evaporation are wilting, drying, hardening and weight loss. Ryall and Lipton (1983) reported that the loss of water from commodities influenced by temperature and also influenced by the relative humidity of the surrounding environment.

Figure 2 shows that the highest weight loss occurred at temperature 70°C for 4 minutes and increase on weight loss i.e. 7.3%. It was caused by blanching with long and high temperatures will result the elements in minimally-processed carrots decomposed due to degradation of the material.

The decline of weight loss during storage at room temperature showed decreasing on weight. The availability of high number of O_2 and fluctuation of temperature would accelerate the process of evaporation which causing water loss (Supriyatmi, 2011).

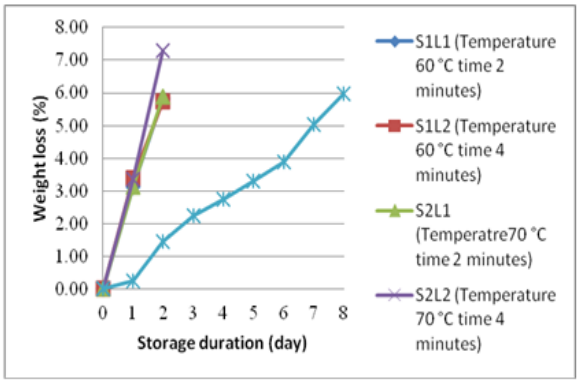

Figure 2. Weight loss of minimally processed of carrot during room temperature storage

Diameter shrinkage

Figure 3 shows diameter loss of minimally-processed of carrot. at temperature of 60°C for 2 minutes was 19.25%, at temperature of 60°C for 4 minutes was 15.40%, at temperature of 70°C for 2 minutes was 15.85%, at temperature of 70°C for 4 minutes was 16.75% and control (no treatment) was 16.35%. The highest shrinkage in diameter was at temperature of 60°C for 2 minutes was 19.25%, while the lowest shrinkage at temperature of 60°C for 4 minutes was 15.85%. Increase of diameter shrinkage was closely associated with the freezing temperature -18°C which can cause shrinkage in its diameter that indicated by wilted and soft. Desrosier (1998) reported that storage for a long time in a low temperature causes the fruit becomes wrinkled that can lead the fruit to be damage on its cells and tissue structures.

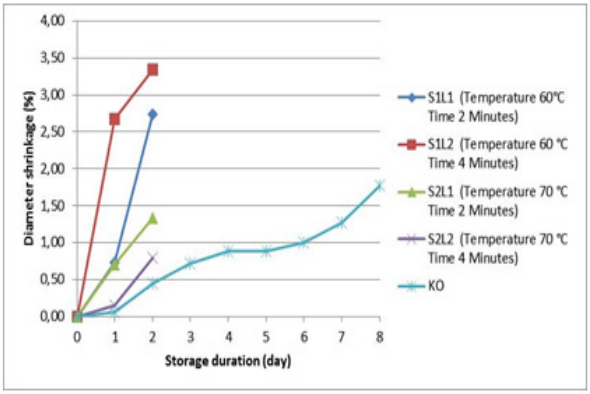

Figure 3. Diameter shrinkage of minimally processed of carrot during freezing

Figure 4 shows increasing in diameter loss of minimally processed of carrot. The highest increase in diameter loss showed at temperature of 60°C for 4 minutes was 3.34% and the lowest increase in diameter shrinkage at temperature of 70°C for 4 minutes was 0.79%. Blanched minimally-processed carrot survived for two days where carrots begin to soften and remove bad odor. It was caused by the condition blanched minimally-processed carrots become more deterioration rapidly due to excessive water activity. Whereas for the treatment of minimally processed carrots without treatment lasts for 8 days. it was indicated by the growth of microorganisms and spots brown on carrots resulting the carrots cannot be consumed. According to Winarno and Aman (1981), suggests that blanching as usual preliminary heating of the fruits and vegetables can inactivate the enzyme. Inactivation of enzymes is necessary to prevent the undesirable enzymatic browning reactions during process.

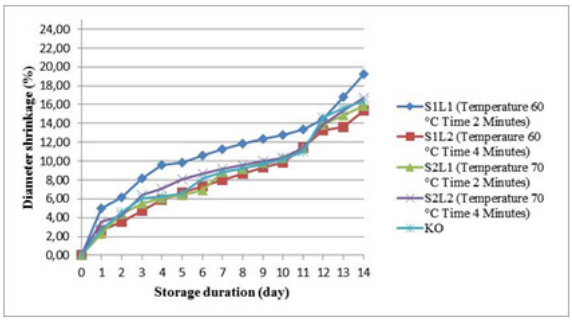

Figure 4. Diameter loss of minimally processed of carrot during room temperature storage

Water content

Water is very important component in food ingredients since water can affect the appearance, freshness, texture, durability, as well as the flavor of foodstuffs. Storability and durability of a material is ability of material to interact toward water molecules contained therein and water molecules in the surrounding air. Determination of water content during frozen storage was done on day 0 until the carrots cannot suitable for consumption. The thawing process beforehand aims to eliminate crystals - ice contained in minimal process of carrot.

Figure 5 shows decline water content each treatment of minimally processed carrot during freezing storage. Decreasing of the water content at temperature of 60°C for 2 minutes was 86.54%, temperature 60°C for 4 minutes was 88.44%, temperature 70°C for 2 minutes was 85.97%, temperature of 70°C for 4 minutes 87.30% and control (no treatment) was 87.62%. Impairment of the smallest water content was at temperature of 70°C for 2 minutes was 85.97%.

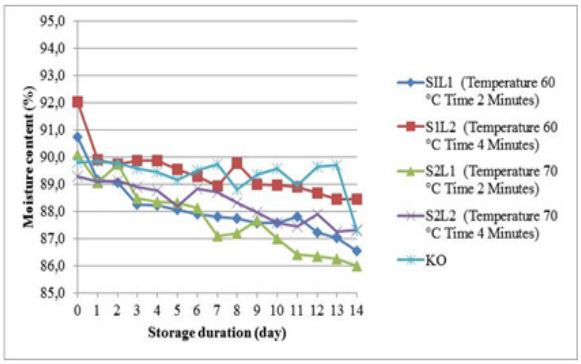

Figure 5. Water content of minimally processed carrot during freezing storage

Impairment of water content is also affected by temperature. If conditions are too low, it could make temperature inside cold storage evaporated, and resulting loss of water due to low RH. The water in carrots evaporates to achieve balance. It was made clear by Fellow (1992), reported that the water content in the material during freezing will change into ice crystals. The formation of ice crystals in foodstuffs affected by temperature. In addition, low RH (relative humidity) in freezing storage chamber could cause carrot peel cracks that will lead movement of water. The research released that the water content of blanched carrots ranging from 89.51% - 90.92%. The high-water content in blanched minimally-processed carrots caused the capacity to store minimally-processed carrots damage and decay rapidly. And, declining of water content are showed at temperature 60°C for 2 minutes 89.51%, 60°C for 4 minutes 90.92%, 70°C for 2 minutes 90.70% and 70°C for 4 minutes 90.63%. High water content caused smelling aroma. Water content in a material need to be specified because the higher the water content, the greater the likelihood to be damaged, and less durability. According to Supriadi *et al*. (2004) critical water content is indicated by the growth of fungi, slime, and changes in aroma.

Treatment of minimally processed carrots without blanching only last for 8 days. It was caused by microorganisms. Consequences are browning on peel minimally processed carrots, and looks dry because moisture reduction 83.594%. Pantastico (1986) reported that most commodity fruits and vegetables have a moisture content of 80% - 95%. The water content will continue to decrease after harvesting. Stored fruit experiencing significant water loss, can lead to wilt or unfresh fruit and wrinkled skin.

Hardness

The research released that the hardness of blanched minimally-processed carrot changes during freezing storage. The hardness frozen carrots decreased during storage. The decline in hardness at temperature of 60°C for 2 minutes was 331.113 kPa to be 100.751 kPa, at temperature of 60°C for 4 minutes was 331.741 kPa to be 103.208 kPa, at temperature of 70°C for 2 minutes was 398.089 kPa to be 130.239 kPa, at temperature of 70°C time 4 minutes was 375.973 kPa became 130.239 kPa, and control (no treatment) was 434.949 kPa to be 113.038 kPa. The lowest hardness decreased at 60°C for 2 minutes the 100.751kPa. It shows at temperature of 60°C for 2 minutes of tissue damage and loss of turgor pressure in the sliced carrots. Carrot tissue composed by cells that is the smallest part, the integrity greatly affects to quality of the texture. Integrity of components of cell (cell wall and middle lamela) and cell turgor pressure is determined by the water content in the vacuole (Chassagne *et al*., 2009).

The research released that the average hardness of minimally-processed carrots, shows that for blanching treatment from day 0 to day 2 decreased, there is decrease in the lowest value at 70°C with no more than 2 minutes at 285.05 kPa. This occurs due to softening of texture of carrots, that could cause changing on the hardness of blanched carrot. According to Winarno (1986), in development and maturation of fruits and vegetables turgor pressure were always changing due to changing of composition of the cell wall. Changes will affect firmness of the fruit becomes soft when ripe. Chemically, cell walls of fruits and vegetables arranged by compounds that affect cell turgor, so that fruits and vegetables become tender. Hardness of carrots without blanching only lasted for 8 days with hardness 797.41 kPa. This could lead downsizing on carrots and then carrot will be more easily damaged without continue of storage.

Vitamin C

The research released that the amount of vitamin C after harvesting carrots namely 0.056%. According to the Nutrition Directorate of the Ministry of Health (1995), stated that the vitamin C content of fresh carrots namely 0.060%. This shows that there was a difference in making the value of vitamin C, it was caused by different environments condition of carrots. At temperature of 60°C for 2 minutes was 0.021%, at temperature 60°C 4 minutes was 0.017%, at temperature 70°C within 2 minutes was 0.016% and at temperature 70°C 4 minutes was 0.022 %. Impairment of vitamin C was the lowest at 70°C than 2 minutes was 0.015%. It was caused by vitamin C soluble in water and easily damage in high temperature like blanching. Loss of vitamin C in cooking or processing of vegetables varies significantly depending on the type of vegetable

and processing techniques that used. Similarly, the water-soluble vitamins, ascorbic acid loss occurred during the process of blanching in high temperature of water. So, in the process of blanching can be noticed of the water temperature used, because the water temperature can affect increasing in activity of the enzyme present in the material. Decomposition of vitamin C without blanching during freezing storage, loss of vitamin C was reduced by 0.032% from 0.056%. Vitamin C was decomposed by heating effect. In addition, decomposition of vitamin C in the freezing process is in process of thawing, that carry several substances in carrot.

Conclusion

It is concluded that the result of blanching which were done at 60°C and 70°C for 14 days at freezing storage showed that minimally processed carrot could not maintain its best quality. It caused by the damage of tissue and the loss of turgor pressure at the sliced of carrot and for blanched carrot where stored in room temperature for 2 days which is indicated by soft carrot, rotten smell aroma, and decomposition of vitamin C. The hardness of blanched carrot during freezing storage decreased for 14 days; the best level of hardness at 70°C in 2 minutes and 4 minutes was 130.239 kPa. The best temperature of blanching for vitamin C with the lowest reducing at 70°C in 4 minutes was 0.022%.

Acknowledgment

This study was the final project of Khairul Umam at Andalas University, Padang, Indonesia.

References

Antara, N.S. 2007. Minimally-processed for increasing the Vallue added for Horticulture products. Paper in Local Seminar Increasing Benefit of Fresh Horticulture Products Retail Through Good handling for Postharvest and Security ,Bali 21st of September 2007. Indonesia: Faculty of Agricultural Technology, University of Udayana.

Chassagne - Berces S., Poirier C., Devaux M.F., Fonseca F., Lahaye M., Pigorini G., Girault C., Marin M. and Guillon F. 2009. Changes in Texture, Cellular Structure, and Cell Wall Composition in Apple Tissue as a Result of Freezing, Journal of Food Research International 42(7):788-797.

Desrosier, N.W. 1988. Food Preservation Technology, p.131-171. Jakarta: UI Press.

Directorate of Nutrition, Department of Health Republic of Indonesia. 1995. List of Food Ingredients Compotision. Jakarta. Department of Health Republic of Indonesia.

Fellow P. 1992. Food Processing Technology (principles and practice). New York: Ellis Horwood.

Fellow, P. 1997. Food Processing Technology, Principles, and Practice. Cambridge England: Woodhead Publishing Limited.

King Jordan A.D. and Bolin H.R. 1989. Physiological and Microbial Storage Stability of Minimally Processed Fruit and Vegetables. Journal of Food Technology 43: 132-135, 139.

Kumalaningsih, S. 2005. Natural antioxidant. Jakarta: PT. Gramedia Utama.

Muchtadi, T.R. 2010.Technology of Food Processing. Bandung: Alfabeta.

Ryall, A.L. and Lipton, W.A 1983. Handling, Transportation and Storage of Fruits and Vegetables. Westport, Connecticut: AVI Publishing Company Inc,

Samadi, B. 2014. Secret of Organic Carrot Cultivation. Jakarta: Pustaka Mina.

Supriadi, A., Sugiyono, Soekarto, S.T. and Purwiyatno Haryadi. 2004. Study of Isothermic Water and Stogare Duration on Instant Corn Rice. Forum of Postgraduate. School of Postgraduate, Institut Pertanian Bogor: Bogor. 27(3) : 221-230.

Supriyatmi, 2011. Use of Absorbant Combination for extending the self-life Banana Cavendish Fruit. Technology of Agroindustry.. Jakarta: BPPT

Winarno F.G. and Aman M. 1981. Physiology of Postharvest Jakarta: Sastra Hudaya.

Winarno, F.G. 1986. Physiology of Postharvest. Jakarta: Sastra Hudaya.

Winarno, F.G. and Jennie, B.S.L.1983. Deteroration of Food Material and Prevention Efforts. Jakarta: Ghalia Indonesia.