Effect of Electrostatic Field on Quality of Carrot Juice during Refrigeration

陳又佮、柯文慶

E-mail: 9510724@mail.dyu.edu.tw

ABSTRACT

Whole carrot and carrot juice obtained through dicing, juice mixing and filtrating were stored in electrostatic field induced device (EFID; E-group). The effect on changes of quality were investigated in contrast to that stored in common refrigerator (R-group) controlled at same temperature (4℃). The results obtained were as follows. 1. Moisture content of whole carrot decreased to 32.4% for E-group and 29.9% for R-group after storage for 15 days. The hardness also decreased with the increase of time and R-group showed obvious lower value than E-group. No obvious changes in color as Hunter L, a, b value were observed during storage. 2. Color values and total carotenoids of carrot juice were decreasing over storage period. The decrease tendency was more obvious for R-group. 3. pH of carrot juice decreased for both storage methods, while titrable acidity relatively increased. They could be easily determined as deteriorative indices due to excellent correlation. 4. Total phenol of carrot juice increased during storage and R-group showed higher value than E-group. Tannin content also increased for R-group, but almost unchanged for E-group in the duration. 5. Total plate counts and organic acids (lactic acid ’ acetic acid) of carrot juice increased for both R- and E-group during storage. The growth of microorganisms was promoted in E-group according to obvious changes were observed for R-group. 6. Total soluble solids of carrot juice decreased for both R- and E-group during storage. reducing sugar had a tendency to increase the first term and to decrease the latter term. This phenomenon might be related with the growth phases of microorganisms. 7. Soluble protein of carrot juice decreased and formol nitrogen (free amino acid) relatively increased for R- and E-group during storage. The decrease and relative increase were related to protein denaturation and decomposition. 8. Turbidity of carrot juice decreased with increasing time. From the results more stable for E-group indicated that EFID had better protective effect on pectin and turbidity factors in carrot juice.

Keywords : electrostatic field induced device, carrot, storage test

Table of Contents

第一章 緒言1 1.1 研究背景及動機1 1.2 研究目的2 第二章 文獻回顧4 2.1 胡蘿蔔之簡介4 2.1.1 胡蘿蔔生產概況及其營養生理功能4 2.1.2 類胡蘿蔔素之結構、特性及其功能7 2.1.3 胡蘿蔔(汁)貯藏及加工過程中色澤之變9 2.2 蔬果(汁)之保鮮與貯藏條件10 2.2.1蔬果保鮮10 2.2.2蔬果汁貯藏過程中品質之變化11 2.3 電子高壓靜電誘導裝置(EFID)簡介12 2.3.1 原理12 2.3.2 冷藏庫外觀與保存食材之特點14 2.3.3 EFID 應用上之優點15 2.3.4 EFID 與傳統技術在食材保鮮效果之比較15 第三章 材料與方法20 3.1 試驗材料20 3.2 電子高壓靜電誘導裝置20 3.3 試驗藥品20 3.4 試驗方法24 3.5 試驗分析項目及方法27 3.5.1 失水率測定27 3.5.2 硬度測定27 3.5.3 可溶性固形物測定27 3.5.4 酸鹼值測定28 3.5.5 可滴定酸度測定28 3.5.6 甲醛態氮測定28 3.5.7 總類胡蘿蔔素測定29 3.5.8 可溶性蛋白質質測定30 3.5.9 單寧測定30 3.5.10 總酚測定31 3.5.11 總生菌數測定31 3.5.12 混濁度測定31 3.5.13 色澤(color)測定32 3.5.14 還原糖測定32 3.5.15 有機酸測定33 3.6 數據統計分析33 第四章 結果與討論34 4.1 貯藏期間胡蘿蔔品質特性之探討34 4.1.1 水分含量及硬度之變化34 4.1.2 色澤之變37 4.2 貯藏期間胡蘿蔔汁品其變化之探討37 4.2.1 混濁度之變化37 4.2.2 色澤之變化40 4.2.3 可溶性固形物之變化44 4.2.4 酸鹼值及可滴定酸度之變化44 4.2.5 甲醛態氮之變化44 4.2.6 總類胡蘿蔔素之變49 4.2.7 可溶性蛋白質之變化51 4.2.8 總酚及單寧之變化51 4.2.9 總生菌數及有機酸之變55 4.2.10 還原糖之變化59 第五章 結論61 參考文獻62

REFERENCES

中文部分 1. 中國國家標準。1982。水果及蔬菜製品檢驗法(可滴定酸度之測定)。CNS8626(N 6167)經濟部標準檢驗局印行。 2. 中國國家標準。1989。水果及蔬菜汁飲料檢驗法(可溶性固形物之測定)。CNS12569(N 6215)經濟部標準檢驗局印行。 3. 中國國家標準。1989。水果及蔬菜汁飲料檢驗法(甲醛態氮之 測定)。CNS12630(N 6219)經濟部標準檢驗局印行。 4. 中國國家標準。1991。食品微生物之檢驗-生菌數之檢驗。CNS10890(N 6186)經濟部標準檢驗局印行。 5. 台灣地區食品營養成分資料庫。2005。蔬菜-胡蘿蔔。行政院衛生署編印。台灣，台北。100-101。 6. 尤新輝。1992。蘋果汁加工與品質變化之探討。食品工業24(5):18-29。 7. 王博廉。2004。電子調變高壓變頻誘導裝置對食品的高壓電場解凍保鮮的方法。食品資訊。202:67-69。 8. 王銘富、阮喜文、金安兒、柯文慶、張雲燕、鄧德豐、賴滋漢、蘇正德。1995。食品學(各論)。第89頁。富林出版社。 台中，台灣。 9. 宋祖瑩。1994。番石榴果漿中混濁物之特性及其安定性之改進。國立中興大學食品科學研究所碩士論文。台中。台灣。 10. 林淑瑗、饒家麟、顏裕鴻、王聯輝、張谷昇、林聖敦、鄔文盛、葉安義、

邱文貴。2004。食品加工－理論基礎篇。第 218 頁。華格那企業有限公司。台中，台灣。 11. 許祥純、傅慧音、田欽仁、洪連欉、楊明華、蔣宗哲、賴盈璋、江文德、謝淳仁、江伯源、巢佳莉。2006。食品生物化學。第 20頁。華格那企業有限公司。台中，台灣。 12. 柯碧珍。2000。葉菜甘藷採收後之儲藏效應對品質影響之研究。國立屏東科技大學熱帶農業研究所碩士論文。屏東。台灣。 13. 黃建升。1994。胡蘿蔔品種與貯藏條件對其榨汁品質影響之研究。國立中興大學食品科學研究所碩士論文。台中。台灣。 14. 黃錦城。1995。果汁微生物作用(最新果汁飲料加工技術)。第121-140頁。食品工業發展研究所－食品工業月刊社。 15. 黃宏福。2002。日本人參。鄉間小路28(3):3-4。 16. 黃肇家。2005。蔬果原料之保鮮技術。食品工業。37(4):5-8。 17. 農業統計年報。2004。蔬菜-胡蘿蔔。行政院農委會編印。台北。台灣。56-57。 18. 陳立欣。2003。營養美味的蘿蔔、胡蘿蔔及甜菜。農業世界243:81-83。 19. 陳永璋。2005。胡蘿蔔於冷藏和冷凍乾燥後抗氧化物質及物理性質之相關分析。大葉大學生物產業科技研究所碩士論文。彰化。台灣。 20. 陳俊成。2005。植物化學物質即其生化活性。食品資訊。207:60-67。 21. 劉英俊、汪金追。1982。食品加工與貯藏。第232頁。中央圖書出版社。台北，台灣。 22. 林靜宜。2001。巴斯德殺菌芒果汁求最適溫度與時間之探討。屏東科技大學食品科學系研究所碩士論文。屏東。台灣。 23. 劉春敏。2004。利用酵素法提昇胡蘿蔔濃縮汁收率及品質之研究。大葉大學生物產業科技研究所碩士論文。彰化。台灣。 24. 賴滋漢、鄭三郎、邱義源、辜瑞金。1991。食品加工。第 156頁。精華出版社。台中，台灣。 25. 賴滋漢、洪協裕。胡蘿蔔榨汁流程效率之改善。1995。 食品科學22(3):240-246。 26. 施明智。1996。食物學原理。第68-70頁。藝軒圖書出版社。台北，台灣。 27. 錢明賽。1993。根菜及莖菜採後處理與貯藏技術(一)。食品工業25(9):18-22。 28. 錢明賽。1998。蔬果中之抗氧化物質。食品工業30(8):21-35。 29. 鄭欽志。2002。生鮮處理。第96-98頁。復文書局。台南，台灣。 30. 蕭寧馨。2002。給妳彩色健康的人生-胡蘿蔔。鄉間小路 28(3):5-6。 英文部分 1. Ames, B. N., Shigenaga, M. K. and Hagen, T. M. 1993. Oxidants, antioxidants and the degenerative diseases of aging. Proc. Natl. Acad. Sci. U.S.A. 90: 7915:7922. 2. Ames, B. N., Gold, L. S. and Willett, W. C. 1995. The causes and prevention of cancer. Proc. Natl. Acad. Sci. U.S.A. 92: 5258-5265. 3. Baker. R. A. and Cameron R. G. 1999. Clouds of citrus juices and juice drinks. Food Technology. 53(1): 64-69. 4. Baloch, A. K., Buckle, K. A. and Edwards, R. A. 1977. Separation of carrot carotenoids on hyflo-super-celmagnesium oxidecalcium sulfate thin layers. J. Chromatogr. 139: 149-155. 5. Bajaj, O., De Bruyn, J. W. and Smeets, L. 1955. Selection of carrots for carotene content. sub-normal content at low temperature. Euphytica. 4: 183-189. 6. Banga, O., De Bruyn, J. W., Van Bennekom, J. L. and Van Keulen, H. A. 1963.Selection of Carrots for Carotene Content. V. The Effect of the soil moisture content. Euphytica. 12: 137-146. 7. Barton-Duell P, 1995. The role of dietary antioxidants in prevention of atherosclerosis. Endocrinologist. 5: 347-356. 8. Bates, R. P. and Koburger, J. A. 1974. High-temperature-short-time processing of carrot juice. Proc. Fla. State Hortic.Soc. 87: 245-249. 9. Bendich, A. and Shapiro, S. S. 1986. Effect of β-carotene and canthaxanthin on the rat. J. Nutr. 116: 2254 -2262. 10. Bendich, A. 1989. Carotenoids and the immune response. J. Nutr. 119: 112-115. 11. Ben-Amotz, A. and Levy , Y. 1996. Bioavailability of a natural isomer mixture compared with synthetic all-trans β-carotene in human serum. Am. J.Clin. Nutr. 12. Beveridge , T. 1997. Haze and cloud in apple juice. Critical Reviews In Food Science and Nutrition. 37: 75-91. 13. Borchgrevink, N. C. and Charley, H. 1966. Color of cooked carrots related to carotene content. J. Am. Diet. Assoc. 49: 116-121. 14. Bradley, G. and Smittle, D. 1965. Carrot quality as affected by variety, planting and harvest dates. J. Am. Soc. Hort. Sci. 86: 397-399. 15. Bradford M.M. 1976. A rapid and sensitive for the quantification of microgram quantities of protein utilizing the principle of protein-dyu binding. Anal. Biochem. 72: 248-254. 16. Brittion, G. 1992. Carotenoids. In Natural Foods Colorants, ed. G. F. Hendry. 141-148. 17. Bushway, R. J. and Wilson, A. M. 1982. Determination of α- and β-carotene in fruits and vegetables by high performance liquid chromatography. Can. Inst. Food Sci. Technol. J. 15: 165-169. 18. Cameron, R. G., Baker, R. A. and Grohmann K. 1998. Multiple forms of pectinmethylesterase from citrus peel and their effects on juice cloud stability. J. Food Sci. 63: 253. 19. Cao, G.., Sofic, E. and Prior, R. L. 1996. Antioxidant capacity of tea and common vegetables. J. Agric. Food Chem. 44: 3426-3431. 20. Caro, A. D., Piga, A., Vacca, V. and Agabbio M. 2004. Changes of flavonoids,vitamin C and antioxidant capacity in minimally processed citrus segments and juices during storage. Food Chem. 84: 99-105. 21. Chen, B. H. and Chen, Y. Y. 1993. Stability of chlorophylls and carotenoids in sweet potato leaves during Microwave cooking. J. Agric. Food Chem. 41: 1315-1320. 22. Chen, B. H., Chen, T. M. and Chein, J. T. 1994. Kinetic model for studying the isomerization of α- and β-carotene during heating and illumination. J. Agric. Food Chem. 42: 2391-2397. 23. Chen, B. H., Peng, H. Y. and Chen, H. E. 1995. Changes of caroteneoids, color, and vitamin A contents during processing of carrot juice. J. Agric. Food Chem. 43: 1912-1918. 24. Cheynier, V., Osse, C. and Rigaud, J. 1988. Oxidation of grape juice phenolic compounds in model solutions. J. Food Sci. 53: 1729-1732. 25. Clydesdale, F. M. and Francis, F. J. 1976. Pigments. In Principles of Food Science-Food Chemistry,ed. O. R. Fennema. 417-430. 26. Evers, A. M. 1989. Effects of Different Fertilization Practices on the carotene content of carrot. J. Agric Sci. Finland, 7-14. 27. Freitas VD, Mateus N. 2001. Structural features of procyanidin interactions with salivary protein. J. Agric. Food Chem. 49: 940-945 28. Gabelman, W. H. 1974. The Prospects for Genetic Engineering to improve nutritional values. In nutrition qualities of fresh fruits and vegetables; White, P., Selvey, N., Eds.; Academic Press: New York, 147-155. 29. Gariballa, S. E. and Sinclair, A. J. 1998. Nutrition, aging and ill health. Br. J. Nutr. 80: 7-23. 30. Giacosa. A., Filiberti, R., Hill, M. J. and Faivre, J. 1997. Vitamins and cancer chemoprevention. Eur. J. Cancer Prev. 6: 47-54. 31. Girard B. and Fukumoto L. R. 1999. Apple juice clarification using microfiltration and ultrafiltration polymeric membranes. Lebensm. – Wiss. u.-Technol. 32: 290-298. 32. Hardh, J. E. 1975. The influence of the environment of the nordic latitudes on the quality of vegetables. Qual. Plant.-Plant. Foods Hum. Nutr. 25: 43-56. 33. Hardh, J. E., Persson, A. R. and Ottosson, L. 1977. Quality of vegetables cultivated at different latitudes in Scandinavia. Acta Agric. Scand. 81-96. 34. Heinonen, M. I. 1990. Carotenoids and provitamin A activity of carrot (Daucus carota L.) cultivars. J. Agric. Food Chem. 38: 609-612. 35. Hulme, A. C. 1958. Some aspects of the biochemistry of apple and peer fruits. Adv. Food Res. 8: 297-234. 36. Inagaki,C. 1947. Vitamin C in natural products. Nogaki(Sci. of Agr.) 1: 237 37. Jimenez, C. and Pick, U. 1993. Differential reactivity of β-carotene isomers from Dunaliella bardawil toward oxygen radicals. Plant. Physiol. 101:385-390. 38. Julknen-Tilitto, R. 1985. Phenolic

constituents in the leaves of morthern willow:methods for the analysis of certain phenolics. J. Agric. Food Chem. 33: 213-218. 39. Kader, A. A., Lipton ,W. J. and Morris L. L. 1973. Systems for scoring quality of harvested lettuce. Hort. Sci. 8: 408-409. 40. Khachik, F., Beecher , G. R. and Whittaker , N. F. 1986. Separation, identification and quantification of the major carotenoid and chlorophyll conatituents in extracts of several green vegetables by liquid chromatography. J. Agric. Food Chem. 34: 603-616. 41. Khachik, F., Beecher , G. R. and Goli, M. B. 1991 .Separation, identification, and quantification of carotenoids in fruits, vegetables and hhuman plasma by high performance liquid chromatography. Pure and Appl. Chem. 63: 71-80. 42. Krinsky , N. I. 1989. Carotenoids and cancer in animal model. J. Nutr. 119: 123-126. 43. Lee, W. G. and Ammerman, G. A. 1974. Carotene stereoisomerizati- on in sweet potatoes as affected by rotating and still retort canning processes. J. Food Sci. 39: 1188-1190. 44. Lee, C. Y., Bourne, M. C.and Van Buren, J. P. 1979. Effect of blanching treatments on the firmness of carrots. J. Food Sci. 44: 615-618. 45. Lombrana, J. I. and Dias, J. M. 1985. Rheological and chemical changes in stored carrot juice. Can. Inst. Food Sci. Technol. J. 18: 213-219. 46. Machlin, L. J. 1995. Critical assessment of the epidemiological data concerning the impact of antioxidant nutrients on cancer and cardiovascular disease . Crit. Rev Food Sci Nutr. 35: 41-50. 47. Mangels, A. R.., Holden, J. M., Beecher, G. R., Forman, M. R. and Northcote, D. H. 1993. The cell wall of higher plants: Their composition , sturcture and growth. Biology Revie. 33: 53-58. 48. Medlicott, A. P. and Thompson, A. K. 1985. Analysis of sugars and organic acids in ripening mango fruits (Mangifera indica L. var Keitt) by high performance liquid chromatography. J. Sci. Food Agric. 36: 561-566. 49. Montgomery, M.W., Reyes, F.G., Cornwell, G. and Beavers, D.V. 1982. Sugars and acid analysis and effect of heating on color stability of Northwest Concord grape juice. J. Food Sci. 47: 1983-1986. 50. Mukker, G. L. 1965. Use of dinitrosalicyclic acid regant for determination of reducing sugar. J. Food Sci. 2: 39-44. 51. Muller, H., Bub, A., Watzl, B. and Rechkemmer, G. 1999. Plasma concentrations of carotenoids in healthy volunteers after intervention with carotenoid-rich foods. Eur. J. Ntur. 38: 35-44. 52. Munsch, M. H. and Simard, R. E. 1983. Relationship in color and carotene of carrot juices . Can. Inst. Food Sci. Technol. J. 16: 173-178. 53. Ong, D. E.and Chytil, F. 1983. In G. D. Aurbach(Ed.), Vitamins and hormones. New York: Academic Press. 105-112. 54. Prabhala, R. H., Garewal, H. S., Meyskens, F. L. and Watson, R. R. 1990. Immunomodulation in humans caused by β-carotene and vitamin. Nutr. Res. 10: 1473-1486. 55. Price, M. L. and Butler, L. G. 1977. Rapid visual estimation and Spectrophotometric of tannin content of sorghum grain. J. Agric. Food Chem. 25: 1269-1273. 56. Purcell, A. E., Walter, W. M. and Thompkins , W. T. 1969. Relationship of vegetable color to physical state of the carotenes. J. Agric. Food Chem. 17: 41. 57. Rodriguez-Amaya, D. B. 1993. Stability of carotenoids during the storage of foods. In Shelf Life Studies of Foods and Beverages – Chemical, Biological, Physical and Nutritional Aspects, ed. F. Charalambous, Elsevier Science, Amsterdam. 591-624. 58. Rothschild, G. and Karsenty, A. 1974. Cloud loss during storage of Pasteurized citrus juices and concentrates. J. Food Sci. 39: 1037-1041. 59. SAS. 1985. " SAS User , S Guide " . SAS Institute, Inc., Cary, N.C. Saguy, I. Kopelman, I. J. Mizrahi, S. Eetend of nonenzymic browing in grapefruit juice during thermal and concentration processes:Kinetics and prediction. Preserv. 1978: 175-184. 60. Saguy, I., Goldman, M. and Karel, M. 1985. Prediction of β-carotene decoloration in model system under static and dynamic conditions of reduced oxygen environment. J. Food Sci. 50: 526-530. 61. Saldana, G., Stephens, T. S. and Lime, B. J. 1976. Carrot beverage. J. Food Sci. 41: 1243-1244. 62. Scott, K. J., Finglas, P. M., Seale, R., Hart D. J. and Froidmont-Gortz, Y., 1996. Inter-laboratory studies of HPLC procedures for the analysis of carotenoids in foods. Food Chem. 57: 85-90. 63. Sarni-Manchado P, Cheynier V, and Moutounet M. 1999. Interactions of grape seed tannins with salivary proteins. J. Agric. Food Chem. 47: 42-47. 64. Seifert, R. M. and Buttery, R. G. 1978. Characterization of some previously unidentified sesquiterpenes in carrot roots. J. Agric. Food Chem. 26: 161-163. 65. Simon, P. W. and Wolff, X. Y. 1987. Carotenes in typical and dark orange carrots. J. Agric. Food Chem. 35: 1017-1022. 66. Stephens, T. S., Salaana, G.., Brown, H. E. and Griffiths F. P. 1971. Stabilization of carrot juice by dilute treatment. J. Food Sci. 36: 36-39. 67. Stitt, M., Kurzel, B. and Heldt, H. W. 1984. Control of photosynthetic sucrose synthesis by fructose 2,6-bisphospnate partitioning between sucrose and starch. Plant Physiol. 75: 554-560. 68. Serafini M, Maiani G. and Ferro-Luzzi A. 1997. Effect of ethanol on red wine tannin-protein(BSA) interactions J. Agric. Food Chem. 45: 3148-3151. 69. Sims, C. A., Balaban, M. O. and Mathews, R. F. 1993. Optimization of carrot juice color and cloud stability. J. Food Sci. 58:1129-1131. 70. Tannenbaum, S. R., Young, V. R. and Archer, M. L. 1985. Vitamins and Minerals. Ch7. In " Food Chemisty 2nd Ed " , O.R.Fennema(Ed.), Marcel Dekker, Inc., New York. 477-544. 71. Tajchakavit S, Boye J. I. and Couture R. 2001. Effect of processing on post-bottling haze formation in apple juice. Food Research International. 34: 415-424. 72. Teixeira Neto, R. O., Karel, M., Saguy, I. and Mizrahi, S. 1981. Oxygen untake and β-carotene decoloration in a dehydrated food. J. Food Sci. 46: 665-676. 73. Yang, C. M., Chang, K. W. and Huang, H. M. 1998. Methods for termination of the chlorophylls and their derivatives. Taiwania 43: 116-122. 74. Yen ,G. C. and Lin, H. T. 1998. Effect of high pressure and heat treatment on pectic substances and related characteristic in guava puree. J. Food Sci. 63: 684-687. 75. Yen, G. C. and Sony T. Y. 1998. Characteristics of clouding substances in guava puree. J. Agric. Food Chem. 46: 3435-3439. 76. Zamora, R., Hidalgo, F. J. and Tappel, A. L. 1991. Comparative antioxidant effectiveness of dietary β-carotene, vitamin E,selenium and coenzyme Q10 in rat erythrocytes and plasma. J. Nutr. 121: 50-56 77. Ziegler, R.G. 1989. A review of epidemiologic evidence that carotenoids reduce the risk of cancer. J. Nutr. 119: 116-122.