Agricultural Sci. J. 42 : 1 (Suppl.) : 651-655 (2011) ว. วิทย. กษ. 42 : 1 (พิเศษ) : 651-655 (2554)

ผลของ 1-MCP และโซเดียมคลอไรท์ที่เป็นกรดต่อคุณภาพของผลมังคุดสดตัดแต่งในภาชนะบรรจุ

Effects of 1-MCP and acidified sodium chlorite (ASC) on quality of in-package fresh-cut mangosteen fruits

ไพรัตน์ โสภโณดร[1] ชูทวีป ปาลกะวงศ์ ณ อยุธยา[1] ศุภชัย ภิสัชเพ็ญ[2] และ เสาวลักษณ์ พงษ์ไพจิตร[3]

Sophanodora, P.[1], Palakawong Na Ayudhya, C[1]., Pisuchpen, S.[2] and Phongpaichit, S.[3]

Abstract

Fresh-cut mangosteen is a potentially marketable product but its quality is easily deteriorated due to enzymatic and microbial activities. Therefore, use of 1-MCP and ASC during preparation of the product affecting the quality was investigated. Mangosteen fruit (stage 2) were treated with 0, 20, 40 or 80 ppm 1-MCP for 12 h at 28±2°C before preparation into fresh-cut product packed in PP tray and OPP/LLDPE film. After storage at 5°C for 12 days, fresh-cut mangosteen without 1-MCP treatment showed rapid softening and continuous increase in weight loss. The 1-MCP treated fruits showed the decreases of ethylene production and respiration rate as well as delay softening and weight loss. Therefore, it could maintain the better quality of in-package fresh-cut mangosteen. The suitable 1-MCP (40 ppm) treated fruits were cut and dipped in tap water (control), 500, or 1000 ppm acidified sodium chlorite (ASC) for 1 min before packing in PP tray and OPP/LLDPE film, and stored at 5°C for 12 days. The results indicated that ASC application non-significantly reduced initial microorganisms. However, ASC could affect browning of the product showing by the significantly reduced browning index (BI) value throughout the storage times.

Keywords: fresh-cut mangosteen, 1-MCP, ASC, acidified sodium chlorite

บทคัดย่อ

มังคุดสดตัดแต่งพร้อมบริโภคจัดเป็นผลิตภัณฑ์ที่สามารถนำออกสู่ตลาดได้ แต่คุณภาพ ของผลิตภัณฑ์อาจเกิดการเปลี่ยน แปลงอย่างรวดเร็วหากไม่มีการปฏิบัติที่ถูกต้อง ดังนั้นการ ศึกษานี้จึงมีวัตถุประสงค์เพื่อศึกษาผลของการใช้สาร 1-MCP และสารโซเดียมคลอไรท์ที่เป็น กรด (ASC) ต่อคุณภาพของมังคุดสดตัดแต่งพร้อมบริโภคในภาชนะบรรจุ โดยใช้ผลมังคุดที่มี ระดับสีผิวที่ 2 มาเก็บรักษาภายในภาชนะพลาสติกที่มี 1-MCP อยู่ในปริมาณ 0, 20, 40 และ 80 พีพีเอ็ม ที่อุณหภูมิ 28±2 °ซ เป็นเวลา 12 ชั่วโมง หลังจากนั้นจึงนำมาตัดแต่ง ให้ได้เนื้อมังคุด บรรจุในถาดพลาสติกพีพี หุ้มด้วยฟิล์ม OPP/LLDPE เก็บรักษาที่ 5 °ซ เป็นเวลา 12 วัน พบว่ามังคุดสดตัดแต่งจากผลที่ไม่ได้ใช้ 1-MCP มีลักษณะอ่อนนิ่มอย่าง รวดเร็ว และสูญเสียน้ำหนักอย่างต่อเนื่อง ส่วนมังคุดสดตัดแต่งจากผลที่ผ่านการเก็บในสภาพ ที่มี 1-MCP สามารถชะลอการผลิตก๊าซเอทิลีน การหายใจ การอ่อนนิ่ม และการสูญเสียน้ำหนัก ดังนั้นจึงคัดเลือกผลมังคุดที่ผ่านการเก็บในสภาพที่มี 1-MCP ที่เหมาะสม (40 พีพีเอ็ม) มาตัด แต่งแล้วจุ่มในสารละลายโซเดียมคลอไรท์ที่เป็นกรดเข้มข้น 0 (น้ำกลั่น), 500 และ 1000 พีพีเอ็ม เป็นเวลา 1 นาที เก็บรักษาในถาดพลาสติกพีพี หุ้มด้วยฟิล์ม OPP/LLDPE ที่ 5 °ซ เป็นเวลา 12 วัน พบว่าสารละลายโซเดียมคลอไรท์ที่เป็นกรดไม่สามารถลดปริมาณจุลินทรีย์ เริ่มต้นได้ แต่มีผลต่อการยับยั้งการเกิดสีน้ำตาลของมังคุดสดตัดแต่ง ($p<0.05$)

คำสำคัญ: มังคุดสดตัดแต่ง, 1-เอ็มซีพี, โซเดียมคลอไรท์ที่เป็นกรด

Introduction

Fresh-cut mangosteen (*Garcinia mangostana* L.) is a potentially marketable product due to its freshness, convenience and human-health benefits. However, fresh-cut mangosteen processing is fraught with difficulty regarding how to preserve fresh-like quality and prolong its shelf-life. Therefore, an appropriate processing treatment on fresh-cut mangosteen in the early ripe stage is needed to be investigated. Application of compounds

[1] ภาควิชาเทคโนโลยีอาหาร คณะอุตสาหกรรมเกษตร มหาวิทยาลัยสงขลานครินทร์ สงขลา 90112

[1]Department of Food Technology, Faculty of Agro-Industry, Prince of Songkla University, Songkhla 90112

[2] ภาควิชาเทคโนโลยีวัสดุภัณฑ์ คณะอุตสาหกรรมเกษตร มหาวิทยาลัยสงขลานครินทร์ สงขลา 90112

[2] Department of Material Technology, Faculty of Agro-Industry, Prince of Songkla University, Songkhla 90112

[3] ภาควิชาจุลชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยสงขลานครินทร์ สงขลา 90112

[3] Department of Microbiology, Faculty of Science, Prince of Songkla University, Songkhla 90112

such as 1-methylcyclopropene (1-MCP) in whole fruits has been shown to block the action of ethylene, inhibiting ethylene response such as ripening and softening. The treatment of 1-MCP on various cultivars of apples (Delicious, Empire, Idared, Law Rome and Mutsu) at harvest could maintain a fresh-cut product with an extended shelf-life (Calderon-Lopez *et al*., 2005). Acidified sodium chlorite (ASC) has recently been approved by the FDA for spray or dip application on various food products, including fresh and fresh-cut produce (FDA, 2001). Fresh-cut carrots treated with ASC demonstrated the lowest growth rate of aerobic bacteria, compared to those treated with other sanitizers, throughout the storage period (Ruiz-Cruz *et al*., 2006). The main objectives of this study were to evaluate the effects of 1-MCP treatment on in-package atmospheric condition, physical and chemical qualities and to compare the efficacy of ASC on reducing microbial populations as well as browning of in-package fresh-cut mangosteen.

Materials and Methods

1. Effect of 1-MCP on quality of in-package fresh-cut mangosteen fruits

Mangosteen (*Garcinia mangostana*, L.) fruits were hand-harvested at stage 2 (partially ripe, yellow-green with pink spot-skin) (Palapol *et al*., 2009). After grading, fruits were treated with 0, 20, 40 and 80 ppm 1-MCP in sealed polystyrene containers for 12 h, then they were prepared into fresh-cut mangosteen, packed in PP tray and sealed with OPP/LLDPE film. Samples were subjected to analyse for in-package atmospheric conditions (O_2, CO_2 and C_2H_4), physical (firmness, weight loss and color) and chemical (ethanol and acetaldehyde) qualities of fresh-cut mangosteen at 0, 3, 6, 9 and 12 days of storage at 5 °C with 85% RH.

2. Effect of acidified sodium chlorite (ASC) on quality of in-package fresh-cut mangosteen fruits

1-MCP treated (40 ppm) mangosteen (*Garcinia mangostana*, L.) fruits were prepared to fresh-cut product and washed with 0, 500, and 1000 ppm of ASC solution at 10 °C for 1 min., then packed in PP tray and sealed with OPP/LLDPE film. Samples were subjected to analyse for physical (color) and microbiological (psychrotrophic microorganisms, total viable count (TVC), yeasts and moulds, *E. coli* and *Salmonella* sp. qualities of fresh-cut mangosteen fruits at 0, 3, 6, 9 and 12 days of storage at 5 °C with 85% RH.

Results

1. Effect of 1-MCP on quality of in-package fresh-cut mangosteen fruits

Atmospheric composition: As a consequence of fresh-cut mangosteen tissue respiration, the package headspace of all treatments were progressively decreased in O_2 but increased in CO_2 and C_2H_4 during the first three days. Then O_2 was increased while CO_2 and C_2H_4 were increased throughout the storage. The treatment with 80 ppm 1-MCP resulted in a lower CO_2 and higher O_2 accumulation than 40 and 20 ppm 1-MCP and the control (Figure 1). Ethylene production of either the control or 1-MCP-treated fresh-cut mangosteen increased rapidly and reached the maximum values on day 3.

Physical quality: Mangosteen treated with 1-MCP had higher firmness than non-treated fruits throughout the entire storage period (Figure 2). Firmness was significantly higher in 1-MCP treated fruit than those of non-treated control fresh-cut ($p<0.05$). Application of 1-MCP could retard weight loss of fresh-cut mangosteen which revealed progressive increase in all treatments over the storage. At the end of 12 days storage, weight loss reached 5.08%. 4.51, 4.49 and 3.56% for control, 20, 40 and 80 ppm 1-MCP treated fruit, respectively (Figure 2). Different concentrations of 1-MCP treatments did not affect color L* value of fresh-cut mangosteen (Figure 2).

Chemical quality: Acetaldehyde and ethanol in the fresh-cut mangosteen were affected by 1-MCP within the storage time (Figure 3). Acetaldehyde and ethanol concentrations in the 1-MCP treated fresh-cut mangosteen were significantly lower than the control ($p<0.05$). Treatments with 40 and 80 ppm 1-MCP resulted in lower acetaldehyde and ethanol than treatment with 20 ppm 1-MCP and the control.

2. Effect of acidified sodium chlorite (ASC) on quality of in-package fresh-cut mangosteen fruits

Color and browning index: Lightness of the fresh-cut mangosteen in all treatments decreased rapidly within the first 6 days of storage. Then it seemed to be stable throughout the end of storage. No significance was found among different ASC concentration treatments ($p>0.05$). It could be concluded that ASC did not affect L* value of fresh-cut mangosteen. However, enzymatic browning in terms of browning index (BI) of the control sample was significantly higher than ASC-treated sample. Washing with different ASC concentrations resulted in non-significantly different BI value (*p>0.05*) (Figure 4).

Microbiological quality: Although ASC was reported as a microbial inhibitor in some reports, it did not show any effect on fresh-cut mangosteen (Table 1). This may be because of low initial microbial load, low temperature storage (5^{o}C) and the acid content in mangosteen

Discussion

1. Effects of 1-MCP on quality of in-package fresh-cut mangosteen: Treatment of whole fruit before preparing into fresh-cut product could affect gas composition in-package. The decrease of O_2 and the increase of CO_2 and C_2H_4 during the first three days were observed which in agreement with the study on the respiration rate of fresh-cut pineapple treated with 1-MCP (Buda and Joyce, 2003). Ethylene production of either the control or 1-MCP-treated fresh-cut mangosteen increased rapidly and then decreased in all treatments, probably due to the fact that 1-MCP could suppress the ethylene production or the in-package ethylene accumulation was transmitted through packing film (Mao *et al*, 2007). Firmness of in-package fresh-cut mangosteen was significantly higher in fruit treated with 1-MCP due to changes in gas composition inside the package. The decrease in O_2 and the increases in CO_2 and C_2H_4 inside the package may lead to physical disorders in the tissue such as firmness (Arias *et al*., 2009). Color (L* value) of fresh-cut mangosteen slightly decreased with the increase storage time, probably resulted from loss of water during storage causing loss of glossy appearance (Rocha and Moris, 2003).

2. Effects of ASC on qualities of in-package fresh-cut mangosteen: The results of ASC on prevention of browning were consistent with the results obtained by Lu *et al*. (2007), who found that ASC retarded the browning reaction in fresh-cut apple. He *et al*. (2008) reported that the anti-browning property of SC in ASC results from the two modes of action. They are the direct inactivation of polyphenol oxidase and the oxidative degradation of phenolic substances.

Conclusion

1-MCP and ASC at different concentrations showed effect on atmospheric concentration, physical and chemical qualities of in-package fresh-cut mangosteens. The deterioration of this produce was mainly due to softening and weight loss during the storage which could be retarded by 1-MCP. Washing fresh-cut mangosteen with ASC solution significantly reduced the browning intensity. However, ASC solution exhibited no efficacy on reduction of microorganisms, including psychrophile, total viable count (TVC), yeasts and moulds, *E. coli*, and *Salmonella* sp.

References

Arias, E., P. Lopez-Buesa and R. Oria. 2009. Extension of fresh-cut “Blanquilla” pear (*Pyrus communis* L.) shelf-life by 1-MCP treatment after harves. Postharvest Biology and Technology 54: 53-58.

Buda, A. S. and D.C. Joyce. 2003. Effect of 1-methylcyclopropene on the quality of minimally processed pineapple fruit. Australian Journal of Experimental Agriculture 43: 177-184.

Calderon-Lopez, B., J.A. Bartsch, C.Y. Lee and C.B. Watkins. 2005. Cultivar effects on quality of fresh cut apple slices from 1-methylcyclopropene (1-MCP)-treated apple fruit. Journal of Food Science 70: 221-227.

FDA. 2001. Secondary direct food additives permitted in food for human consumption. 21 Code of Federal Register 173.325.

He, Q., L. Luo and P. Chen. 2008. Elucidation of the mechanism of enzymatic browning inhibition by sodium chlorite. Food Chemistry 110: 847-851.

Lu, S., Y. Luo, E. Turner and H. Feng. 2007. Efficacy of sodium chlorite as an inhibitor of enzymatic browning in apple slices. Food Chemistry 104: 824-829.

Mao, L., G. Wang and F. Que. 2007. Application of 1-methylcyclopropene prior to cutting reduces wound responses and maintains quality in cut kiwifruit. Journal of Food Engineering 78: 361-365.

Palapol, Y., S. Ketsa, D. Stevenson, J.M. Cooney, A.C. Allan and I.B. Ferguson. 2009. Colour development and quality of mangosteen (*Garcinia mangostana* L.) fruit during ripening and after harvest. Postharvest Biology and Technology 51:349-353.

Rocha, A. M. C. N. and A.M.M.B. Morais. 2003. Shelf life of minimally processed apple (cv. Jonagored) determined by colour changes. Food Control 14: 13-20.

Ruiz-Cruz, S., Y. Luo, R.J. Gonzalez, Y. Tao and G.A. Gonzalez. 2006. Acidified sodium chlorite as an alternative to chlorine to control microbial growth on shredded carrots while maintaining quality. Journal of the Science of Food and Agriculture. 86: 1887-1893.

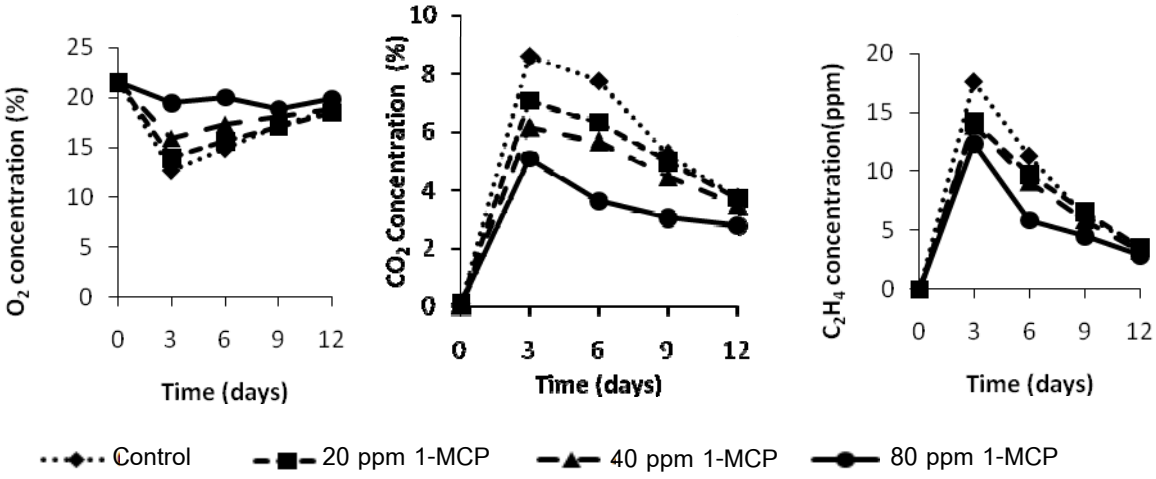

Figure 1. Concentrations of O_2, CO_2 and C_2H_4 in in-package headspace of 1-MCP treated fresh-cut mangosteen during storage

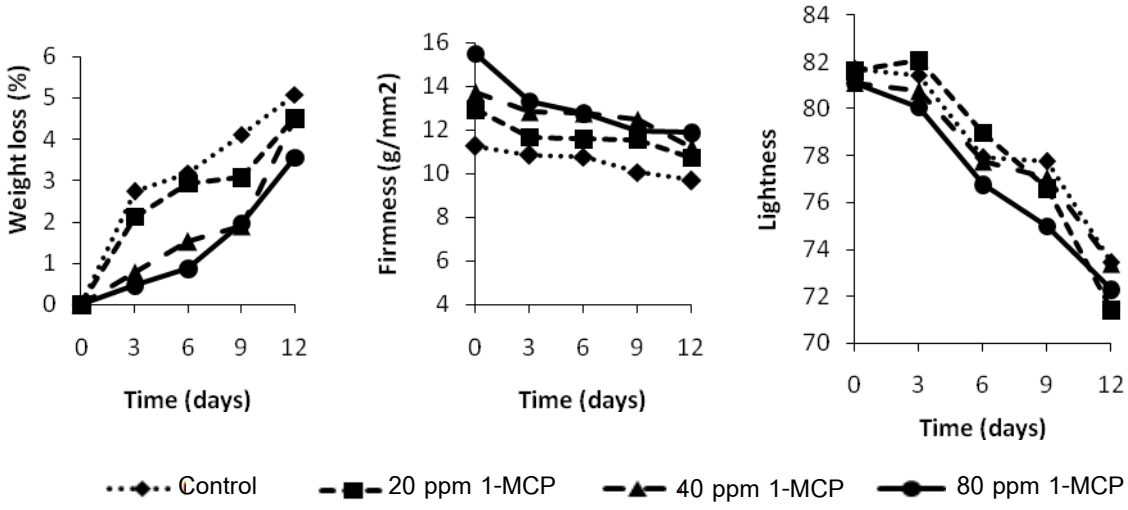

Figure 2. Weight loss, firmness and lightness of 1-MCP treated fresh-cut mangosteen during storage

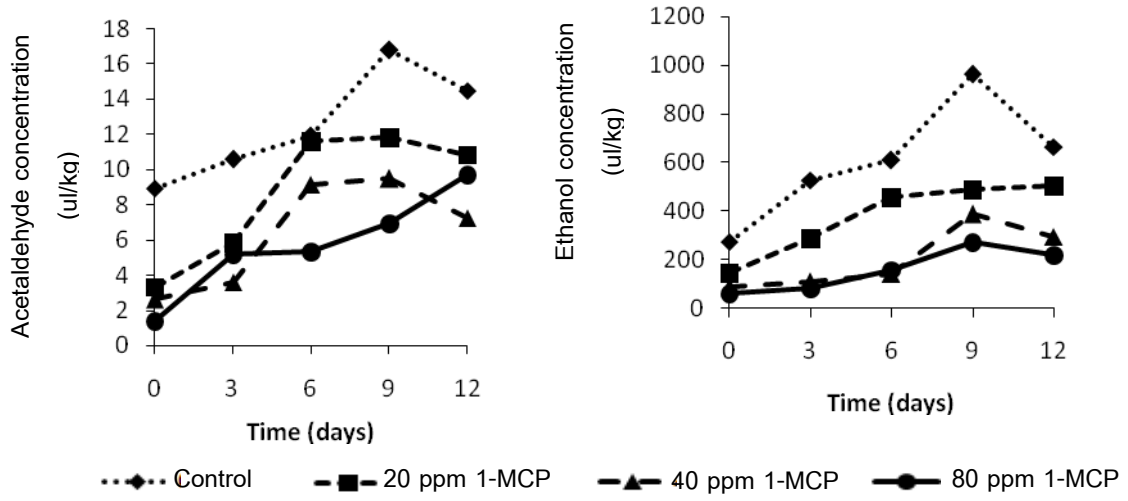

Figure 3. Changes in acetaldehyde and ethanol in-package headspace of 1-MCP treated fresh-cut mangosteen during storage

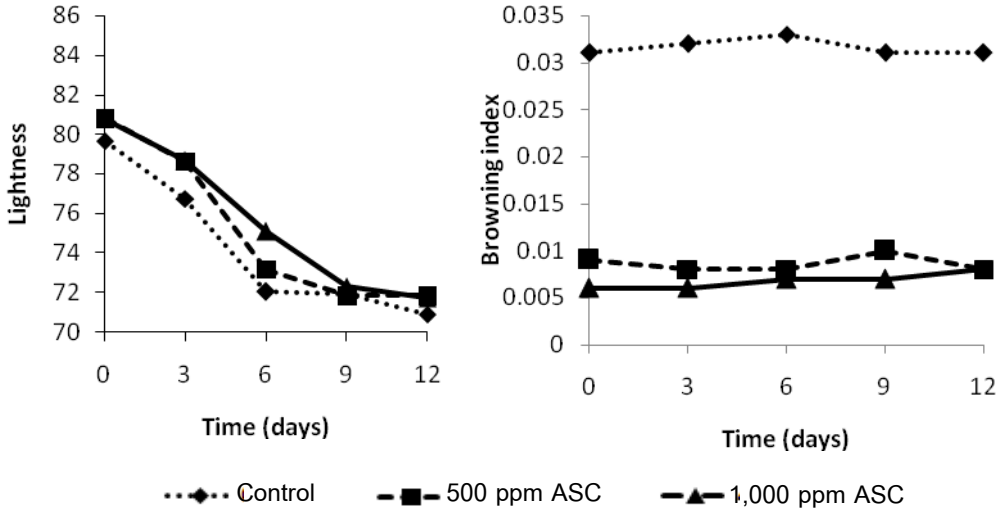

Figure 4. Effect of ASC on lightness and browning index of in-package fresh-cut mangosteen

Table 1. Microbial population of all the treatments (control, 500, and 1000 ppm ASC solution).

	Storage time (days)				
	0	3	6	9	12
Psychrophile	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g
TVC	<10 CFU/g	10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g
Yeast & Mould	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g	<10 CFU/g
E. coli	<3 MPN/g	<3 MPN/g	<3 MPN/g	<3 MPN/g	<3 MPN/g
Salmonella	Negative	Negative	Negative	Negative	Negative