ผลของการใช้น้ำมันมะพร้าวดัดแปลงร่วมกับเชลแลค บรรจุภัณฑ์ชนิด LDPE และ 1-MCP ต่อคุณภาพและโรคผลเน่าของมังคุดภายหลังการเก็บเกี่ยว

Effects of Ethanolic Shellac - Modified Coconut Oil, LDPE Packaging and 1-MCP on Postharvest Quality and Fruit Rot Diseases of Mangosteen Fruits

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บทคัดย่อ

การศึกษาผลของการใช้น้ำมันมะพร้าวดัดแปลงร่วมกับเชลแลค (Ethanolic shellac-modified coconut oil (ES-MCO) ร่วมกับถุง low density polyethylene (LDPE) และ 1-MCP ชนิดบรรจุซอง (EthylBloc™) ต่อคุณภาพและโรคผลเน่าของมังคุดภายหลังการเก็บเกี่ยว ทำโดยนำผลมังคุดอยู่ในระยะผลมีสีชมพู (ระยะ 3) มาล้างด้วยน้ำประปา เคลือบด้วย ES-MCO ความเข้มข้น 2% (v/v) หรือจุ่มในสารกำจัดเชื้อราคาร์เบนดาซิม ความเข้มข้น 500 มล./ล. ก่อนบรรจุในถุง LDPE ที่มี 1-MCP ชนิดบรรจุซอง จากนั้นเก็บรักษาที่ 13°C ความชื้นสัมพัทธ์ 95% นาน 42 วัน สำหรับผลมังคุดในชุดควบคุม คือ มังคุดที่ไม่เคลือบและไม่บรรจุถุง มังคุดที่เคลือบด้วย ES-MCO และมังคุดที่จุ่มในสารกำจัดเชื้อราคาร์เบนดาซิม ผลการทดลอง พบว่าการใช้ ES-MCO+LDPE+1-MCP หรือ คาร์เบนดาซิม+LDPE+1-MCP มีประสิทธิภาพดีในการชะลอการเปลี่ยนแปลงค่าสีของเปลือกและกลีบเลี้ยง การสูญเสียน้ำหนัก การแข็งของเปลือก (ความแน่นเนื้อของเปลือกต่ำ) อัตราส่วน total soluble solid/titratable acid (TSS/TA) และการผลิตเอทิลีน อย่างไรก็ตาม พบว่ามังคุดในทุกทรีตเมนท์มีอัตราการหายใจไม่แตกต่างกันทางสถิติตลอดอายุการเก็บรักษา นอกจากนี้ พบว่าการใช้ ES-MCO+LDPE+1-MCP และคาร์เบนดาซิม+LDPE+1-MCP มีผลช่วยชะลอการเกิดโรคผลเน่าโดยมีค่าดัชนีการเกิดโรคผลเน่าต่ำกว่ามังคุดในชุดควบคุม อย่างมีนัยสำคัญทางสถิติตลอดอายุการเก็บรักษานาน 28 วัน ผลการทดลองนี้แสดงให้เห็นว่าการใช้ ES-MCO+LDPE+1-MCP เป็นทางเลือกหนึ่งที่มีประสิทธิภาพในการรักษาคุณภาพมังคุดและสามารถชะลอการเกิดโรคผลเน่าได้ดีเทียบเท่ากับการใช้สารกำจัดเชื้อราคาร์เบนดาซิม

คำสำคัญ : มังคุด, น้ำมันมะพร้าวดัดแปลง, EthylBloc™

Abstract

The effects of ethanolic shellac-modified coconut oil (ES-MCO), low density polyethylene (LDPE) bagging and 1-MCP sachet (EthylBloc™) on postharvest quality and rot diseases of mangosteen fruits were studied. Fruits at maturity stage 3 (reddish pink) were washed with tap water, coated with 2% ES-MCO or 500 ml/l carbendazim (fungicide), and then packed in LDPE bags containing a 1-MCP sachet. Non-carbendazim treated, non - ES-MCO coated and non-packed fruits were served as the control. All samples fruits were stored at 13°C and 95% relative humidity for 42 days. The ES-MCO+LDPE+1-MCP treatment and the carbendazim+LDPE+1-MCP treatment each showed the greatest effective in delaying the changes of calyx and pericarp color, weight loss, hardening of the pericarp and ethylene production. However, there were no significant differences on total soluble solids/titratable acid ratio (TSS/TA) and respiration rate among treatments throughout storage time. Furthermore, the ES-MCO+LDPE+1-MCP treatment and carbendazim+LDPE+1-MCP treatment both delayed the development of fruit rot diseases significantly as indicated by lower disease index values when compared with the controls during storage for 28 days. These results suggest that using ES-MCO+LDPE+1-MCP treatments may serve as an alternative method for maintaining eating quality and for delaying fruit rot the development in mangosteen as well as fungicide carbendazim.

Keywords: EthylBloc™, mangosteen, modified coconut oil

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Introduction

Mangosteen is a climacteric fruit and is known as the queen of fruit because of its high quality color, shape and flavor. The fruit rapidly changes and senesces naturally after harvest, throughout the physiological process involved in ripening, including changes in color, flavor, pericarp hardening, and pathogen infection (Piriyavinit *et al*., 2011). At room temperature, it has a short shelf-life (4-5 days) as the pericarp becomes hard and the calyx dehydrates. Modified atmosphere packaging (MAP) under low temperatures (Pranamornkith *et al*., 2003) and edible coatings (Accaseavorn *et al*., 2006) are used to extend the shelf-life of mangosteen. Pranamornkith *et al*. (2003) reported that an MAP bag can be used to extend storage life and maintains the quality of mangosteen for 16 days at 12°C. Application of an edible coating to mangosteen fruits can delay senescence including the ripening processes of color change, weight loss, and fruit decay, as well as improving market value. Shellac coating has been shown delay calyx wrinkling, weight loss, pericarp hardening, respiration rate and ethylene production without off-flavor development throughout storage at either temperature of 30°, 28°, 13° or 10°C (Accaseavorn *et al*., 2006). Application of a 2% ethanolic shellac-modified coconut oil (ES-MCO) coating to the mango fruit inhibited and killed spores of *Collectotrichum gloeosporioides*, a causal agent of anthracnose disease in fruits (Sripong *et al*., 2014). In addition, treatment with 1-methylcyclopropene (1-MCP), which is an ethylene inhibitor (Watkins, 2006) has been shown to prolong the shelf life of mangosteen by delaying hardening of the pericarp, color changes and calyx wilting (Piriyavinit *et al*., 2011). However, the combined effects of coating, bagging and 1-MCP have not yet been reported in mangosteen. Thus, the objective of this research was to investigate the effects of a combination of ES-MCO, low density polyethylene (LDPE) bagging and 1-MCP on postharvest quality and fruit rot disease of mangosteen during storage at 13°C.

Materials and Methods

Mangosteen fruits at maturity stage 3 (reddish pink) were selected for uniformity of color and size without any visible disease incidence. The fruits were washed with tap water, coated with 2% ES-MCO or 500 ml/l carbendazim (fungicide), packed in LDPE bags containing a 1-MCP sachet and then stored at 13°C and 90-95% RH for 42 days. Non - carbendazim treated, non - ES-MCO coated and non – packed fruits were served as the control. Fruit quality and disease development were evaluated every 7 days. Each treatment had 4 replicates with 5 fruits in each replicate. The color of the pericarp and the calyx were each measured using a Minolta Colorimeter (Model RC 300) and reported as the color changes (delta E, ΔE), which were calculated using the formula: (ΔE) = $((L^*_t-L^*_0)^2 + (a^*_t-a^*_0)^2 + (b^*_t-b^*_0)^2)^{1/2}$ (where L^*_t, a^*_t and b^*_t is lightness, green-red and blue-yellow at time t, and L^*_0, a^*_0 and b^*_0, which are initial lightness, green-red and blue-yellow colors, respectively). Weight loss and pericarp firmness were determined with a balance and a texture analyzer, respectively. Total soluble solids (TSS) and titratable acidity (TA) were determined in flesh juice. Ethylene production and respiration rate were measured with a GC-8A (Shimadzu, Japan). Disease development was observed and expressed as the disease index (DI) using the formula: DI = $\sum$(df)/ND, where d = the degree of rot severity assessed on the fruit, f = respective quantity of fruit, N = the total number of fruits examined and D = the highest degree of disease severity occurring on the scale. The experiment was arranged as completely randomized design (CRD) and the means of each treatment were compared using the Duncan's new multiple range test (DMRT) at $p \leq 0.05$.

Results

Color change in the pericarp and in the calyx of mangosteen fruit during storage at 13°C are shown in Figures 1A and 1B, respectively. Over 42 days of storage, it was found that the treatments with carbendazim+LDPE+1-MCP or ES-MCO+LDPE+1-MCP could delay the ΔE of pericarp color in comparison with the treatments. The ΔE of the calyx tended to increase during the storage time and there were no significant differences among treatments during storage for the first 14 days. From days 21 to 42, the lowest ΔE was shown in the fruits treated cabendazim+LDPE+1-MCP (9.29 to 17.97) followed by the 2% ES-MCO+LDPE+1-MCP combination (7.49 to 23.91). These results indicate that both the cabendazim+LDPE+1-MCP and the ES-MCO+LDPE+1-MCP treatment could retard color changes in both the mangosteen pericarp and the calyx.

Weight loss in all treatments increased throughout storage (Figure 1C). However, the ES-MCO+LDPE+1-MCP combination was the best treatment to reduce weight loss followed by the carbendazim+LDPE+1-MCP treatment. The firmness of the pericarp in all treatments decreased sharply in the first 7 days of storage and continuously declined or remained constant over the following 28 days except in the control fruits which showed the lowest firmness on day 21. Pericarp firmness in all treatments increased sharply from day 35 to day 42. However, the ES-MCO+LDPE+1-MCP or the carbendazim+LDPE+1-MCP combination treatments delayed this increase in firmness (hardening) (Figure 1D). TSS/TA ratio slightly increased from day 0 to day 28 with no significantly difference among treatments. After day 28 the TSS/TA ratio of both the ES-MCO+LDPE+1-MCP and the carbendazim+LDPE+1-MCP treatments were significant lower than that of the controls (data not shown). Ethylene production in all treatments increased and reached a peak on day 35 (19.39-24.28 µl C_2H_4/kg.h), particularly in the ES-MCO+LDPE+1-MCP (22.79 µl C_2H_4/kg.h) and the carbendazim+LDPE+1-MCP (24.28 µl C_2H_4/kg.h) treatments where there had been an earlier suppression of ethylene production. Ethylene production in all treatments decreased sharply in the final days of storage (6.46-12.27 µl C_2H_4/kg.h) (Figure 1E). The highest respiration rate was found on day 35 in the fruits treated with carbendazim (112.14 mg CO_2 /kg.h), followed by control fruit, ES-MCO alone, carbendazim+LDPE+1-MCP and ES-MCO+LDPE+1-MCP treated fruits respectively (106.59, 102.56, 91.75 and 86.53 mg CO_2 /kg.h). However, there were no significant differences among treatments during the 35 days of storage (data not shown).

No disease incidence (DI) was observed until after 14 days of storage. The DI of the control was significant higher ($p \leq 0.05$) than that of the other treatments from days 21-28 (Figure 1F). Treatments with ES-MCO+LDPE+1-MCP and ES-MCO only, seemed to help in delaying fruit rot disease development as did treatments with carbendazim or carbendazim+LDPE+1-MCP. However, there were no significant differences in DI among treatments.

Discussion

Mangosteen fruit is senescence is characterized by a rapid increase in pericarp hardening, browning and wilting in the stem end and calyx; together with increased sensitivity to microbial infection, all of which reduce fruit quality. In our previous studies, we found that 1-MCP+LDPE could maintain the quality of mangosteen fruit by delaying the ripening process and also the onset of disease development. In this study, we used ES-MCO coating combined with LDPE+1-MCP to maintain quality and to control the fruit rot development. The results showed that the treaments of ES-MCO+LDPE+1-MCP and carbendazim+LDPE+1-MCP reduced ethylene production; and suppressed changes in the TSS/TA ratio, thus confirming that the ripening processes of mangosteen fruit could be delayed by ES-MCO+LDPE+1-MCP or by carbendazim+LDPE+1-MCP. These overall results may be related to the fact that 1-MCP is an effective inhibitor of ethylene action, delaying a number of genes associated with the senescence and ripening processes (Watkins, 2006). In addition, the results showed that both of the 2% ES-MCO+LDPE+1-MCP and the carbendazim+LDPE+1-MCP combination helped to delay the development of changes in skin color; the onset of browning and shrinkage of both the stem end and the calyx, changes in fruit firmness and the reduction in weight loss compared to the controls. These effects may be related to the effect of the skin coating combined with LDPE+1-MCP within the fruit to prevent chlorophyll degradation, maintain the level of lignin content and as well as providing a barrier to the loss of water from the fruit when there is no packaging (Li *et al*., 2013; Bayogan and Delgado, 2013; Accaseavorn *et al*., 2006). Hence, ES-MCO+LDPE+1-MCP and carbendazim+LDPE+1-MCP could maintain fruit quality during the storage period that was evaluated. Furthermore, ES-MCO had a direct effect on fungal growth due to the potential of lauric acid, monolaurin and other fatty acids which are the main components of ES-MCO that may have antifungal properties to suppress fungal pathogen development (Sripong *et al*., 2014).

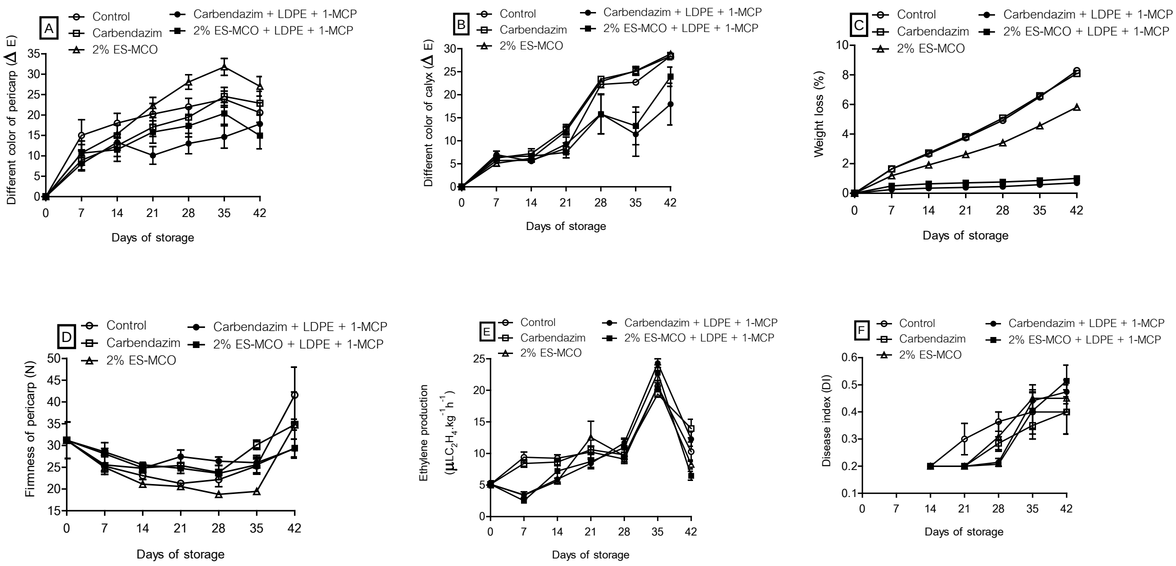

Figure 1 Different color of pericarp (A) and calyx (B), weight loss (C), pericarp firmness (D), ethylene production (E) and disease index (F) of mangosteen fruits coated with 2% ES-MCO or 500 ml/l carbendazim (fungicide), packed in LDPE bag containing 1-MCP sachet sachet before storage at 13°C, 90-95% for 42 days. Non - carbendazim treated, non - ES-MCO coated and non-packed fruit were served as the control.

Summary

Application of the ES-MCO + LDPE bagging + 1-MCP combination may act as an alternative method for delaying senescence processes in mangosteen fruit, including decreased weight loss, delayed color changes, retained fresh green color of the calyx and suppressed pathogenic infection when fruits are harvested at maturation stage 3 and then subsequently stored at low temperature.

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