ผลของสภาพปราศจากออกซิเจนระยะสั้นต่อการผลิตเอทิลีนและคุณภาพผลบ๊วย *(Prunus mume)* ในระหว่างเก็บรักษา

Effect of Short-term Anoxic Condition on Ethylene Production and Quality of Japanese Apricot *(Prunus mume)* During Storage

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลของสภาพปราศจากออกซิเจนเป็นระยะเวลา 6 ชั่วโมงต่อการผลิตเอทิลีนและการเปลี่ยนแปลงคุณภาพผลบ๊วยในระหว่างการเก็บรักษาที่อุณหภูมิ 20 องศาเซลเซียส เป็นระยะเวลา 6 วัน พบว่าผลบ๊วยที่ได้รับสภาพปราศจากออกซิเจนมีปริมาณเอทิลีน และ 1-aminocyclopropane-1-carboxylic acid (ACC) น้อยกว่าผลในชุดควบคุมอย่างมีนัยสำคัญในวันที่ 0 และวันที่ 2 ของการเก็บรักษา และมีค่าความแน่นเนื้อในวันสุดท้ายของการเก็บรักษามากกว่าอย่างมีนัยสำคัญ โดยสภาพปราศจากออกซิเจนมีค่าความแน่นเนื้อเท่ากับ 1.76±0.06 นิวตัน และชุดควบคุมมีค่า 1.18±0.07 นิวตัน แต่อย่างไรก็ตามไม่พบความแตกต่างอย่างมีนัยสำคัญของปริมาณของแข็งทั้งหมดที่ละลายน้ำได้และกรดที่ไทเทรตได้ระหว่างชุดควบคุมและชุดทดลองตลอดระยะเวลาการเก็บรักษา การใช้สภาพปราศจากออกซิเจนเป็นระยะเวลา 6 ชั่วโมงก่อนเก็บรักษา สามารถชะลอการเปลี่ยนแปลงความแน่นเนื้อได้ ทั้งนี้อาจเป็นผลมาจากการการชะลอการเพิ่มขึ้นของปริมาณ เอทิลีน และ ACC แต่อย่างไรก็ตามผลการทดลองเหล่านี้จะต้องได้รับการยืนยันโดยการวิเคราะห์สารชีวโมเลกุลอื่นๆที่เกี่ยวข้องกับการผลิตเอทิลีนต่อไป

คำสำคัญ: สภาพปราศจากออกซิเจน การสุก เอทิลีน

Abstract

The objective of this research was to observe the effect of anoxic condition for 6 hours on ethylene production and quality change of Japanese apricot *(Prunus mume)* during storage at 20°C for 6 days. It is found that ethylene production and 1-aminocyclopropane-1-carboxylic acid (ACC) concentration in anoxic treated fruit was significantly lower than the non-treated fruit at day 0 and day 2 of storage and maintained significantly higher fruit firmness than those untreated control. The fruit firmness of anoxic treated fruit was 1.76±0.06 N and non-treated fruit was 1.18±0.07 N. However, anoxic treatment was not significantly effect on total soluble solids (TSS) and titratable acidity (TA) in neither treated nor non-treated fruit during storage. It suggested that anoxic treatment for 6 hours delay softening in Japanese apricot which might be involved with suppression of ethylene and ACC concentration. However, these results have to be confirmed by further analyzing of the other biomolecules related to ethylene biosynthesis.

Keywords: anoxic treatment, ethylene, Japanese apricot

Introduction

Apricot (*Prunus mume*) is classified in a climacteric fruit type with short storage life (Muñoz-Robredo *et al.*, 2012). An increase of ethylene production is the important key which monitoring changes of physiological, biological, and chemical activities (Lohani *et al.*, 2004). Pretreatment with a very low oxygen atmosphere exposure may cause delaying the ripening in fresh fruit and vegetable (Pesis *et al.*, 1994). Anoxic treatment is used for

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retain postharvest quality in many fresh produces such as suppressing ethylene production in carnation (Chen and Solomos, 1996), maintaining firmness in peach fruit (Polenta *et al*., 2005), inhibiting internal browning in pineapple (Phonyiam *et. al*., 2014) and reducing physiological and chemical losses in green asparagus (Techavuthiporn and Boonyaritthongchai 2016). Nevertheless, the effect of anoxic treatment on postharvest quality of Japanese apricot has not yet been examined. The objective of this study was to evaluate the role of anoxic treatment on the delaying of ripening process of Japanese apricot fruit.

Materials and Methods

Japanese apricot (*Prunus mume*) cv. 'Inazumi' was harvested at maturity stage. Fruits were randomly placed in plastic chambers and subjected to pure nitrogen. The oxygen level in head space of chamber was maintained to be ≤ 0.05% (v/v) and determined by a gas analyzer. The treatments were maintained for 6 hours at room temperature with humidified N_2 flow (200-250 mL/min). Untreated fruits were placed without nitrogen flushing as a control treatment. Fruits were kept in corrugated boxes and stored at 20°C (90-95% RH) and randomly performed every 2 days. Frozen samples were dehydrated by freezing method for further analysis. Total soluble solid (TSS) was monitored on fruit juice using a digital hand refractometer. Titratable acidity (TA) of the juice was determined by titration method using 0.1N NaOH. Flesh firmness was evaluated by a penetrometer and expressed in Newtons (N). Ethylene production was evaluated as previously described by Hataitip *et al.* (2011). The results were expressed in nano liter of ethylene released per kilogram of tissue per hour (nl $kg^{-1}h^{-1}$). ACC concentration was determined according to the method of Kondo *et al.* (2007). The results was determined by a known amount of ACC as standard and expressed as nmol of ACC g^{-1}DW.

Results

Changes in fruit firmness of apricot over storage period were shown in table1. The firmness in anoxic treated fruit lower declined than untreated control during measuring date. Meanwhile, TSS and TA did not showed significant difference after 4 days of storage.

Ethylene production in apricot increased markedly after 2 days of storage (Fig.1A). Ethylene production of treated fruit was delayed at the beginning, and significantly increased after 2 days of storage. The strongly increase of ethylene throughout storage period was found in untreated control. ACC concentration of untreated apricot (control) was very high at the beginning compared with that of the anoxic treated fruit. Treated fruit had a peak of ACC content at 4.69 nmol g^{-1} fruit weight on day 4 while untreated fruit had a peak of 3.46 nmol g^{-1} fruit weight on day 2 (Fig. 1B).

Table 1 Changes of fruit firmness, TSS and TA of 'Inazumi' Japanese apricot during storage at 20°C.

Physical and chemical parameters	Treatment	Days after treatment			
		0	2	4	6
Fruit firmness (N)	Untreated control	65.95±2.04	52.19±2.43b	23.36±2.89b	11.27±0.69b
	Anoxic treatment		67.70±1.22a	34.46±2.23a	17.23±0.61a
TSS (%Brix)	Untreated control	6.27±0.30	5.73±0.19b	7.20±0.33ns	6.53±0.19ns
	Anoxic treatment		6.93±0.19a	7.20±0.33ns	7.20±0.33ns
TA (%Mallic acid)	Untreated control	4.72±0.35	3.99±0.04b	5.32±0.10ns	5.15±0.08ns
	Anoxic treatment		5.36±0.05a	6.07±0.67ns	5.27±0.25ns

Values are the means ±SD of three replications, all difference are significant at $p<0.05$.

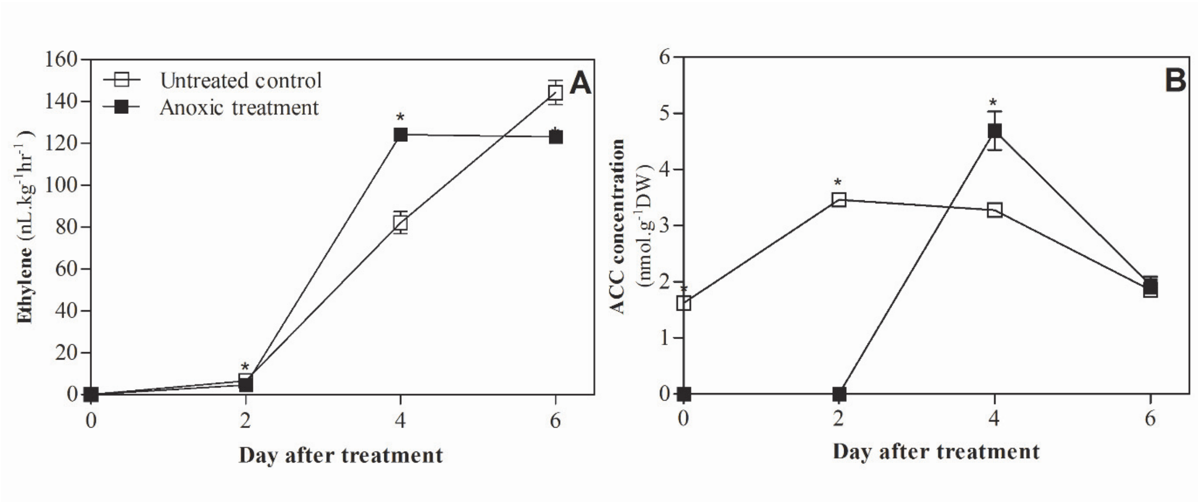

Figure 1 Changes of ethylene production (A) and ACC concentration (B) in 'Inazumi' Japanese apricot during storage at 20°C. Values are the means ±SD of three replications, *: significant difference at p<0.05

Discussion

Fruit firmness can be considered as a parameter for evaluating the ripeness of fruit (Shinya *et al*., 2013). Anoxic treatment has been reported to prolong the firmness, including promotes enzymatic activities in kiwifruit (Song *et al*., 2009). In addition, this study indicated that short-term anoxic treatment delayed the softening in Japanese apricot during storage at 20°C. This finding is in agreement with Techavuthiporn and Boonyaritthongchai (2016), green asparagus under the combination of anoxia and modified packaging had greater maintained fiber and lignin content than untreated control during storage at low temperature. No significant differences in total soluble solids and titratable acidity were observed. It can be indicated that these mechanisms was not affected by anoxic treatment or the anoxic tread period is too short.

The amount of ethylene regulates various activities of plant growth, development, ripening, including senescence process (Atkinson *et al*., 2011). The production of ethylene in apricot was extremely low before ripening stage (Muñoz-Robredo *et al*., 2012). In this work, the production of ethylene in Japanese apricot was delayed in treated fruit than that untreated fruit during 2 days of storage. As described by Paul and Pandey (2014), low O_2 atmosphere minimized the synthesis and action of ethylene as well as decreased the expression of genes. ACC is a direct precursor for synthesis of ethylene, which can be regulated the production level of ethylene (Van de Poel and Van Der Straeten, 2014). In this study lower ACC concentrations were detected in treated fruit during 2 days of storage. Previously Ketsa *et al*. (2013) found low oxygen condition eliminated the conversion of ACC to ethylene. This suggests that the mechanism of ACC as well as ethylene production at the beginning period of storage might be inhibited by anoxic treatment.

Summary

This work demonstrated that 6 hour of anoxic treatment can maintain fruit firmness of 'Inazumi' Japanese apricot which may be involved with suppression of ethylene production and ACC content during initial storage period.

Acknowledgement

I would like to express my appreciation to School of Agro-Industry, Mae Fah Luang University and Japan Student Services Organization (JASSO) scholarship for their support throughout the period of my studied.

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