Fruits of bilimbi (Averrhoa bilimbi L.) as a New Natural Source of Ethylene for Ripening of ‘Saba’ Banana (Musa balbisiana BBB)

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Injured and uninjured fruits of bilimbi (Averrhoa bilimbi L.) at 0%, 5% and 10% (w/w) were packed with mature green ‘Saba’ bananas for 24 h and then allowed to ripen in open air. Use of 5% uninjured bilimbi fruits hastened ripening of bananas compared with the control treatment. Increasing the concentration of bilimbi fruits to 10% and injuring them with three 5-mm deep punctures or 4-cm long, 1-cm wide and 0.2-cm deep scrape bruises from a piece of stainless steel further hastened ripening of banana. Use of 10% injured bilimbi fruits effectively ripened bananas to table ripe stage after 5 d, while the control fruits were just beginning to develop color. Ethylene production of bilimbi fruits was high. Bilimbi fruits stressed by transport and injury evolved as much as 2403.8 nL g⁻¹ h⁻¹ after 24 h. The relatively high amounts of ethylene produced by bilimbi fruits effectively induced the ripening of mature green ‘Saba’ bananas. Based on the results, bilimbi fruit may be an effective natural source of ethylene for ripening of ‘Saba’ banana.

Key Words: Averrhoa bilimbi, ethylene, natural ripening agent, ‘Saba’ banana

INTRODUCTION

Bunches or fingers of ‘Saba’, a popular cooking banana in the Philippines, ripen unevenly, i.e., within 5–16 d from harvest (Acedo and Bautista 1991). This undesirable characteristic of ‘Saba’ banana becomes a problem for small traders because consumers usually buy the fruits as they start to ripen or at the firm ripe stage. Ripening agents have often been used to address this problem.

The most effective ripening agent is ethylene which ripens bananas evenly within a short period of time. It is commercially available in gaseous or liquid form. Since commercial ethylene is costly, ‘Saba’ traders use acetylene from calcium carbide (Bautista 1982). It is cheap, easy to use and readily available in the local market but it is flammable, explosive and exudes an objectionable odor during use.

Another alternative is the use of bioethylene, or ethylene from natural sources. The use of fresh leaves of kakawate (Gliricidia sepium Jacq. Steud), rain tree (Samanea saman Jacq. Prain), and star fruit (Averrhoa carambola L.) to ripen fruits is a common practice in the Philippines (Bautista et al. 1990). Bioethylene can also be obtained from fruits and vegetable peels which give off relatively high amounts of ethylene (Sjaifullah 1983; Sjaifullah and Bautista 1984). Other sources of bioethylene should be explored for better, more commonly available ripening agents.

Fruits of bilimbi (Averrhoa bilimbi L.), also known as lime tree or locally as kamias, are believed to be a possible source of bioethylene as they were observed to soften fast especially when injured, which could mean that they produce a high level of ethylene. The fruits are commonly used as food flavoring, as a souring agent for local dishes, or they may be eaten raw. Bilimbi fruit is also used to remove stains on clothes and metal blades and as a hand wash due to its high acidity and high oxalic acid content (Orwa 2009; Pushpakumara 2007; Morton 1987; Coronel 1986).

This study determined the effect of bilimbi fruit on the ripening behavior of ‘Saba’ bananas and explained its effect in terms of ethylene production.

MATERIALS AND METHODS

Three ripening trials were conducted. Three mature ‘Saba’ banana hands were packed with 0–10% (w/w) mature bilimbi fruits (uninjured or injured) or with leaves of bilimbi either sealed in polyethylene bag or wrapped in newspaper for 24 h. Injury was inflicted by puncturing the bilimbi fruits with a thumbnail three times (5 mm deep) or scraping them with a 1-cm wide piece of stainless steel.
stainless steel to create bruises (4 cm long, 1 cm wide and 0.2 cm deep). Fruits from a bilimbi tree outside the laboratory (University of the Philippines Los Baños) or from Calauan, Laguna (about 13 km away) were used as ripening agents. The fruits were removed from the pack and allowed to ripen naturally in carton boxes at 30 °C until they attained table ripe stage (peel color index 6). Peel color index (PCI) for banana was as follows: 1 - mature green, 2 - breaker, with tinge of yellow, 3 - more green than yellow, 4 - more yellow than green, 5 - yellow with green tips, and 6 - full yellow/ table ripe stage.

Determination of ethylene production was done in triplicate by enclosing 40–180 g of bilimbi fruits or 3–4 g of bilimbi leaves in a 1-L or a 0.5-L static system (a tightly closed glass jar with mixing and sampling ports) at ambient room temperature, 30 °C. One-milliliter gas samples were collected and injected in a gas chromatograph (Shimadzu GC-8A, Kyoto, Japan) with a flame ionization detector.

RESULTS AND DISCUSSION

Preliminary trial of bilimbi as ripening agent showed that ‘Saba’ bananas enclosed with 5% freshly harvested bilimbi fruits ripened twice as fast as the control while bilimbi leaves had no effect (data not shown). Thus, the succeeding ripening trials used only bilimbi fruits.

Obvious difference in peel color was observed between the control and the bananas enclosed with 5% uninjured bilimbi fruits as early as day 2 (Fig. 1A). Ripening progressed fast, based on the PCI, with the bilimbi-exposed ‘Saba’ bananas achieving PCI 5 (yellow with green tips) on the 6th day whereas the control bananas reached only PCI 2 (with a tinge of yellow).

Similarly, the use of 5% and 10% injured bilimbi fruits (punctured with the thumbnail three times) resulted in hastened ripening of ‘Saba’ bananas compared with the control (Fig. 1B). Effects were seen starting only on the 3rd day. However, accelerated rate of ripening was observed when 10% injured bilimbi fruits than when only 5% injured fruits were used, reaching PCI 4–5 in less than 4 d (Fig. 1B and 1C). Full yellow or table ripe stage (PCI 6) was reached 5 d after. Again, the difference in peel color of the treated fruits was very distinct. While the treated fruits were already yellow, the control fruits had only started to turn light green.

Scrape-bruised bilimbi fruit (10%) also accelerated ripening of ‘Saba’ bananas. The bananas reached PCI 6 also on the 5th day. Regardless of the type of injury inflicted on the bilimbi fruit, ripening was similarly accelerated (Fig. 1C).

Gas chromatography showed that uninjured bilimbi leaves evolved 13.3 nL g⁻¹ h⁻¹ ethylene while the uninjured fruits evolved almost 7x as much, 86.8 nL g⁻¹ h⁻¹ ethylene in 27 h (Fig. 2A). Ethylene from leaves did not