Postharvest Biology and Technology 113 (2016) 58–65

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

Postharvest dip treatment with a natural lysophospholipid plus soy lecithin extended the shelf life of banana fruit

Zienab F.R. Ahmed[a,b], Jiwan P. Palta[b,*]

[a] Department of Horticulture, South Valley University, Qena 83523, Egypt
[b] Department of Horticulture, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706, USA

ARTICLE INFO

Article history:
Received 10 September 2014
Received in revised form 27 October 2015
Accepted 27 October 2015
Available online 18 November 2015

Keywords:
Lysophosphatidylethanolamine
Shelf life
Fruit firmness
Membrane ion leakage
Ethylene production
Senescence
Membrane lipids
Phospholipids
Banana

ABSTRACT

Lysophosphatidylethanolamine (LPE), a natural phospholipid, has been investigated for retarding senescence and promoting the shelf life of fruit and other plant tissues. LPE is a water insoluble phospholipid. For most experimental purposes, LPE is dispersed in water prior to treatment of fruit using sonication. In this study, the water solubility of LPE was improved by mixing it with soy lecithin prior to mixing with water. A combination of LPE and lecithin was used for a dip treatment of banana fruit. Banana fruit at ripening stage 2 (3/4 green) were dipped in this solution for 30 min and then stored at room temperature for 10 d. A combination of 200 mg L^{-1} LPE and lecithin gave the best shelf life. In this treatment over 75% of the fruit were marketable 7 d after treatment. While only about 20% and 28% of the fruit were marketable in the water (control) and lecithin treated-fruit respectively. Fruit treated with lecithin alone had better shelf life as compared to the control. Furthermore, the LPE + lecithin treatment gave better shelf life as compared to the LPE alone treatment. At 7 d after dip, fruit treated with LPE + lecithin had lower ion leakage from peel tissue, higher pulp firmness, and thicker peel as compare to the control and lecithin treatments. A dip treatment with NAA (1-naphthalene acetic acid) was compared with LPE + lecithin for fruit marketability and changes in various fruit properties during ripening. Although NAA improved shelf life and retarded fruit softening as compared to the control, this treatment resulted in abnormal de-greening of fruit peel tissue. Fruit treated with LPE + lecithin had normal yellow color development and had lower ethylene production as compared to NAA and control treatments. The results of this study suggest that a dip treatment with a combination of LPE and lecithin may have potential for improving shelf life of banana fruit.

1. Introduction

Phospholipids and lysophospholipids have been reported as potential growth regulators (Cowan, 2009; Wang and Chapman, 2013). The application of lysophospholipids such as LPE can also promote ripening and accelerate ripening-related changes. For example, pre-harvest treatment with LPE enhanced the color of cranberry, apple, red pepper, table grape and tomato fruit (Farag and Palta, 1991; Hong et al., 2007; Kang et al., 2003; Ozgen et al., 2005). LPE treatment allowed normal ripening of tomato fruit while maintaining fruit firmness and increasing shelf life of the fruit while retarding fruit and leaf senescence (Farag and Palta, 1993). This improvement in shelf life and reduced senescence of leaf tissue was accompanied with reduced ion leakage from these tissues. The exact mechanism by which LPE delays senescence and improves shelf life is not known. However, LPE has been found to inhibit the activity of phospholipase D (PLD), in a highly specific manner (Ryu et al., 1997). PLD is known to be activated during ethylene induced senescence (Wang, 2002) and this activation leads to membrane breakdown. It thus appears that LPE may be enhancing shelf life by preserving membrane health during senescence and aging of fruit.

Banana is classified as a climacteric fruit. In this fruit, a series of physiological and biochemical changes are known to lead to the development of the soft edible fruit (Prasanna et al., 2007; Tapre and Jain, 2012). Some of the primary changes during this ripening process include an increase in membrane permeability (leakage), loss of fruit pulp firmness, decrease in starch, increase in sugar, decrease of peel thickness as well as changes in color and aroma (Baur and Workman, 1964; Seymour et al., 1993; Wade and Bishop, 1978).

* Corresponding author at: Department of Horticulture, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI 53706, USA. Fax: +1 608 358 5672.
E-mail addresses: zinabriad@yahoo.com (Z.F.R. Ahmed), jppalta@wisc.edu (J.P. Palta).

http://dx.doi.org/10.1016/j.postharvbio.2015.10.016
0925-5214/

Commercially, bananas are harvested mature green, stored in modified atmosphere rooms and treated with ethylene gas before marketing (Ahmed et al., 2006). This gas treatment is known to provide uniformly ripened fruit within a few days. Change in peel color during ripening is associated with breakdown of chlorophyll and replacement by other pigments such as carotenoids (Kay, 1991; Seymour et al., 1993). Fruit are considered marketable as long as the peel color is mostly yellow with very few brown spots. Ripened banana fruit goes from marketable to unmarketable within 1–3 d. Therefore, improving shelf life of the banana fruit by a couple of days can add significant commercial value.

Fruit ripening is known to be controlled by the plant hormone ethylene (Barry and Giovannoni, 2007). Several of postharvest treatments have been tested to improve shelf life of banana fruit to regulate ethylene action or synthesis (Golding et al., 1998; Harris et al., 2000). For example 1-MCP gas treatment has been found to block ethylene receptors and prevent ethylene effects on fruit tissues and extend shelf life (Serek et al., 1994; Sisler and Serek, 1997). Although treatment with 1-MCP maintained fruit firmness and extended the shelf life, it delayed ripening of the fresh fruit and developed undesirable effects (Jiang et al., 2002; Lohani et al., 2004; Pelayo et al., 2003). These undesirable effects including uneven coloration and a reduction of flavor compounds, thus making 1-MCP treatment unsuitable commercially for extending the shelf life of banana fruit (Golding et al., 1998; Pelayo et al., 2003; Watkins, 2006).

Auxin and ethylene are thought to work synergistically and affect a number of aspects in plants including fruit ripening. Early

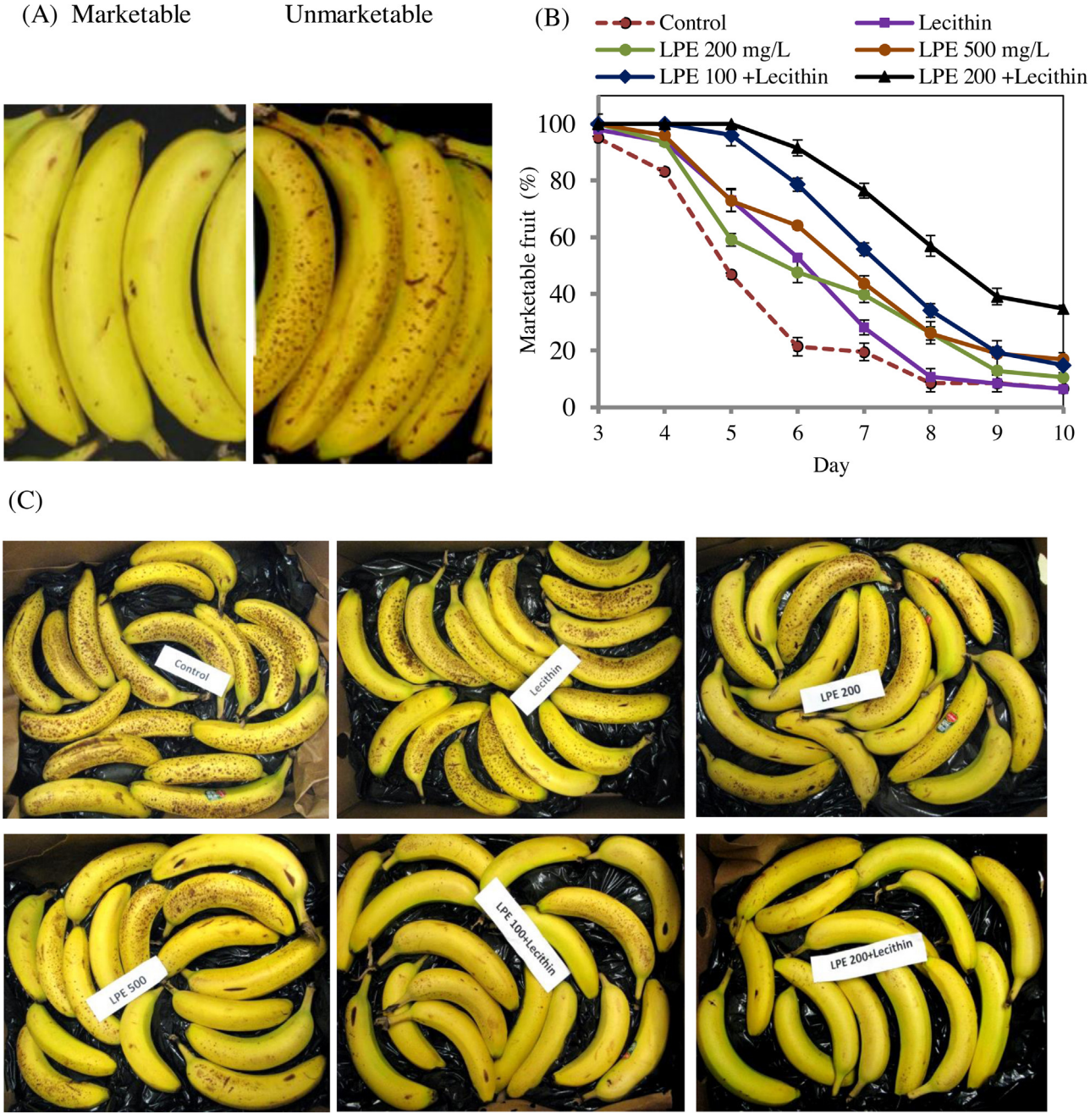

Fig. 1. Effect of treatment with LPE, in the presence and absence of lecithin, on marketability of banana fruits. Fruits were dipped for 30 min in either LPE 200 or 500 mg L^{-1} alone or mixed with lecithin (500 mg L^{-1}) solution. Water dip for 30 min served as control. Fruits were stored at room temperature for 10 d and daily rated for marketability (A). Data for marketability were recorded form 20 fruits per replication and three replications per treatment ($n = 3$). (B). Pictures of the fruits at 6 d after treatment (C).