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Research paper

Delayed pericarp hardening of cold stored mangosteen (*Garcinia mangostana* L.) upon pre-treatment with the stress hormones methyl jasmonate and salicylic acid

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ABSTRACT

Fruits are commonly subjected to cold storage, which can elicit negative changes in the fruit's physiology. This is more apparent in tropical fruits such as mangosteen, which experience pericarp hardening during chilling injury and senescence, due to diversion of phenolics content into increased lignin synthesis. The aim of this study was to explore treatments that may ameliorate the effects of cold storage on soluble phenolics content and fruit quality. Freshly harvested fruit were exposed to salicylic acid (SA) or methyl jasmonate (MJ) at one of five levels, and stored at 6 °C for 12 d. Physico-chemical quality attributes, total soluble phenolics content, polyphenol oxidase (PPO) activity and antioxidant activity were assessed. MJ significantly enhanced ($P < 0.05$) antioxidant activity and PPO activity, while delaying pericarp hardening. Fruit quality is closely linked to bioactivity, and can be dually enhanced by treatment with stress hormones.

1. Introduction

As increasing interest is directed towards the benefits of consuming natural products with potent antioxidant activity, approaches for enhancing the bioactive content of fruits and vegetables are becoming of more interest. Exploring the stresses that plant products endure and their effects on antioxidant levels can provide mechanisms for enhancing the activity of naturally occurring bioactive compounds in fruits and vegetables (Gonzalez-Aguilar et al., 2010). The effects of this approach have been assessed as an economical method for enhancing the quality of various tropical fruits (Mustafa et al., 2016), and in this study the stress responses of mangosteen fruit are reported.

Cold storage is a common practice for slowing down respiration and metabolic changes of fruits and is an economical method for transporting tropical fruits to overseas markets. However, tropical fruits are highly sensitive to chilling injury, which can have a negative impact on their quality and shelf-life (Vyas et al., 2015). Altered fruit physiology may be apparent upon exposure to such temperature stresses during postharvest storage. These include the production of secondary metabolites, and the plant stress hormones salicylic acid (SA) and methyl jasmonate (MJ) (Kim et al., 2006).

SA and MJ are involved in a variety of stress responses that balance stress-related redox reactions (Suza et al., 2010). These two hormones have the potential to be exploited as commercial tools for enhancing the nutritional and sensory quality of tropical fruits. Application of postharvest tools to reduce food losses requires an understanding of the obstacles faced throughout the supply chain, as well as the inherent mechanisms of stress amelioration.

Ripening of fruits is a complex genetically controlled process involving various interlinked changes in the fruit quality (Seymour et al., 2013). Mangosteen is a tropical fruit that shows a climacteric pattern of respiration, however it can only fully ripen if harvested at the middle of the ripening process (Abdul-Rahman et al., 2017; Lerslerwong et al., 2013; Palapol et al., 2009). Although considerable research has been carried out on the nutraceutical properties of mangosteen, there are few studies directed towards understanding the postharvest life of the fruit (Wittenauer et al., 2012; Zadernowski et al., 2009).

It is characterised by high anthocyanin content, as well as proanthocyanins and xanthones (Palapol et al., 2009). A characteristic increase in firmness and lignin content occurs during storage and in response to stress, which manifests as pericarp hardening (Ketsa and Atantee, 1998; Ketsa and Koolpluksee, 1993). This increase in firmness is also apparent towards the end of the fruit's shelf life, and can adversely affect fruit quality and marketability.

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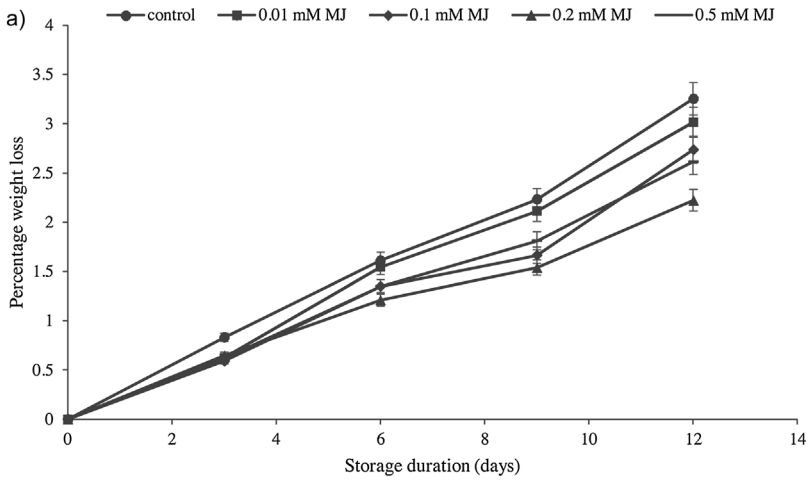

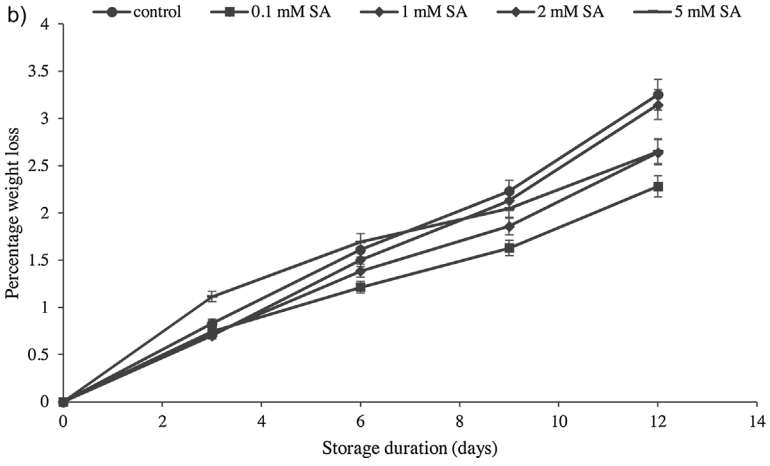

Fig. 1. Effect of different concentrations of a) methyl jasmonate and b) salicylic acid on weight loss of mangosteen stored at 6 °C for 12 d. Values are the means ± SE.

Increased lignification of mangosteen is a stress response that diverts the phenolics content towards synthesis of lignin. Phenolic compounds are primarily synthesized through the phenylpropanoid pathway (Oh et al., 2009). Moreover, phenolic content is also regulated by the activity of polyphenol oxidase (PPO), which oxidises phenolic compounds into highly reactive quinones (Yingsanga et al., 2008). The activity of PPO is reportedly enhanced under biotic and abiotic stresses and involves the stress hormones MJ and SA (Siboza et al., 2014; Oh et al., 2009; González-Aguilar et al., 2004).

The aim of the present study was to assess changes in phenolic metabolism of mangosteen upon exposure to SA and MJ during cold storage.

2. Materials and methods

2.1. Plant material

Freshly harvested mangosteen was purchased from a commercial farm in Malacca State of Malaysia. Fruits were selected at purple-red maturity (stage 5) and were disease free and uniform sized. The fruits were washed with 0.05% sodium hypochlorite followed by distilled water then air-dried at ambient temperature.

2.2. Treatments and storage conditions of fruits

Two sets of experimental treatments, each composing of five levels, were adopted during this experiment: methyl jasmonate (MJ) and salicylic acid (SA). MJ vapour at concentrations of 0.00, 0.01, 0.1, 0.2 and 0.5 mM were applied by incubating the fruits for 16 h in 45 L airtight containers. SA was applied at concentrations of 0.0, 0.1, 1.0, 2.0 and 5.0 mM, and was administered by dipping fruits in the respective solution. After treatment, treated and untreated fruit (control) were allowed to dry at room temperature. The fruits were then stored in corrugated boxes, with a single box for each treatment, at 6 °C, 60–70% relative humidity for 12 d, and fruits were randomly sampled for each treatment every three days.