INDUCED RIPENING AGENTS AND THEIR EFFECTS ON FRUIT QUALITY OF BANANA

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Abstract: Artificially ripened bananas were shown to be considerably diferent from naturally ripened bananas in some studies. The ethylene & acetylene gas liberated from calcium carbide, used successfully in the trade and they have been widely studied for their effectiveness on initiating and accelerating the ripening process and their effects on fruit quality and health related issues. Lauryl alcohol was also shown as a ripening agent for bananas. Ripening is a genetically programmed highly coordinated irreversible phenomenon which includes many biochemical changes including tissue softening, pigment changes, aroma and flavor volatile production, reduction in astringency, and many others. Most studies suggest that there is no difference in biochemical composition and sensory quality in bananas treated with chemicals that induce ripening from naturally ripened bananas. The present articles discussed about induced ripening agents and their effects on fruit quality of bananas.

Key words: Ethylene & acetylene, calcium carbide, biochemical

Introduction: Fruit ripening is the initiation of fruit senescence which is a genetically programmed highly coordinated process of organ transformation from unripe to ripe stage to yield an attractive edible fruit [1]. It is an irreversible phenomenon involving a series of biochemical, physiological, and organoleptic changes [2]. These changes include changes in carbohydrate content, increment of sugar content, changes in colour, texture, aroma volatiles, favor compounds, phenolic compounds, and organic acids. Respiration is a good indicator of cellular metabolic activity, and respiratory pattern is characteristic of the stages in the life cycle of a fruit such as development, ripening, and senescence [3]. Fruit ripening is closely linked to ethylene, a phytohormone that can trigger initiation of ripening and senescence. In climacteric fruits, as ripening proceeds there is a strong respiratory peak with high level of ethylene production. While in non-climacteric fruits respiration rate is almost constant or shows a steady decline until senescence occurs, with little or no increase in ethylene production [4]. Therefore, climacteric fruits are referred to as ethylene dependent fruits and they have the capability to ripen after the harvest, often with the help of exogenous ethylene. However it is generally claimed that non-climacteric fruits ripen only if they remain attached to the parent plant [5]. The relationship between ethylene and fruit ripening has been studied for many decades. There are two systems of ethylene biosynthesis. The ethylene biosynthesis pathway in higher plants has been well studied. Briefly, ethylene is synthesized from methionine. Methionine is regenerated from ACC through the Yang cycle [1]. However, more efforts in understanding the ethylene response during fruit ripening have focused on the characterization of tomato homologs. The ethylene is perceived by receptors (ETR) in endoplasmic reticulum (ER). Ethylene receptors are multigene families encoding two types of closely related proteins, one subfamily with a histidine kinase domain and the other subfamily with a serine/threonine kinase function [6]. The receptors are negative regulators and in the absence of ethylene, constitutive Triple Response (CTR1) gets activated. Changes during Ripening Compositional and structural changes occur during ripening leads to the fruit being desirable and edible. Among these changes, textural change is very important and a major event in fruit ripening. These textural changes differ with species where some fruits such as banana, mango, and papaya undergo substantial softening and fruits such as apple normally exhibit less softening. Textural changes and fruit softening are due to depolymerization and solubilization of cell wall components and loss of cell structure [7]. Change in turgor pressure and degradation of cell wall polysaccharides and enzymatic degradation of starch are determinant mechanisms of fruit softening. Cell wall polysaccharides such as pectin, cellulose, and hemicellulose undergo solubilization, de-esterification, and depolymerization during ripening [8]. Cell wall degrading enzymes, such as pectin methylesterase, polygalacturonase, β-galactosidase, endo-1,4- β -d-glucanase, and many others, are involved in this mechanism. Further loss of neutral sugars and galacturonic acid followed by solubilization of the remaining sugar residues and oligosaccharides are also included in cell wall modifcations [8]. In some fruits such as bananas which contain high level of starch in the fruit fresh, enzymatic hydrolysis of starch is a major factor in fruit softening. Colour development is an important maturity index of many fruits and associated with ripening. In many cases the colour change during fruit ripening is due to the unmasking of preexisting pigments by degradation of chlorophylls and synthesis of anthocyanins and carotenoids [9]. Many fruits emit volatile compounds which are responsible for favors and aroma of the certain fruit. The metabolism of fatty acids and branched amino acids act as precursors of aroma volatiles in fruit [10]. Aroma and favors volatile profile of fruits mainly consist mainly of esters, alcohols, aldehydes, ketones, and terpenes. Many studies have been done to explain the association between volatile synthesis and ethylene production. Ethylene treatments can enhance the aroma volatile production in mangoes and honeydew melons [11, 12].The Induced Ripening of Bananas Fruit ripening is a combination of physiological, biochemical, and molecular processes leading to changes in pigments, sugar content, acid content, favors, aroma, texture, etc. Artificial ripening enables traders to minimize losses during transportations as well to timely release the product at desired ripening stage. Bananas can be artificially ripened using diferent ripening agents.

Ethylene Gas: The most popular method practiced in developed countries is application of ethylene gas in ripening rooms. Modern banana ripening rooms are designed with techniques to control temperature, humidity, and ethylene gas concentration and they are equipped with proper ventilation and exhausting systems. Banana combs are properly packed and kept in these rooms and then ethylene is supplied at proper temperature and humidity. Von Loesecke [13] commented that some scientists showed that ripening of bananas can be induced by exposing them to vapor of apples, which was confirmed when it was shown that ripening of bananas can be accelerated using the vapor that had previously passed through ripe bananas. Finally, it was concluded that exogenous ethylene treatment can induce ripening of bananas with increased rate of respiration and increased level of endogenous ethylene [14, 15]. Burg and Burg [24] reported that low ethylene concentration as 0.1ppm is effective in accelerating the ripening of bananas. Dominguez and Vendrell [16] showed that exogenous ethylene, 100ppm treatment for 12 hours, can immediately increase the endogenous ethylene and CO2 production similar to respiratory climacteric. Further this study showed that increment in respiration depends on time of treatment whereas 12-hour treatment was slightly effective than 6 hours treatment.

Acetylene: Calcium carbide when hydrolyzed produces acetylene which is an ethylene analogue. Mostly in developing countries, calcium carbide is widely used for artificial ripening of bananas, though it is prohibited by the government regulations. Hartshorn [17] conducted a series of experiments to identify effects of acetylene on ripening process of bananas. It was shown in this study that acetylene emits from calcium carbide can enhance banana ripening as treated fruits were uniformly yellow with good favour, Tompson and Seymour [18] reported that bananas do not respond to acetylene at 0.01ml/L while the treatment with acetylene in 1 ml/L led to indistinguishable colour and soluble solids content compared to those ripened by exposure to ethylene at same concentration. Calcium carbide is considered as hazardous due to several reasons. Commercial calcium carbide contains traces of arsenic and phosphorous hydride [19,20] and acetylene emitted from commercial calcium may also contain up to 3 ppm arsenic and up to 95 ppm phosphorous hydride [19, 21]. Arsenic and phosphorous hydride can be poisonous to humans and cause vomiting, diarrhea with or without blood, burning sensation of the chest and abdomen, thirst, weakness, difficulty in swallowing, irritation or burning in the eyes and skin, permanent aye damage, and so on [19]. Exposure to acetylene gas can cause headache, vertigo, dizziness, delirium, seizure, and even coma [20]. The Sarananda [22] reported effect of acetylene liberated from calcium carbide on ripening of banana. in this study that naturally ripened fruits have excellent sensory quality with fresh colour, favour, taste, and overall acceptability compared to calcium carbide treated fruits at the stage of fully yellow .Nevertheless it was shown that calcium carbide treated fruits achieved the same sensory quality when they were kept for one day more after reaching the fully yellow stage. However calcium carbide treated fruits exhibited the least organoleptic quality compared to naturally ripened and ethephon treated bananas in (23) Kulkarni et al., 2011, showed that sensory quality and other physicochemical quality attributes were excellent in ethephon (500-1000 ppm) treated bananas compared to naturally ripened fruits at the 6th day of storage.

Conclusions The banana ripening process can be enhanced using artificial ripening agents such as ethylene gas, ethephon, acetylene (emitted from calcium carbide), ethylene glycol, and alkyl alcohols. Smoke generated from burning green leaves or kerosene burners are also used as traditional methods in banana ripening. Many studies on the effect of diferent ripening agents on fruit quality appear to show that naturally ripened bananas exhibit better sensory characteristics compared to treated fruits.

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