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Ripening of Fruits through Pre And Post Treatments of Different Chemicalswith Reference to Guava

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Abstract

Ripening is an irreversible biochemical change during the maturation of fruits. Due to simultaneous ripening in various crops there is market glut, results in huge spoilage loss and poor revenue to the grower. During fruit ripening ethylene production is increased. If somehow, we are able to regulate the production of ethylene, ripening can be delayed. This concept can be implemented with different chemicals which inhibit the production of ethylene or minimize its production. At the same time the production of ethylene may be inclined by using various chemicals. This approach will cause early, flexible harvesting and marketing of the fruits. Above all, manipulation of ripening time will help to avoid market glut, significant reduction of post-harvest losses and add more income to the grower. As for as quality of the produce is concerned, it is cleared in reviewed literature that there is no difference in sensory quality and biochemical composition of the produce when treated with different chemicals that induce ripening. Only the important point to keep in mind is the safe limit and edible nature of the chemical to be used in this concern.

Key words-Ripening, Early, Delay, Safe limits, Chemicals

Introduction: -

Guava is a small tree or evergreen shrub. This fruit belongs to the family It is an important fruit Myrtaceae and native of Tropical America. It is mostly known due to its food and nutrition value all over the world. It is grown in large area of world due to its wider adaptability. It is considered as 4^{th} most important fruit crop in area and production. It is contributing 4.1% in India's total fruit production. In India it grows in an area of 2.60 lakh hectare and gives 38.26 lakh tonnes with average yield of 14.75 metric tonnes per hectare (Anon, 2017). Amongst 150 species of genus *Psidium* only *Psidium guajava* has been put under commercial cultivation. Red pulp guava contains more protein, crude fibre than white

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pulp guava while white pulp guava contains more carbohydrate content as compared to red pulp guava. Red pulp varieties contain less moisture content. Guava fruits are enriched with iron element including pectin and above all, it is also a good source of Ca(14-30 mg / 100 g) and P (23.37 mg / 100 g) like minerals as well as various vitamins like vitamin 'C' riboflavin, niacin, thiamine and vitamin 'A'. fruits are freshly consumed or used in processing for the manufacturing of products like jelly, jam, cheese, paste, nectar etc. (Boora, 2012). Due to the presence of vitamin A in guava fruit it is most useful for eyes, due to the presence of vitamin C, vitamin E, and antioxidants etc. it is good for nourishment of skin. Leaf of guava plant are used as medicine of dysentery. Guava fruit has greater demand in both international and local market for processing and fresh consumption purposes. Share of India in fresh guava fruit export is about 0.65 per cent which may be further increased if properly handled post-harvest to earn more foreign exchange (Mitra *et al*., 2007).

Fruit life can be categorized in three stages:

A) Fruit set
B) Development
C) Ripening

Process of fruit ripening is a genetically programme. It is complex in nature which alters fruit color, flavor, texture, and other traits of the fruit. (Alexander and Grierson, 2002).Ripening process is the commencement of senescence initiation, a highly coordinated natured process of organ alteration from immature to ripe stage, resulting in an attractive edible fruit (Perotti*et al*., 2014). Ripening is an irreversible type of activity which involve a series of physiological, biochemical, along with organoleptic changes (Joshi*et al*.,2017). These variations include changes in various constituents like carbohydrate, sugar content, colour, texture, flavour and phenolic compounds, along with organic acids. During fruit ripening a series of changes that lead to change in color, texture, pigment formation, breakdown of starch etc. and development of aroma, flavour etc. in the same (Brecht, 2002). In other words. Due to various processes like solubilization of cell wall components and depolymerization, the fruit softening occurs. (Korban et. al., 2010). During process of respiration there is breakdown of complex molecules to simpler molecules that result in supplying energy. From cellular metabolic activity is is indicated that ripening process may occur and is a distinguishing feature during different phases of life of fruit like development, maturing, and senescence stage (Tripathi *et al*., 2016). With advancement of ripening in climacteric fruits,

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the respiration is at its peak due to production of high amount of ethylene gas. On the contrary this rate is almost persistent or steady decline towards senescence, showing that ethylene production is very low (Bouzayen*et al*., 2010). We can conclude that climacteric fruits as ethylene dependent fruits, as they have potential to ripen with the help of ethylene. Simultaneously, it is admitted that fruits which are non-climacteric in nature, mature and ripen only if they are attached with mother fruit plant (Pathak *et al*., 2018).

Chemicals which enhance fruit ripening: -

Ethephon

It has been recommended by Kassem *et al*., (2011) that spraying of ethephon speeds up the ripening process and harvest period. Balota*et al*., (2004) appealed that ethephon compound can encourage various growth and development process at cellular level along with other processes like stress-response operation linked with photosynthesis. Again Kassem *et al*., (2012) submitted that fruit ripening time is speeded up by the application of the ethephon. Glasner*et al*., (1999) proposed that harvesting period, date depends on weather conditions, demand in market and specific cultivar characters. For effective management, it is suggested that various practices also include spraying of the ethephon which gives the stagnant fruit production along with better quality. Many scholars have evaluated the influence of ethephon (ethrel) on characteristics of various fruit crops like Serrano *et al*., (2001), Al-Juburi*et al*., (2001), Klee and Clark (2002), Pesis (2005) and Dal Ri *et al*., (2010) evidenced that ethylene has an vital role in berry growth and development of grapevine. Marzouk and Kassem (2011) recommended that after ethephon treatment of fruits, same may be used for direct consumption and harvest date is also premature date but at the same time shelf life is shortened.Ethrel compound break down itself and lead to production of ethylene and same has been supplied to fruits and consequently ripening (Singh *et al*.,2018).

Abscisic Acid (ABA): - It is a plant growth hormone and play an important role in a life cycle of plant. Concentration of abscisic acid is very less in unripe fruit, but it starts increasing as fruit ripen (Sutthiwal, 2012). It helps in several plant developmental processes, including seed and bud dormancy and the control of organ size and stomatal closure. Application of Abscisic acid by dipping and vacuum infiltration is used to check the role of Abscisic Acid in unripe green and mature bananas. Ripening of banana fruit was greater in Abscisic acid infiltration at 10^{-3} M than at 10^{-4} M. Abscisic acid application increases ripening process in banana fruit by regulation of ethylene production along with respiration, which lead to fruit colour change and fruit softening (Jiang *et al*., 2000). Application of exogenous Abscisic Acid or ACC increases ripening of fruits by accelerating ethylene production and respiration (Zhang *et al*.,2009). Abscisic acid can also be called as another plant ripening control factor because of the reasons that ABA accrues ethylene released in climacteric type fruits (Zhang *et al*., 2009a, b). The spray/use of abscisic acid on fruit increase metabolites production, which are involved in ripening process, i.e. increase ripening process in fruits (Jeong*et al*., 2004, Ban *et al*., 2003, Chernys and Zeevaart, 2000, Giribaldi*et al*., 2010). In Abscisic acid lack orange mutants de-greening stage start at a later stage (Rodrigo *et al*., 2003).

1) **2,4-D: -** Application of2,4-D increases ripening process of banana fruits and is responsible to shift the respiration peak and climacteric peak and other related activities like PEL, were recorded on 4th and 10th day of application of 2,4-D in comparison to 16th day in control.Mixture of ethephon along with calcium carbide are used to induce flowering and control the problem of erratic flowering in pineapple. Some growers are also using 2,4-D in combination above said chemicals. This approach is based on the concept that 2,4-D would act to promote growth as well as, increase in fruit weight and size (Raposo et al.,2019).

Chemicals which delay fruit ripening: -

Concept of delaying fruit ripening: - Ethylene is a plant growth hormone which affects plant growth and development (Barry and Giovannoni, 2007; Bapat *et al.*, 2010). In plant cell there are specific sites known as ethylene binding receptors and these are activated by ethylene and ripening process is started.

To decrease the ripening process and extend the postharvest life of the fruits particularly in climacteric fruits, it is necessary to avoid/lessen the activity of ethylene (Ponce *et al.*, 2009, Watkins *et al.*, 2000). Basal level of ethylene production in fruits, may be blocked by various chemicals and are able to delay the natural process of ripening (Kandungan*et al*., 2013).

1) **Gibberellic Acid (GA_3): -** It has many types, and all are used as natural plant growth regulators. It occurs maximum in plant tissues. Various kinds of plant physiological processes like flowering, seed set and fruit development etc. are influenced by GA_3(Richards *et al*., 2001). It is also proved that this is also able to deferred anthocyanin synthesis along with chlorophylls degradation. Application of GA3 increased the physico-chemical characters of various fruit of both types climacteric and non-climacteric. Treatment of banana fruit with GA_3 results in delay in ripening process and climacteric peak to the 19th day as compared to

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16^{th} day of control fruit (Pyasi et. al., 2004).Gibberellic acid influence maturing process in fruits and may hasten ripening activity, (Rizk-Alla and Meshrake, 2006).

2) Nitric Oxide (NO): - It has been reported that NO level in the unripe fruit is more than that of ripe fruit. A researcher discovered that NO concentration is highest in tomato, cherry, and tomato during the unripe stage.NO treatment significantly delays the loss of pulp firmness in ripening banana fruit due to reduced production of ethylene (Cheng *et al*., 2009). It has been suggested that NO delays fruit ripening via monitoring ethylene (Manjunatha et al., 2010).

3) Oxalic acid: - (Post harvest Application)

Treatment with oxalic acid may decreased deterioration of the fruitsthroughoutstorage periods. It reduces and delay the rate of respiration process along with and ethylene production and firmness. Treated fruits exhibited advanced superoxide dismutase activity and antioxidant capability along with declined production of reactive oxygen species during last stages of storage as compared to non- treated fruits (Huang et. al., 2013). Pre application of oxalic acid including with other storage types like controlled atmosphere, may increase the storage duration and decrease fruit decay rate in mango (Zheng et. al., 2005). Treated fruits may produce very less ethylene in comparison to control fruits during storage (Zheng et. al., 2007). Oxalic acid @ 5 mm may delay the senescence in jujube fruit by lessening the rate of ethylene production (Wang et. al., 2008). Application of oxalic acid may lessen the decrease in the colour development of banana fruit (Huang et. al., 2013). Anthocyanin synthesis and flesh reddening were expressively repressed treated plum fruits, decreased PAL activity was also recorded in such fruits. It was pronounced that variable: maximal chlorophyll fluorescence (Fv/Fm), a sign of ripening process, declines very slowly in treated plum fruits (Wu et. al., 2011).

4) Salicylic acid: - Salicylic acid delay the banana ripening (Srivastava and Dwivedi, 2000) and exhibits its inhibitory effect on mango crop (Zainuri et. al., 2001). Salicylic acid treated fruits are more soft, lower in sugar contentand respiration. The activity of cell wall degrading enzymes viz. cellulase, polygalacturonase and polygalacturonase and xylanase is found to reduce in the presence of salicylic acid (Srivastava et. al., 2000). There is a close relationship between change in SA level in tissues of fruit and extent of fruit ripening and softening (Zhang et. al., 2003). SA treatment is responsible to decrease respiration and inclines the activity of various antioxidant enzymes (superoxide dismutase, peroxidase, catalase and ascorbate peroxidase etc.) also influences lipoxygenase activity and

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Malondialdehyden contents in treated fruits (Mo et. al., 2008). SA at 2mm concentration decreases ethylene production of fruit and fungal decay (Babalar et. al., 2007). SA inhibit ethylene production in kiwifruit (Fattahi et. al., 2010).

5) Calcium chloride (cacl$_2$): - This chemical is able to delay the ripening of fruits,as level of calcium in fruit results in a low respiration and ethylene production rate (Hewajuligee*t al*., 2003).Calcium chloride at the concentration of 5.0 % and 7.5 % delay the fruit ripening for 3-4 days as compared to untreated fruits (Muhammad A. A. and H. Ali, 2004).

6) Hydrogen Sulphide (H_2S): - It was proved by Hu *et al*., (2014) that life of pear slices was prolonged by application of Hydrogen sulphide (fumigation) due to inhibition of many fungal pathogens (*Penicillium expansum and Aspergillus niger*). Vasileios *et al*., (2018) disclosed that application of H2S can inhibit ripening process and senescence like activities in many fruits and various sources for H2S can be used for this purpose like sodium hydrosulphide or sodium sulphide. Additionally, the application of hydrogen sulphide on fruits also sustain the chlorophyll content, increase carotenoid, soluble protein, and total antioxidant capacity (Ge et. al., 2017). Above results suggest that application of hydrogen sulphide on banana fruit delay the ripening process of banana fruits. Treatment with 45 and 90 µmol L^{-1} H_2S resulted in delayed maturation and senescence of kiwifruit (Zhu et. al., 2014).

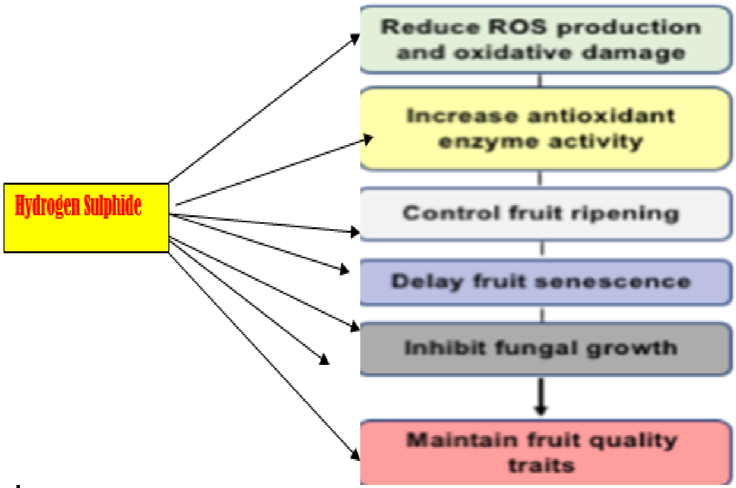

Fig 1- Proposed effects of Hydrogen Sulphide

7) KMnO$_4$: - Treatment of $KMnO_4$ on fruits decreased post-harvest losses which results in the delay in ripening of fruits (Ishaqe*t al*., 2009).Application of $KMnO_4$ oxidizes the ethylene which is produced by the fruit and enlengthen the fruit shelf life (Resendee*t al*.,

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2001). Ethylene oxidation by $KMnO_4$ results in the formation of CO_2 and water (Sorbentsystems, 2005). Silva *et al*., (2009) observed that concentration of CO_2 inside the bags between 5 – 10 % in $KMno_4$ treated fruits from 1^{st} to 12^{th} day of storage. In treatments without the application of $KMnO_4$ concentration of CO_2 in the bags is more than 10 % in the 3^{rd} day of storage which may be result in the physiological disorder in papaya. A decrease in physiological weight is found in $KMnO_4$ treated peach fruits in all the stages of storage as compared to the control of peach fruit (Kaur, A. P., & Kuldip, S. (2011). Concentration of ethylene gas is decreased with increased $KMnO_4$ quantity. A reduction of about 2.2 % is obtained for a 20 gm (Correa *et al*., 2005).

Effect on fruit Quality

A. Ethephon-

Sabuz*et al*., (2019) revealed that regardless of various treatments of ethephon, weight loss, total soluble solids, sugars, CO2 production and total carotenoid exhibited inclining trends up to storage of 6 days however acidity, Vitamin c along with ethephon (residue level) disclosed decreasing trends. At 4th day, application of ethephon @750-1000 ppm induced yellow color while control fruits were recorded with greenish (unripe) colour even after 6 days. At 6 days total sugars total soluble solids including ascorbic acid, were found the highest in 750-1000 ppm applied fruits in comparison to 250-500 ppm application. Therefore, mangoes ripened by application of ethephon @ 750- 1000 ppm can be consumed without any kind of health risk.

B. **Abscisic acid** It has been proved that treatment with abscisic acid encourages development of fruit colour and inclined CCI including levels of carotenoids in Navel orange (Muneer *et al*.,2018). Wang *et al*.,(2016) stated that colour of the fruit is improved in Navel sweet orange with application of ABA. It has been recorded that treatment with NDGA declined the biosynthesis of carotenoids in flavedo subsequently hindering fruit colour advancement in M7 Navel. It was further reported that exogenous treatment of Abscisic acid declined organic acids in mandarin cv ‘Ponkan.

C. 2,4-D

Singh *et al.*, (2019) described that control treatment gave total soluble solids. Out of tried plant growth regulators, 2,4-D given better results as compare to NAA and GA3. As for as tomato fruit diameter is concerned various treatment shown non-significant results statistically among themselves. Pundir & Yadav (2001) submitted similar kind of results in tomato. The effect of various PGR has been discussed in several cucurbit crops including CCPU, BA and 2,4-dichlorophenoxyacetic (2,4-D). It was concluded that 2,4-D has given the

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best results in watermelon (Camacho *et al*., 2003) Miguel *et al*., (2000a, 2000b) tested various plant growth regulators including 2,4-D in watermelon crops in Valencia (eastern Spain).

D. Gibberellic acid

Uddain and Hossain (2009) recorded that application of GA3 lead to increase in fruit weight of tomato. Shinde *et al.* (2001) evaluated the effect of GA3 in Alphonso mango and applied at various phases of the trees. It was recorded that all treatments of GA3, irrespective of meaningfully reduced the problem recurring flowering. Overall it was concluded that GA3 application @ 50 to 100 ppm was an effective approach for governing recurring blossoming in Alphonso mango. Choudhury*et. al.* (2003) evaluated to study the effect of GA3 on Sapota fruits cv. Pala subjected GA3 (100 ppm and 200 ppm) treatment. It was found that GA3 helped in extending the shelf life, improved total soluble sugars, acidity and decreased PLW (physiological loss in weight).

Future Perspectives

Fruit development and ripening are prime and significant phases in plant life in field of horticulture. Many research trials are still going on these phases due to short shelf life and perishable nature of the fruit. These are the prime causes for huge and considerable economic losses. Hence, it is not a matter of surprise that the first genetically modified crop in market was tomato (a vegetable). From review of literature it is concluded that ethylene production plays a critical role in ripening activity, but now focus is done towards the concept that some other molecules including processes are also responsible for the same. Along with ethylene some other phytohormones like auxin, gibberellins cytokinin, jasmonates, ABA including brassinosteroids are also known to play important role in fruit ripening process (Srivastava and Handa, 2005; Seymour *et al*., 2008). Currently, use of polyamines have shown good potential in this concern (Mehta *et al*., 2002; Nambeesan*et al*., 2008, 2010). Molecular genetics and Fruit breeding are able to provide substantial perceptions towards response and abiotic in fruits. Supplementary efforts are also anticipated to disengage the effect of epigenetic aspects in ripening related processes (Martienssen and Colot, 2001; Seymour *et al*., 2008). It is highly desirable to develop and field test transgenic cultivars of fruit plants that are suited to cultivate well in sustainable agricultural approaches that have minimal requirement on chemical compounds along with positive impact on plant metabolism (Neelam *et al*., 2008; Mattoo and Teasdale, 2010). Short shelf life and perishable nature of the fruit can be managed by finding such chemicals or compounds which can early or delay

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the ripening process in fruits. By doing so we can avoid huge economic losses due to market glut of main production season.

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