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Post-Harvest Quality Improvement Technology Horticulture Fresh Fruit

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Abstract: In agriculture, the term post-harvest is defined as various actions or treatments given to agricultural products after harvest until the commodity is in the hands of consumers. The term postharvest is scientifically referred to as postproduction which can be divided into two parts or stages, namely postharvest and processing. Postharvest handling, often referred to as primary processing, is a term used for all treatments from harvesting until commodities can be consumed "fresh" or in preparation for processing at the next stage. Postharvest products in horticultural commodities are part of horticultural crops that have been harvested with various objectives, especially to provide added value and profit for horticultural farmers. Post-harvest treatment does not change the appearance or appearance of the product, including various aspects of marketing and distribution. Processing (secondary processing) is an action that changes plant products to another condition or form to make the product more durable (preservation), preventing unwanted changes or for other uses, including for food processing and food industry processing.

Keywords: Horticulture, Post-harvest.

Introduction

Indonesia is a country with a tropical climate so a variety of fruit plants can thrive in Indonesia. The prospects for some types of fruit in the domestic market are quite good. Fruit cultivation activities in Indonesia are very economically profitable. In addition to providing benefits for farmers to reduce fruit imports, it also has the potential to penetrate the export market.

Metabolic activity in fresh fruit is characterized by the process of respiration. Respiration produces heat which causes an increase in heat. So that the process of deterioration such as water loss, withering, and growth of microorganisms will increase. Rotting microorganisms will get their ideal growth conditions with an increase in temperature, and humidity and are ready to infect the fruit through existing holes. During transportation to consumers, postharvest fruit products are subjected to physical stress, vibration, and friction under conditions where temperature and humidity spur the decay process.

One of the efforts and strategies to overcome these problems is the application of postharvest handling and processing technology, which is carried out through the introduction of technology, counseling and technology assistance, and provision of postharvest facilities. Drying and powdering technology will reduce volume and weight, extend shelf life increase economic value, and facilitate transportation (Rahmat and Yuyun, 2009). However, so far the attention and emphasis on the application of this technology is still limited, although many research results have been produced by various research institutions. Therefore, there is a need for a breakthrough in post-harvest technology research and primary fruit

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processing that is applicable, and then disseminated to farmers and business actors.

Horticulture, especially vegetables, is a source of provitamin A, vitamin C, and minerals, especially calcium and iron. In addition to this, vegetables are also a source of fiber which is very important in maintaining a healthy body. Vegetables can also provide their satisfaction, especially in terms of color and texture. On the other hand, vegetables are agricultural products that when harvested are not handled properly will soon be damaged. This damage occurs due to physical, chemical, microbiological, and physiological influences. (Hotton, 1986) Although these changes are initially beneficial, namely changes in color, taste, and aroma, if these changes continue and are not controlled, they will ultimately be detrimental because the material will be damaged / rotten and cannot be utilized. In Indonesia, horticulture that can not be utilized is termed as "loss" (losses) reached 25-40% (Muhtadi, 1995).

Post-harvest handling of horticultural agriculture generally aims to extend freshness and reduce the level of yield loss implemented through the utilization of good facilities and technology. Post-harvest handling of horticultural agriculture also prevents unwanted changes during storage.

Problem

The problem to be solved in this research is how to explore, find, and understand the process of improving the post-harvest quality of horticultural fresh fruit.

Research Objectives and Benefits

The purpose of this research is to explore, discover, and understand the process of improving the post-harvest quality of horticultural fresh fruit.

The benefits of this research are as scientific information material for farmers, researchers, and the general public on how to improve the post-harvest quality of horticultural fresh fruit.

Research Methods

This study uses a literature study method from newspapers and official reports, and oral sources carried out by collecting library data, reading and recording, and processing research materials. This research study was conducted from June to September 2023.

Results and Discussion

Definition of Value Added of Agricultural Products

Value added is the increase in the value of a commodity due to processing, transportation, or storage in a production process. In the processing process, value-added can be defined as the difference between the value of the product and the cost of raw materials and other inputs, excluding labor. Meanwhile, the margin is the difference between the value of the product and the price of raw materials only. This margin includes the components of production factors used, namely labor, other inputs, and processing entrepreneur fees (Hayami et al, 1987).

Post-harvest of Horticultural Crops

Horticulture, especially vegetables, is a source of provitamin A, vitamin C, and minerals, especially calcium and iron. In addition to this, vegetables are also a source of fiber which is very important in maintaining a healthy body. Vegetables can also provide their satisfaction, especially in terms of color and texture. On the other hand, vegetables are agricultural products that when harvested are not handled properly will soon be damaged. This damage occurs due to physical, chemical, microbiological, and physiological influences. (Hotton, 1986) Although these changes are initially beneficial, namely changes in color, taste, and aroma, if these changes continue and are not controlled, they will ultimately be detrimental because the material will be damaged / rotten and cannot be used. In Indonesia, horticulture that can not be utilized is termed as "loss" (losses) reached 25-40% (Muhtadi, 1995).

This value is very large when compared to developed countries. These losses occur naturally after harvest due to the activity of various types of enzymes that cause a decrease in economic and nutritional value. Horticultural damage can be accelerated if handling during harvest or after harvest is poor. For example, the commodity is bruised, scratched, or torn or also by other causes such as microbial growth. This is where the importance of post-harvest handling can inhibit the process of material destruction, among others through preservation, controlled storage, and refrigeration, because of the perishable nature of the material, post-harvest handling must be carried out carefully. In a broader scope, post-harvest technology also includes the manufacture of frozen, dried, and canned materials (Bourne, 1999). Post-harvest activities themselves start from the time the horticultural commodity is taken/separated from the plant (harvest) until the commodity reaches the consumer.

Horticultural Post-Harvest Handling

Horticultural commodities should be given post-harvest handling as soon as possible to maintain their quality and minimize various forms of loss. Post-harvest handling of horticultural products, which are generally consumed fresh and perishable, aims to maintain their freshness and prevent unwanted changes during storage, such as shoot growth, root growth, twisted stems, wrinkled fruit, many pods, green sweet potatoes, overripe, and others.

Treatment can be in the form of cleaning, washing, binding, preservation, sorting, grading, packaging, cold storage, coiling, and others (Mutirawati, 2007). To reduce these losses, it is necessary to know:

1. Biological properties of crops handled: structure and composition of crops
2. Basics of post-harvest physiology: respiration, transpiration, ethylene production
3. Appropriate post-harvest handling technology.

Water loss can result in qualitative and quantitative loss of the product. Reduced appearance due to withering and wrinkling, reduced succulence due to decreased flexibility, reduced crispness, and loss of freshness are all qualitative losses. For products sold by weight, water loss is quantitative. About 5% weight loss is required to reduce the market potential of leafy vegetables, and about 10% for other products such as apples and potatoes (Hardenberg et al, 1986).

Factors Affecting Quality

There are several factors that directly or indirectly affect quality. Both pre-harvest and post-harvest factors are very important and interact with each other, causing the evaluation of the quality of horticultural products to be a complex process. These interactions cause variations in the quality of fresh produce over time (M. Yusuf Samad, 2006).

1. Pre-harvest Factors
   - Cultivar and rootstock genotypes
     Genotype controls plant characteristics, such as leaf and fruit shape. However, the growing environment affects the expression of these genotypes.
   - Climatic conditions during the production period
     In dry weather conditions where irrigation is available, product quality is often better. But under conditions of prolonged wet periods with rainstorms, the quality will not be good.
   - Cultivation practice
     Agronomic practices, with the availability of irrigation, fertilization, and implementation of crop control and protection strategies directly affect postharvest survival.
   - Plant population
     Generally, a high plant population will result in products that are mostly small in size. Conversely, a low plant population will produce some large products.

2. Post-harvest Factors
   - - Harvest
     The time of day and method of harvesting directly affect the quality of the product to be sold. The best time to harvest is early morning or late afternoon when the ambient temperature is low.
   - - Post-harvest treatments
     A very important factor affecting the overall quality of horticultural products is time. Since

the quality of the product is at its peak at harvest, the longer the period between harvest and consumption, the greater the quality loss.

One of the fundamental problems of the low quality of horticultural commodities is pathogen attacks in the post-harvest phase. Post-harvest diseases in horticultural commodities still have not received maximum attention. In developing countries, post-harvest handling facilities are still very minimal with quality demands on horticultural commodities that are still low so that the estimated yield loss can reach 50% or more. Post-harvest pathogen activity in horticultural commodities can cause losses and decreased product quality. This is because the metabolic activity of post-harvest pathogens can produce toxins that are harmful to human health so horticultural products are not suitable for consumption and trade. Although postharvest handling has been done well, some factors that can affect the development of postharvest pathogens such as the environment and the ability of pathogens to attack the product during the storage phase that supports the pathogen can still develop (Deciana et al., 2014).

Ingredient Quality and Post-Harvest Losses

Quality is very important to be able to image the product as desired by consumers. The quality of the product to be sold is highly dependent on the condition of the product at the point of receipt and its post-harvest management at retail centers. Moreover, the need for storage to make the product available is always present, so the involvement of adequate handling technology must always be considered and consequently the cost of such technology must be provided.

Post-harvest handling of horticultural products, which are generally consumed fresh and perishable, aims to maintain their freshness and prevent unwanted changes during storage, such as shoot growth, root growth, twisted stems, wrinkled fruit, many pods, green sweet potatoes, overripe, and others. Depot treatments include cleaning, washing, binding, baking, sorting, grading, packaging, cold storage, coiling, and others (Mutirawati, 2007).

Respiration

Post-harvest losses in tropical fruits are due to a lack of understanding of the nature of the product, such as high moisture content (30-90%), very high respiration rates, soft fruit tissue that is susceptible to wounding and highly perishable so that the post-harvest life is very limited (Paull and Chen, 2014). The respiration rate of tropical and sub-tropical fruits varies widely, depending on the type and variety of the product, the degree of ripeness, the degree of injury, and the temperature of the product (Yahia et al., 2011). The higher the respiration rate, the shorter the shelf life of the product. The limited shelf life of fresh fruit products is influenced by a combination of factors, including product characteristics, external conditions, microbial contamination, physiological disorders, mechanical damage, and the level of post-harvest treatment (Kusumaningrum et al., 2015).

Physiologically, plant parts that are harvested and used for fresh consumption are still alive, characterized by metabolic activity called respiration (Salunkhe and Desai, 1984). Respiration takes place to obtain energy for its life activities. In this respiration process, plant materials, especially complex carbohydrates, are broken down into the simplest form of carbohydrates (sugars) which are then oxidized to produce energy.

In general, young, actively growing cells tend to have higher respiration rates than older or more mature cells. Respiration after harvest should be viewed as follows: Stored carbohydrates produced by photosynthesis are no longer produced (in most products) after harvest. The use of these carbohydrates after harvest will therefore reduce the value of the product as a carbohydrate source and some quality changes will occur. Oxygen (O2) is required for the respiration process. The supply of O2 must be maintained in the cells of the product if the product is to remain viable. Carbon dioxide (CO2) is generated. This gas must be released, usually by good ventilation arrangements. Air (H2 O) is generated. This water affects the composition and texture of the product.

The by-products of respiration are carbon dioxide (CO2), water vapor (H2 O) and heat. The higher the respiration rate, the faster these

breakdowns are which leads to the deterioration of the product. The water produced is transpired and if not controlled the product will quickly wither. Therefore, respiration rate is often used as a good index to determine the post-harvest shelf life of fresh produce (Ryal and Lipton, 1972). Various products have different respiration rates, generally depending on the morphological structure and tissue development level of the plant part (Kays, 1991).

Horticulture Storage

Storage of horticultural commodities is an effort to maintain the commodity (harvest) from the time it is harvested until it is time to use it. Therefore, storage also means an effort to maintain the harvested commodity remains in a fresh condition and at the same time still has good quality. The storage in question is storage at cold temperature conditions and storage at controlled atmospheric conditions. Storage is needed especially for horticultural commodities that are easily damaged after entering the post-harvest period because the storage method can reduce the rate of respiration and other metabolism, reduce the aging process, reduce water loss and aging, reduce damage due to microbial activity, and reduce unwanted growth processes such as budding. The benefits of applying post-harvest technology should not only be seen in the selling price of the product but also in the level of shrinkage and the ability to access the market (Kitinoja and Kader, 1995).

An important characteristic of post-harvest fruit commodities is that the material is still alive and still performing its metabolic activities. However, metabolism is not the same as the parent plant growing in its original environment, because the harvested product experiences various kinds of stress such as loss of nutrient supply, and conditions that are different from its ideal growth with increased temperature, and humidity.

In addition, the harvesting process often results in wounding as well as packaging and transportation, which can cause further mechanical damage. Metabolic activity in fresh fruit is characterized by respiration. Respiration produces heat which causes an increase in heat in the product itself, so that the deterioration process such as water loss, withering, and growth of microorganisms will increase. Rotting microorganisms will get ideal growth conditions and are ready to infect the fruit through existing holes. During transportation to consumers, post-harvest fruit products are subjected to physical stress, vibration, and friction under conditions where temperature and humidity spur the decay process.

Good packaging can suppress collisions, facilitate air exchange, and reduce evaporation. The principles of making packaging are economical, available materials, easy to make, lightweight, strong, can protect commodities, ventilated, and odorless. In addition, packaging serves to protect products from physical, mechanical, and microbiological damage, as well as create attractiveness for consumers and extend product shelf life (Anonimous, 2011).

Quality Factors

Horticultural commodities have properties that can still do breathing after harvesting, so if harvested and not immediately handled properly horticultural commodities will soon experience damage. This damage occurs due to physical, chemical, microbiological, and physiological influences. Although these changes are initially beneficial, namely changes in color, taste, and aroma, if these changes continue and are not controlled, they will be detrimental because the material will be damaged / rotten and cannot be used. The diversity of the physical and morphological conditions of fruits and vegetables also characterizes their sensitivity to mechanical and pathological damage. Mechanical damage includes impact, pressure, and vibration. Pathological damage is caused by attack by pathogenic microorganisms, especially fungi and bacteria. The physical morphological condition of the product also affects the transpiration or evaporation of water from the product (Jhon David, 2016).

The conventional definition of quality is to describe the direct characteristics of a product such as performance, reliability, ease of use, and aesthetics. In a global market with an increasingly high level of competition, quality is strategically

defined as something that can fulfill the wants or needs of consumers (I Made Supartha Utama, 2006). Based on the above conception, quality essentially refers to the main notions such as:

1. Quality consists of a series of product features, both direct features and attractive features that fulfill consumer desires to provide satisfaction from using the product.
2. Quality consists of everything free from deficiency or damage. Quality is very important to be able to image the product as desired by consumers. The quality of the product to be sold is highly dependent on the condition of the product when it is received and its post-harvest management in retail sales centers.
3. The most common fruit quality is described by the freshness, cleanliness, and brightness of the leaf color. Leaf freshness is directly proportional to its water content. Water loss can result in qualitative and quantitative loss of the product. Reduced appearance due to withering and wrinkling, reduced succulence due to decreased turgidity, reduced crispness, and loss of freshness are all qualitative losses. For products sold by weight, water loss is quantitative (Hayati, R., Syamsuddin, and Halimursyadah. 2015).

Setbacks

Deterioration of horticultural products begins to occur soon after harvest. Deterioration is a term used to describe any change that leads to quality loss along with physiological changes, mechanical damage, water loss, and any other form of deterioration of the product. The fruit has a high rate of quality deterioration such as withering, yellowing of leaves, and decay. Fruit should be given post-harvest treatment as soon as possible to maintain its quality and minimize various forms of loss. To minimize these losses, it is important to understand the nature of the product and the effect of handling to maintain the optimum condition of the product.

Some important considerations that must be considered are physiological, physical, pathological, environmental conditions, and economic considerations (Sudjatha, W. and N. W. Wisaniyasa. 2017).

1. Physical considerations

Physical damage can occur at all stages from harvesting, handling, grading or sorting, packaging, transportation, storage, and finally reaching the consumer. Common damages are bruises, cuts, punctures, broken parts, abrasions, and abrasions. Damage can also be indicated by the production of stress metabolites (such as sap), and brown discoloration of damaged tissue, inducing the production of ethylene gas which spurs the process of product deterioration. Physical damage also triggers both physiological and pathological deterioration (attack by spoilage microorganisms).

2. Pathological considerations

Fruit contains large amounts of water and nutrients that are very good for the growth of microorganisms. Rotting microorganisms can grow when conditions allow such as the presence of openings, and appropriate temperature and humidity conditions. Rotting microorganisms such as Erwinia carotovora and Pseudomonas marginalis (the cause of soft rot disease) in vegetables can produce enzymes that can soften the tissue. Plant tissues can produce protective materials in response to injury. Materials such as lignin and suberin, which accumulate and precipitate around the wound, can act as a protective barrier against attack by spoilage microorganisms.

3. Consideration of environmental conditions

Environmental conditions that affect the deterioration of fruit products are temperature and humidity. Temperature is the most influential factor in the rate of deterioration of postharvest commodities. Every 10^{o}C increase in the rate of deterioration increases two to three times.

Commodities that are exposed to temperatures that are incompatible with the optimal storage temperature cause various physiological damages. Room humidity affects water loss after harvest. Water loss means loss of weight and appearance. Water loss is unavoidable but tolerable. Signs of water loss vary for different products, and signs of deterioration become apparent only when the amount of water loss differs. Generally, signs of

deterioration are obvious when the water loss is between 3-8% of the weight.

4. Economic considerations
The economic conditions and living standards of consumers are factors that must be considered in determining handling methods and provision of facilities. Excessive investment in post-harvest handling of fruit may result in economic losses, as consumers are unable to absorb the additional costs. This suggests that the application of handling methods is largely determined by the extent to which consumers are willing to pay more for a better level of handling.

5). Increased sensitivity to attack by pathogenic microorganisms.
Pathogenic microorganisms do not aggressively invade fresh produce, they need an entry point to invade the tissue and carry out infection. Harvesting will create various entry points for pathogens to invade, such as mechanical, physiological, and insect damage. The more these damages, the higher the sensitivity to microorganism infection.

Post-harvest diseases are a major underlying cause of yield loss in most horticultural commodities. Among all types of post-harvest pathogens, fungal pathogens are the main cause of post-harvest damage in vegetables and fruits. Post-harvest diseases can occur from planting, harvesting, post-harvest handling in the field, packaging, transportation, and storage. Post-harvest diseases in fruits and vegetables are influenced by the type of commodity and cultivar, maturity of the product when harvested, storage and transportation conditions, and conditions when the product is marketed. These conditions cause economic losses during marketing and make fresh products unfit for consumption (Lia Angraeni, 2019).

Post-harvest Loss
In the process of post-harvest handling, losses occur which vary in magnitude depending on the type, variety, and method of handling the type of agricultural product. Post-harvest losses or shrinkage can be caused by several factors and these losses can be grouped into three categories, each of which has economic implications, namely quantitative, qualitative, and nutritional losses.

Quantitative losses are reductions in body weight that can be easily measured quantitatively. Qualitative losses are losses that are difficult to measure quantitatively and are usually based on subjective considerations, while nutritional value losses are a combination of quantitative and qualitative losses. Qualitative food losses can be caused by damage, contamination, and nutritional changes. The type of damage and loss that receives less attention is in the form of qualitative loss in the form of damage to nutritional value. Certain types of pests attack the most nutritious parts, which contain the highest vitamins and protein. However, the phrase post-harvest handling is a complex notion because it involves not only technical factors but also social and economic factors.

Benefits of Improving Post-Harvest Quality of Horticultural Fresh Fruit
In the development of the domestic economy, the agricultural sector is often directed to be able to support the industrial sector which is striving to become a resilient sector. One of the supports of the agricultural sector to the industrial sector, for example, is the provision of raw materials. Because of the linkages between the agricultural and industrial sectors, the development of the agro-industry industry is expected to increase the added value of agricultural products and expand job creation. In addition, agro-industry will make agricultural products more diverse in their uses.

Storage of postharvest products of horticultural commodities at temperatures below the critical temperature will cause changes in the physiology of the stored product and cause the product to be unmarketable or consumable. Fruits, vegetables, and tubers are highly perishable postharvest products, which will soon rot and become unfit for consumption if not handled properly during harvesting, sorting, separation, selection, transportation, and storage (Loekas Soesanto, 2020).

Various studies have recommended various ways of implementing post-harvest horticulture that are quite effective. Therefore, the

improvement of an integrated crop management system accompanied by the development of harvesting and post-harvest handling technology is one of the elements needed to achieve good product quality.

Efforts to improve the quality of horticulture until now continue to be made both among scientists and industry players. Facing the era of free trade, horticultural products of high quality, quality, and competitiveness are needed, therefore a good and healthy cultivation and maintenance process must be carried out. This activity is expected to be able to encourage the improvement of farmers' ability to produce high and quality fruit production which can certainly increase the income and welfare of the community.

Utilization of horticultural products in addition to consumption can also be used as composting material (Hefriyandi, 2015).

Conclusions

The conclusions of this study are as follows:

Post-harvest handling of horticultural products is a very important thing to do considering that this material spoils quickly in a relatively short time. One thing that is worth proposing is the use of an integrated storage system where controlled cooling is combined with transportation (moveable storage) so that commodities quickly reach consumers in a fresh state.

Various studies have recommended various ways of implementing post-harvest horticulture that are quite effective. Therefore, the improvement of an integrated crop management system accompanied by the development of harvesting and post-harvest handling technology is one of the elements needed to achieve good product quality.

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