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A COMPARATIVE STUDY ON FACTORS AFFECTING THE SHELF LIFE OF FRUITS

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Abstract

The purpose of this research aims to analyze the effect of temperature on shelf life of fruits. Shelf life detoriation are effects of problems related to fruit collection, transportation and trade etc. After observations and tests that collect temperature and shelf life record, the study found that ethylene release plays a major role in shelf life detoriation. This ethylene gas has moderate respiration rate when fruits are attached to tress or plucked unripe. This respiration rate would reach the peak when the fruits are in ready to eat stage i.e. ripped.

Keywords: Ethylene gas, temperature, shelf life.

1. INTRODUCTION

Quality determines the shelf life as well as selling price of fresh fruits or vegetables and therefore, quality monitoring of fresh commodities have paramount importance in their post harvest handling and supply chain management. Quality of fruits and vegetables is based on its sensory properties, nutritional value, safety and defects. Fruits and vegetables with superior sensory and nutritional qualities have high economic value. The quality is mostly based influence of various external and internal factors[1].Size, shape, color, gloss, firmness, texture, taste and freedom from external defects such visible blemishes. Fruits produce a wide range of volatile organic compounds that impart their characteristically distinct release of ethylene gas and contribute to unique flavor characteristics are key importance in determining consumer acceptance. Fruit aromas consist of a complex mixture of VOCs whose composition is specific to plant species and fruit variety. The perish ability of the fruit is attributed to the adverse physiological changes, loss of weight due to respiration and transpiration, softening of flesh and loss of resistance to microbial attack. Thus the per capita availability of fruits is further reduced due to a high level of postharvest loss. Reduction of postharvest losses by prolonging the shelf life of fruits can help to improve the situation.

Fresh fruit and vegetables product	Atmosphere temperature range (°C)	O_2 (%)	CO_2 (%)
Apple	0-5	1-2	0-3
Apricot	0-5	2-3	2-3
Grapes	0-5	2-5	1-3
Grapefruit	10-15	3-10	5-10
Lemon	10-15	5-10	0-10
Lime	10-15	5-10	0-10
Mango	10-15	3-7	5-8
Orange	5-10	5-10	0-5
Peach	0-5	1-2	3-5
Pear (Asian)	0-5	2-4	0-3
Pear (European)	0-5	1-3	0-3
Plum	0-5	1-2	0-5
Tomatoes (green)	12-20	3-5	2-3
Tomatoes (ripe)	10-15	3-5	3-5
Potato	7	-	-
Mandarin/tangerine	4-7	-	-

Table 1: Different shelf life of fruits at corresponding temperature and humidity.

The prolonging of shelf life of a fruit consists of slowing down the process leading to ripening, and if possible, stopping the degradation and fermentation changes that causes senescence after ripening. Changes in the physic-chemical properties occur during different stages of ripening. Softness, sweetness of flesh skin color, flavor vary between stages among the varieties. Thus the perish ability of fresh fruits after harvest is an international issue commonly concerned. Fresh fruits have been frequently exported as unpackaged with limited storage and shelf lives. Currently there are about 25% of fruit products non-edible due to rot in the storage and transportation process and upto 30% of above decay losses in some post harvest perishable fruits. For instance, ethylene is one of the products of normal metabolism of plants. Right amount of ethylene would act as plant hormones and promote the organizations respirations and the fruit ripening. The fruit climacteric is usually accompanied with the increased release of ethylene and ethylene affects directly the climacteric frequencies and intensity in turn, while the adjustment of ethylene biosynthesis is intervened by many factors[1]. For example, high temperature promotes the synthesis of ethylene and low temperature prevents the generation of ethylenes and delays the fruit maturing process. Therefore, it is suggested to maintain fresh fruits in low temperature, high humidity, low oxygen, high carbon dioxide, low ethylene and sterile environments and opposite cases is unfavorable.

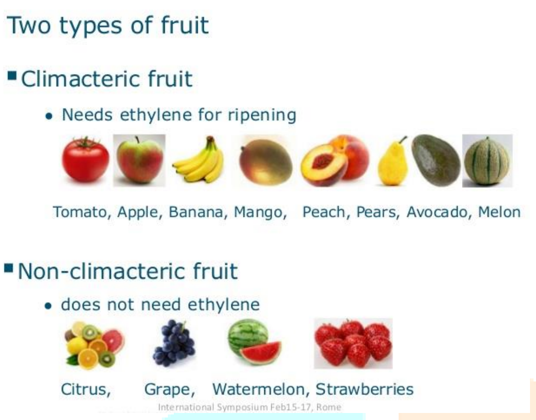


Fig 1: Types of fruits based on ethylene release; source: google images

2. WHAT IS SHELF LIFE?

Shelf life can be determined from two sides: the product side or the consumer side. Determining shelf life from the product side implies investigating the deterioration of the product as a function of time and several models are available to assist in the determination. Alternatively, determining shelf life from the consumer side implies asking consumers to accept or reject food which has been stored for various lengths of time without normally specifying the reason for[2] acceptance or rejection. When shelf life is determined from the product side, sensory evaluation of the food is likely to be used either alone or in combination with instrumental or chemical analyses to determine the quality of the product.All fruits and vegetables are living plant parts containing 65 to 95 percent water, and they continue their living processes after harvest. Their post-harvest life depends on the rate at which they use up their stored food reserves and their rate of water loss.[2] When food and water reserves are exhausted, the produce dies and decays. Anything that increases the rate of this process may make the produce inedible before it can be used. Knowledge of the likely shelf-life of such perishable products as fruits and vegetables is of utmost importance to those who manage the fresh produce chain from the grower to the retailer and finally consumer.When we say shelf life of fruits, it generally refers to how fresh the fruit is or how ripen the fruit is. This process of ageing of fruits after harvest refers to shelf life of fruits. This shelf life is disturbed by various factors which includes moisture, exposure to sunlight, temperature, transport handling etc. Out of the following factors all the biological factors further leads to increase respiration of the fruits. This respiration includes release of ethylene gas to environment, thus these forms the major factor affecting the shelf life. Ethylene is one of the products of normal metabolism of plants. Right amount of ethylene would act as plant hormones and promote the organization's respiration and the fruit ripening. The fruit climacteric is usually accompanied with the increased release of ethylene and ethylene affects directly the climacteric frequencies and intensity in turn, while the adjustment of ethylene biosynthesis is intervened by many factors. Release of ethylene is measured by mere observation of fruits which is depicted by various parameters viz. dullness of the fruit skin, loss in taste of the fruit, black spots on selective fruits, stiffness of the fruit skin and many more. Ethylene is said to be the growth regulator in fruits.[3]

2.1 FACTORS AFFECTING SHELF LIFE

2.1.1 AEROBIC EXPRESSION

Factors affecting shelf life generally refers to the components those act as the feed to increase the ethylene respirations of plants. Atmospheric gases form the base factor of increased respiration. After the harvest of the fruit it is exposed to gasses such as the oxygen, carbon dioxide. These gases have minimal effect when the fruits are kept in open surface as there is mobility of gases. But during the transportation the fruits are trapped in containers. These containers form the close environment in which the atmospheric gases get trapped. The molecular formula for ethylene is CH_2-CH_2, as it being a carbon compound enhances it scope in presence of carbon dioxide. During the initial stages the gases have average effect on the shelf life. But the second factor enhances this growth viz. Temperature, the increase temperature to do insufficient mobility of gasses and the external solar radiation falling on the containers, increases the activation energy (Ea) of the gases, this results in chemical reactions between the gases and the ethylene present on the skin of the fruit[3][4]. This reaction feeds the respiration of fruits. And thus fruits lose their nutritive value. It is a contagious process, if one fruit is affected to such biological changes it transfer them to the adjacent fruits and this excessive release of ethylene results in early ripening of other fruits. Advance studies have shown that bananas have the highest respiration rate among all the fruits in both open and close environments[4].

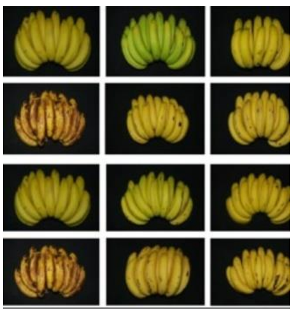


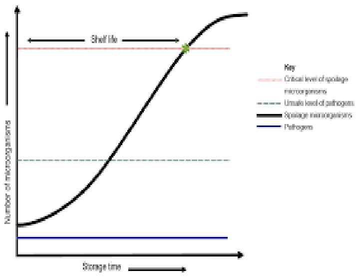
Fig 2: Respiration rate of Banana Fruit and the effect of ethylene

2.1.2IMPROPER PACKAGING

The inhibitory effect of CO2 on many spoilage bacteria is proportional to the amount of dissolved CO2 in the product. Thus the effectiveness of MA packaging is generally determined by the amount of available CO2 that can dissolve into the food, and is a function of the partial pressure of CO2 inside the package and the degree of filling (DoF) (i.e., volume of product vs. volume of package (mL/mL)). The amount of gas dissolved in a product at equilibrium is proportional to the partial pressure in the atmosphere surrounding the product according to Henry's law. Various reports have shown the relationship between Henry's law and packaging variables such as temperature, gas composition and DoF on the amount of dissolved CO2 in the product. However, many of the publications on MAP do not state the DoF or the amount of dissolved CO2, and this makes comparison between different studies difficult and replication impossible [5].

2.1.3 EFFECT OF LIGHT

Determining the effect of light on the shelf life of foods is a difficult experimental area. The major problem seems to be ensuring that all the packages have been exposed to an even and consistent light source. Clearly, the surface area of the package in relation to its volume is crucial in any interpretation of the results. Recently, Manzocco et al. (2012) showed that shelf life estimation of photosensitive foods (specifically sunflower and soybean oils) under actual or accelerated conditions cannot be correctly determined if the effect of light is not taken into account. They presented a model that predicted the shelf life based on changes in both light intensity and temperature, although the effect of temperature as an accelerating factor was quite limited[6]. It would be of great interest if this research was expanded to include all the common packaging materials used to pack vegetable oils. Again, unless the surface area of the package exposed to light is specified, then the research will not be able to be repeated[7].



Graph 1: Shelf life testing of photosynthetic fruits.

3. METHODS OF MAINTAINING THE SHELF LIFE

The shelf life of the fruits can be increased if the factors affecting are maintained. Controlling the temperature would control the maximum factor that affect the shelf life of fruits. Following are the ways through which the temperature can be controlled.

3.1 DEVELOPMENT OF INTEGRATED COOLING ENVIRONMENT

An integrated cooling lowers the close container temperature. This creates the humid environment which favors in lowering the activation energy. This lowers the respiration rate of the fruits and helps in maintaining the shelf life[8]. A temperature controlled environment adjusts the temperature as per the fruit requirement. This lowers the close container gasses to settles and due to non availability of feed to respire the fruits maintain their shelf life. The metabolic activities of the fruit also lower maintaining the nutritive value of the fruit. Thus a fruit stored at controlled temperature, is seen fresh at the consumer level and gains its cost as well. This technique is beneficial for overseas transportation of fruits[9].

Fig 2: Modified Aerobic Packaging(MAP), used for sustainable transportation; source: google images

3.2 EDIBLE COATING

Edible coatings are thin layer of material which provides a barrier to moisture, oxygen and solute movement for the food. It can be a complete food coating or can be disposed as a continuous layer between food components [. Polysaccharides, lipid-based substances and protein films are commonly used as edible coatings. Edible coatings provide a barrier to moisture and minimize the loss of moisture during storage. He\ can also act as a gas barrier and slow down the respiration, senescence and enzymatic oxidation. In addition, edible coatings help to preserves color, texture and volatile compounds of fresh fruits and vegetables. It also maintains the structural integrity and protects against mechanical damages. However, thick coating on fruits and vegetables surface becomes an undesirable barrier between the external and internal atmosphere and restricts exchange of respiratory gases (CO_2 and O_2). It may result in anaerobic respiration, which produces much more carbon dioxide, acetaldehyde and ethanol.

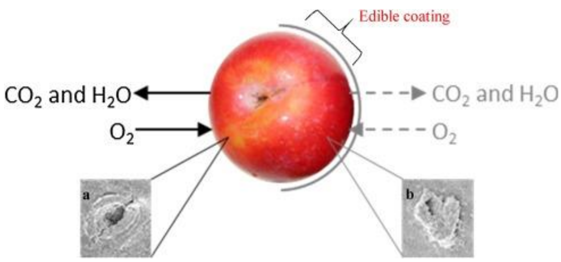


Fig 3: Image depicting edible coating technique. Source: google images

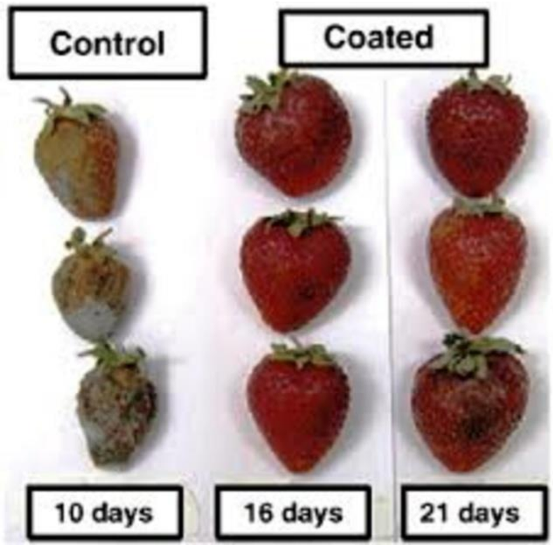


Fig 4: Difference between coated and uncoated fruits after certain time interval

3.3 CHEMICAL CONTROL

Postharvest calcium chloride ($CaCl_2$) application is receiving considerable attention in recent times due to its positive effects on shelf life whilst maintaining quality of many fruits and vegetables [. It has been found that calcium chloride delays ripening and senescence, reduces respiration, extends shelf life, maintains firmness, and reduces physiological disorders of many fruits and vegetables[10][11]. Pre- and postharvest calcium application delayed senescence in many fruits without any negative effect on consumer acceptability. For instance, a 1% $CaCl_2$ treatment was found to have reduced fungal attack, slowed down fruit ripening, and maintained structural integrity of cell walls of strawberry, whilst the same application also delayed softening and increased storage life by almost 3 months in Kiwi fruits stored at 0°C. In loquat fruit, calcium chloride ($CaCl_2$) dip extended shelf life by 4-5 weeks. In tomatoes, calcium chloride treatment is vital for maintaining quality of fruits by reducing the physiological disorders, increasing the fruit firmness, delaying ripening process, and prolonging the shelf life.$CaCl_2$ has been found to have delayed fruit color development in tomatoes and slowed down ethylene production thereby extending shelf life by 92%. Also, fruits treated with $CaCl_2$ have been shown to have reduced physiological weight loss and maintain higher firmness levels during storage [11]

4. CONCLUSION

Shelf life of the fruit can also be extended when appropriate postharvest handling practices and treatment methods are employed. The physical and mobility factors contribute in hampering the shelf life of fruits. These fruits consumed may lead to unusual chemical interactions in body. Though there are different techniques involved to enhance the shelf life of fruits but there is still need of an economic technique. Following techniques require a considerable amount of instruments, its housing the power requirements. For producers of weak economic background such expenditure exceeds the profit gain. More over all though practical affect the nutritive quality of fruit. This creates a need for further research based on postharvest technology should be carried out to improve the efficacy of treatments as well as to address the safety issues. Although there are different physical, chemical and gaseous treatments are available, their effectiveness should be investigated extensively.

5. CONFLIC OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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