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Post harvest activities to enhance shelf life and qualities of fruits: Principles and methods

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Abstract
The profit of farmer's community can be enhanced by extending the shelf life and quality of fruits by various methods like Curing, pre-cooling, cold storage, modified Atmosphere Storage (MAS), Controlled Atmosphere Storage (CAS) wax coating etc. In all these methods, the shelf life is extended by reducing the respiration rate and moisture loss from the fruits. Modified atmosphere and Controlled Atmosphere treatments also reduce transpiration loss (loss of moisture) and rate of respiration. For this packaging and wrapping materials play important roles. In places, where refrigeration and storage facilities are not available, protective skin coating is one of the methods for increasing storage life of fresh fruits. From storage point of view, high density polyethylene (HDPE) bag was considered to be the best among corrugated boxes, wooden boxes, polyethylene bags and high density ethylene bags. Temperature plays important role in reducing different catalytic and moisture loss processes. The low temperature and controlled atmospheric storage techniques have undoubtedly have increased the shelf life of fruits upto 3 weeks during storage

Keywords: Shelf-life, Waxing, Coating, CAS, MAS, Transpiration, Respiration, Wrapping, Packaging

Introduction

Productivity of total fruits in India has become almost stable. On the other side, post harvest loss of fruits is still lying between 25 to 30%. Therefore, the purpose of obtaining maximum profit will be served only if production is supplemented with the similar efforts to minimize post harvest losses and to enhance the shelf life and quality of fruits.

In the harvesting season, there is a glut of fruits in the market. In these days farmers cannot get reasonable price, so it becomes imperative to prolong the shelf life of the fruits in the best interest of farmers' community and consumers as well (Hayat *et al*., 2003) [5]. There are different methods of extending shelf life viz., Curing, pre-cooling, cold storage, modified Atmosphere Storage (MAS), Controlled Atmosphere Storage (CAS) wax coating etc. In all these methods, the shelf life is extended by reducing the respiration rate and moisture loss from the fruits (Rajkumar *et al*., 2007) [12].

In fruits, a series of biochemical changes such as degradation of chlorophyll, biosynthesis of carotenoids, anthocyanins, essential oils and flavour components increase the activity of cell wall degrading enzymes. It is initiated by the autocatalytic production of ethylene which increases rate of respiration causing physiological, biochemical and organoleptic changes ultimately resulting into characteristic colour, taste, and aroma with desirable softening (Tharanathan *et al*., 2006) [15].

Since, there is an adverse relationship between respiration rates and post harvest life of fresh commodities; the effects of CA/MA on the shelf life of fruits also stems out of its influence on the various enzymatic changes taking place in the fruits during ripening which help in maintaining physico–chemical qualities. Modified atmosphere and Controlled Atmosphere treatments also reduce transpiration loss (loss of moisture) and rate of respiration. For this packaging and wrapping materials play important roles. Elevated CO_2 atmosphere inhibits activity of Aminocyclopropane-1- carboxylic acid (ACC) synthase (key regulatory enzyme for ethylene synthesis), while ACC Oxidase activity is stimulated at low CO_2 and/or high O_2 levels. Elevated CO_2 atmosphere, thus, inhibits ethylene action. Moreover, optimum atmospheric composition also retards biosynthesis of carotenoids and oxidation of phenolic compounds (Menon and Goswami, 2007) [8].

In places, where refrigeration and storage facilities are not available, protective skin coating is one of the methods for increasing storage life of fresh fruits (Bisen and Pandey, 2008) [3]. The wax coating, oils and similar materials also reduce evaporation of water and exchange of respiratory gases (CO_2 and O_2) by adding natural resistance of skin and also directly improve the appearance of fruit (Rathore *et al*., 2009) [13].

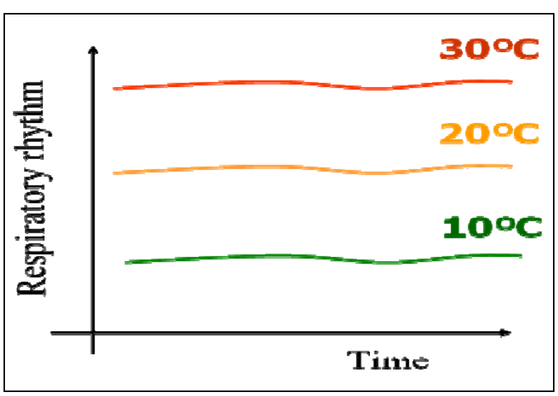
The application of coatings can be carried out by dipping the fruits/parts in the paraffin liquid or by spraying the wax solution as a mist over the fruit surface. Coatings can retard ripening and water loss, and reduce decay (McGuire and Hallman, 1995; Baldwin *et al.*, 1997) [7, 1], but may also alter flavor. Semi-permeable coatings can create a modified atmosphere (MA) similar to CA storage with less expense incurred. However, the atmosphere created by coatings can change in response to environmental conditions such as temperature and humidity due to combined effects on fruit respiration and coating permeability (Baldwin *et al.*, 1995) [2].
Parihar and Kumar (2007) [10] observed the effect of different packaging materials on shelf life of guava fruits. From storage point of view, high density polyethylene (HDPE) bag was considered to be the best among corrugated boxes, wooden boxes, polyethylene bags and high density ethylene bags. Percentage weight loss and decomposition rate were also lowest in HDPE bags. In a recent study, it was reported that mango fruit stored in waxlined cartons sealed with chitosan films have a longer shelf life and retained a higher level of desirable quality attributes than fruits stored in wax-lined carton sealed with low density polyethylene (LDPE) films or in perforated plastic boxes (Srinivasa, *et al*., 2007) [14].
The application of MA/CA technology allows extending the storage life while retaining the overall quality. MA/CA with higher CO_2 and lower O_2 (than normal air atmosphere) can delay ripening by inhibiting the production of ethylene, delaying the biochemical activities associated with ripening such as slowing down the changes in skin and flesh colour, flavour, aroma and texture (fruit softening), and promoting resistance to the attack of postharvest pathogens by increasing the concentration of antifungal compounds due to oxidative process (Prusky and Keen, 1993) [11]. A reduced O_2 concentration of around 3 to 5% and an elevated CO_2 concentration of 5 to 10% are the suggested atmosphere compositions for a successful MA/CA system for mango fruit (Yahia, 1998 & 2009; Kader, 1994) [16, 17, 6].
In addition to these, fruit cultivation is the sector, where growers are not fully dependent on use of chemical fertilizers and other chemicals till date. Hence, production and handling organically is still easy in this sector. Thus, the development of simple and affordable coating and biodegradable packaging material at ambient temperature is the dire need of the day to maintain the post harvest quality of mango.
Temperature plays important role in reducing different catalytic and moisture loss processes. It was investigated that the life of Baneshan mango was extended from 6-9 days by low temperature (5-13 ^{0}C) as compared to its normal life of 4 days at ambient temperature. The life was further extended to 8, 12 and 23 days at room temperature, cool chamber and cold storage, respectively, when treated with bavistin fungicide, paraffin wax and wrapping with HM-film that provide modified atmosphere coupled with low temperature (Narayana *et al*., 1996) [9]. Effect of temperature on respiration rate in different fruits is depicted in table.

Table 1: Effects of temperature on the respiration rates of selected fruits expressed in millilitres of carbon dioxide produced per kilogram per hour [mlCO2/kgh].

Fruits	0 ^{0}C	5 ^{0}C	7 ^{0}C	10 ^{0}C	13 ^{0}C	15 ^{0}C	18 ^{0}C	20 ^{0}C
Avocado	-	10-25	-	25-80	-	62-157	-	40-150
Breadfruit	-	-	-	-	-	-	-	38-178
Banana	-	-	-	-	10-30	12-40	15-60	20-70
Cherimoya	-	-	-	25-100	-	45-150	-	75-250
Peach	2-3	6-9	-	8-12	-	32-34	-	32-55
Pineapple	-	2	-	4-7	-	10-16	-	28-43
Strawberry	6-10	-	-	25-50	-	-	-	50-100
Guava	-	-	-	4-30	-	-	-	10-70
Kiwi	1.5-2	5-7	-	9-12	-	3-4	-	15-20
Mango		-	-	12-16	15-22	19-28	-	35-80
Passionfruit	-	15-30	-	20-40	-	-	-	45-100
Papaya	-	-	3-5	4-6	7-9	10-12	-	15-35
Watermelon	-	-	2-4	3-5	5-8	8-10	-	-
Sapote	-	-	-	-	-	-	-	25-35

Source: California University, http://www.postharvest.ucdavis.edu/produce/producefacts/

In general, the rate of deterioration is increased 2 to 3 fold for every 10 ºC rise in temperature. High temperature also increases the transpiration rate.



Conclusion

An in-depth study of related literature indicated that majority of the research works are related to low temperature storage with combination of many treatments. The low temperature and controlled atmospheric storage techniques have undoubtedly have increased the shelf life of fruits upto 3 weeks during storage, but these are costly and out of reach of common farmers or producers not only in India but also in other major mango growing countries. In this scenario Shelf-life of fruits can also be enhanced at ambient condition for more than a week without deterioration in physico-chemical qualities simply by reducing the rate of respiration and moisture loss. Least mechanical injury during harvesting, removal of field heat, coating, wrapping and packaging make significant difference to solve the purpose.

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