Chapter 6: Effect of film packaging in extending shelf life of *H. polyrhizus*

6.1 Introduction

H. polyrhizus is fast gaining popularity as an economically important crop, especially in the Asian market. However just like any new crop, this fruit too has been besieged with problems ranging from viral infections to the most common fruit-associated dilemma of how to extend storage life.

The quality and shelf life of most fruits are largely dependent on measures such as harvesting at optimum-maturity and handling thereafter. Besides storage temperature, atmospheric condition also plays a vital role in maintaining postharvest fruit quality. In the presence of normal air, shelf life of fruit is limited by two principal factors, which are firstly chemical effect of atmospheric oxygen and secondly the growth of aerobic microorganism that leads to postharvest quality loss. Kader and Ben-Yehoshua, (2000) reported that these factors either individually or in association with one another can cause changes in colour, flavour and texture that leads to overall fruit quality deterioration.

Alleviation of physiological disorders and preservation of fruit quality from postharvest loss can be done by introducing depleted oxygen and/or enriched carbon dioxide levels which will eventually reduce respiration and inhibit or delay enzymatic reactions as well as reduce microbial growth (Carol, 1996). The modification of oxygen and carbon dioxide concentration in the atmosphere surrounding the fruit to a level different from those in the air is referred as modified atmosphere (Kader *et al.,* 1989).

We have successfully developed and introduced film-packaging technology to extend the shelf life of bananas (Nair and Tung, 1992, Chandran, 1998) by hermetically vacuum sealing (pressure 300 mm Hg) Mas bananas (*Musa acuminata*, AA) within a low density polyethylene (PE) plastic bag (60 mm thick) and subjected to storage at 16˚C. The fruit remained green for more than 16 weeks and ripened normally on exposure to ambient air.

Packaging in a low permeability plastic film impedes the diffusion of oxygen to the product even though it does not produce completely anaerobic conditions (Newton and Rigg, 1979). As the fruit respire, oxygen level decreases and the carbon dioxide level increases within the sealed bag. This will ensure the respiration rate of the fruit is reduced and the consumption of respiration substrates is retarded. Ultimately, postharvest fruit quality can be maintained with simple modified atmosphere storage.

There is little information on the use of film packaging to extend the shelf life and its effect on several quality parameters on Hylocereus fruit. Therefore the objective of this experiment is to determine the effects of film packaging on *H. polyrhizus.* The evaluation was carried out on certain parameters defining fruit quality over a 14 day-storage period while subjecting them to three different temperatures; low (6˚C), intermediate (16˚C) and high (23 ± 1˚C) temperature of RH 85 to 95% .

6.2 Materials and methods

6.2.1 Plant material

H.polyrhizus were harvested from a farm at Bukit Tagar (latitude 3˚ 31' 60"N, longitude 101˚ 28' 60"E) where the planting arrangement as mentioned in (subtopic 3.2.1- pg 30-31). The fruit were sorted and graded by size and appearance. Fruit at three stages of development were used for this study namely mature green, one week before full ripe (as previous study showed fruit of two week old had the similar characteristic of fruit of one week old thus in this study it was not harvested) and full ripe labelled as sample A(green mature with average weight of 221 ± 9g), sample B(1 week before ripe with average weight of 325 ± 5g) and sample C (full ripe with average weight of 430 ± 7g) (Figure 6.1).

6.2.2 Film packaging

All the fruit were packaged using clear wrap (0.8 micron) with the properties; 100% Polyethylene cling film with high viscosity, high invisibility and limited permeability to water and oxygen while can endure temperature from -60˚C to 120˚C. The clear wrap was used in this experiment in replace of translucent as previous preliminary works done showed the suitable usage of clear wrap that ensures sample purity and eliminate contamination. The packaged fruits were then stored at three different storage conditions; at (23 ± 1˚C) (RT) representing ambient storage, at an intermediate temperature (16˚C) representing controlled storage and at a low temperature (6˚C) representing cold storage.

A

B

C

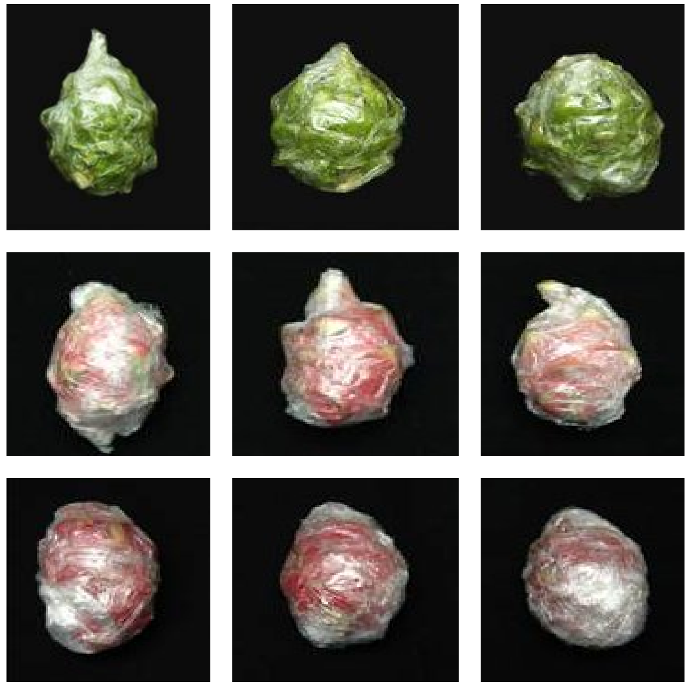

Figure 6.1: The 3 stages of fruit used in this study. A, B and C represents mature green fruit, unripe fruit and ripe fruit respectively. Figure also shows the fruit after 4 layers of film packaging.

6.2.3 Physicochemical analysis

Fruit were assessed for quality at harvest, and day 7 and day 14. Fruit for assessment were removed from storage and left at room temperature for 6 hours before analysis were carried out. This was done to allow the fruit to adapt to room temperature conditions. All measurements were carried out in triplicates.

Fruit were visually assessed for as mentioned in Chapter 3 (subtopic 3.2.1)

6.3 Results

Film packaging showed positive results as a mean to extend the storage life of *H. polyrhizus*. As shown in Figure 6.3, fruits packed in film and stored at 6˚C remained unchanged after 14 days of storage. The mature green fruit remained firm and did not show any change in colour to indicate that ripening had not commenced while in storage (Fig 6.3). Similarly, the unripe and ripe fruit also remained as they were on the first day of storage. The cross section of the fruit also supported this observation whereby the pulp remained firm and intact without any sign-of tissue breakdown. However fruit stored at RT and 16˚C did not show the same positive results. In both cases, the fruit started to ripen and soon deteriorated while in storage.

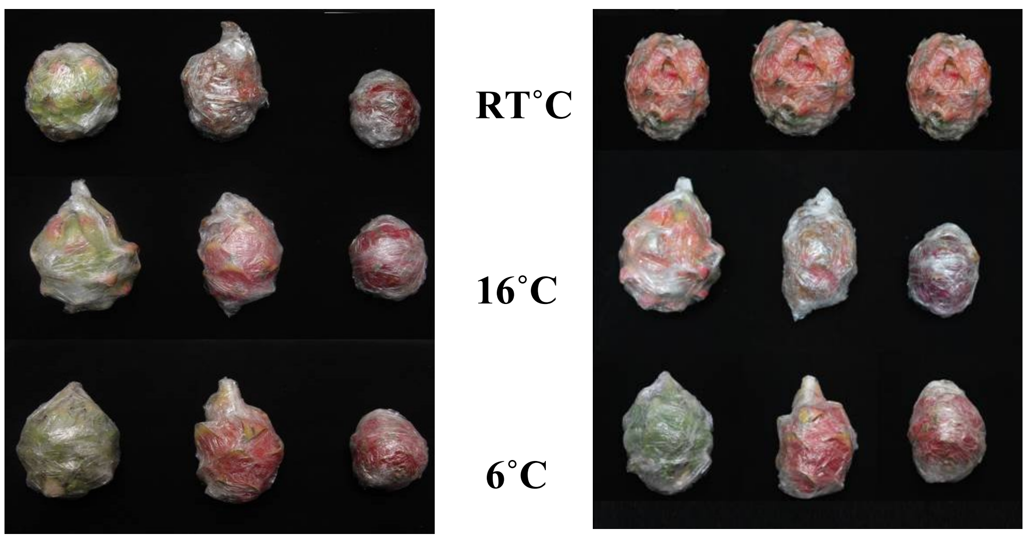

Figure 6.2a Figure 6.2b

Figure 6.2a and 6.2b: Condition of fruit after 7 and 14 days of storage at RT˚C, 16˚C and 6˚C respectively

A B C

Wrapped

Exterior

Interior

Figure 6.3: Fruit stored at 6˚C showed the best results after 14 days of storage. Wrapped fruit at all three stages of fruits remained unchanged and appeared fresh both on the exterior and the pulp.

Sample	Treatment	Storage (˚C)	Firmness (kg f)	Total soluble solids (˚Brix unit)	Days after packaging
Green	Control	RT	0.86 ± 0.02	7.3 ± 0.4	0
Unripe	Control	RT	0.55 ± 0.02	10.7 ± 0.3	0
Ripe	Control	RT	0.41 ± 0.04	13.1 ± 0.5	0
Green	Unpacked	RT	0.17 ± 0.02	6.1 ± 0.3	14
Unripe	Unpacked	RT	0.13 ± 0.01	8.1 ± 0.1	14
Ripe	Unpacked	RT	0.10 ± 0.00	12.1 ± 0.2	14
Green	Packed	RT	0.16 ± 0.03	3.6 ± 0.1	7
Unripe	Packed	RT	0.12 ± 0.01	9.1 ± 0.1	7
Ripe	Packed	RT	0.09 ± 0.01	11.7 ± 0.6	7
Green	Unpacked	16	0.61 ± 0.02	7.2 ± 0.2	14
Unripe	Unpacked	16	0.24 ± 0.03	8.1 ± 0.2	14
Ripe	Unpacked	16	0.22 ± 0.01	11.9 ± 0.1	14
Green	Packed	16	0.18 ± 0.03	4.1 ± 0.4	14
Unripe	Packed	16	0.18 ± 0.01	5.9 ± 0.5	14
Ripe	Packed	16	0.19 ± 0.01	9.7 ± 0.5	14
Green	Unpacked	6	0.74 ± 0.01	8.0 ± 0.3	14
Unripe	Unpacked	6	0.33 ± 0.02	10.4 ± 0.3	14
Ripe	Unpacked	6	0.32 ± 0.04	12.3 ± 0.2	14
Green	Packed	6	0.80 ± 0.02	5.3 ± 0.2	14
Unripe	Packed	6	0.22 ± 0.01	7.7 ± 0.2	14
Ripe	Packed	6	0.31 ± 0.01	11.6 ± 0.4	14

* control in this experiment are fruits packed on day of harvest at room temperature

Table 6.1: Summary of results for TSS and firmness. Table shows that film packaged fruit stored at 6˚C remained firm and did not significantly show any sign of ripening throughout the storage period.

Analysis of the fruit firmness and measurement of TSS also supported this observation (Table 6.1). Fruit stored at 6˚C showed much higher firmness value, 0.80 kg f, compared to an average of 0.15-0.20 kg f for fruit stored at 16˚C and room temperature.

6.4 Discussion

An important consequence of film packaging is its effect on fruit appearance as has been observed throughout this study. Generally, colour is evaluated as one of the main attributes along with texture that characterise the freshness and marketability appearance of most fruit (Clydesdale, 1993). Results indicate that all fruit packed successfully maintained bracts/peel colour up to two weeks when stored at low temperature. The similar pattern was also observed in fruit harvested mature green in which the colour remained green. However, fruits packed and stored at RT and 16˚C showed changes in bracts/peel colour. These changes are enhanced by high temperature which contributed to the degradation of chlorophyll and also the appearance of new pigments in the harvested mature green fruit. Meanwhile fruit harvested unripe and full ripe fruit showed signs of physiological disorders such as sunken tissue and decay when stored at high temperature which could be possibly related to higher respiration rate.

Besides colour, texture also plays a vital role in freshness of the fruit. In this study, pulp firmness decreased regardless of fruit packaging. Reduction in pulp firmness is directly correlated with fruit softening which is contributed by enzymatic degradation of pectin, turning an undesirable fruit to desirable fruit. However, fruit packed and stored at low temperature maintained greater firmness compared to those stored at 16˚C and ambient in which the fruit remained firm up to two weeks storage. This is probably due to suppression of enzymatic activity under low temperature.

Fruit quality assessed in terms of TSS and firmness showed that fruit packed and stored at low temperature were successful in retaining the TSS as well as the firmness compared to those held at ambient temperature in which the TSS was high but the fruit firmness was very low. On the contrary, fruit packed and stored at 16˚C showed low firmness with low TSS. The above phenomena can be regarded as an effect of temperature on biochemical reactions which are enhanced 2 to 3 fold when there is an increase of 10˚C in the temperature (Kader *et al.,* 1989). The decrease in TSS when stored at high temperature can be explained due to higher respiration rate that causes fruit to use up storage reserve and thus reduce the TSS level.

It is known that postharvest fruit quality can be preserved while extending the shelf life by introducing film packaging as a mean to modify the atmosphere surrounding the fruit. However, the modification alone cannot play the role but need a proper storage condition in terms of temperature to achieve the purpose. In fact, types of film permeability and thickness contribute to the successfulness of the packaging. As in this study, the film packaging facilitated towards the extension of the fruit shelf life at low temperature. In a package with low permeability towards oxygen, the oxygen level will tend to decrease whereby carbon dioxide level increases (Beaudry *et al.,* 1992). This will eventually lower the respiration rate that contributes to fruit deterioration and thus reduces the substrate utilisation (Kader, 1995).

Nevertheless there is limitation or critical threshold regarding the level of oxygen and carbon dioxide within the package that can cause undesirable conditions (Kader *et al.,* 1989). Films that have very low permeability towards oxygen will tend to promote anaerobic condition. Hence, the development of physiological disorders or fermentative conditions can be observed in the produce packaged and thereafter shorten the shelf life (Zagory and Kader, 1988; Exama *et al.,* 1993).

Therefore, from this study, packaging seems to be successful in preserving fruit quality of *H. polyrhizus* when stored at low temperature (6˚) regardless of sample type. Storage life of fruit packed and stored at RT was shorter (7 days) compared to low and intermediate temperature (14 days). The above results indicated that in designing a packaging method to extend shelf life of fresh fruit, it does not only take into consideration the type of film used but also the storage temperature that have been set up for the postharvest condition.