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# Physical and chemical quality changes of longkong (*Aglaia dookkoo* Griff.) during passive modified atmospheric storage

[1]Venkatachalam, K. and [1,2]*Meenune, M.

[1]*Faculty of Agro-Industry, Prince of Songkla University, Hat-Yai, Songkhla 90112, Thailand.*
[2]*Postharvest Technology Innovation Center, Commission of Higher Education, Bangkok 10400, Thailand*

**Abstract:** Longkong is a tropical and non-climacteric fruit which is highly perishable after harvest. The shelf life extension of longkong by using passive MAP with two different OTR packages and stored at 18ºC, 25ºC and at a 85% of relative humidity was investigated. In this study, physical and chemical quality changes of longkong was monitored. At the end of storage longkong stored under 18ºC in M1 and M2 package was found better quality than other storage conditions and it resulted, less reduction in colour in both L* and b* values, less accumulation of $CO_2$, weight loss and also less reduction in pH, titratable acidity and sugar was found. Although, fruit stored in M1 had a better quality than M2, it evidenced by in L* (56.69), a* (10.55) and b* (32.64) values. Weight loss was 2.61% and TSS was 14.2º Brix found at the end of storage.

**Keywords: Longkong, postharvest, passive modified atmospheric package, oxygen transmission rate, quality**

## Introduction

Longkong (*Aglaia dookkoo* Griff.) is an economically important plant in the peninsula of Thailand and it belongs to the Meliaceae family, originates from the south of Thailand. It is widely distributed from the south through the east and is also cultivated in Australia, Sri Lanka, Vietnam, Myanmar, India, and Puerto Rico (Paull, 2004). Longkong is a tropical fruit, which comes in racemes and roughly round in shape. There are 15 to 25 fruits per raceme. Young fruit skin is pale green and when ripe it turns to yellow colour. The fruit has five separate segments, with one to five seeds covered by white, translucent flesh. The fruit flesh is aromatic and juicy and has sweet but slightly sour taste. During ripening, astringency in the flesh declines, while the sugar increases around 6-fold (Paull *et al.,* 1987). The demand for this fruit is increasing tremendously due to its juicy and has a pleasant taste. It also contains a variety of nutrients, including proteins and carbohydrates, a low fat content and a high content of vitamins and minerals (Sapii *et al.,* 2000; Sabah, 2004). Longkong is classified as a non-climacteric fruit and usually harvested ripe when peel colour turns yellow (Lichanporn *et al.,* 2008). Its postharvest life is limited about 4-7 days under room temperature due to deteriorate its quality such as pericarp browning, changes in texture, appearance and off-flavour after harvest (Teerapawa and Premanode, 1991; Lichanporn *et al.,* 2009; Sangkasanya and Meenune, 2010).

The combination of low storage temperature and MAP are extensively used to extend the shelf life of many intact and fresh-cut fruits and vegetables because they reduce respiration rate and cut surface deterioration and enzymatic browning reactions (Gorny, 1997; Thompson, 1998). Passive modification of the atmosphere created naturally by the product may retard deterioration and maintain the quality (Kader *et al.,* 1989). MAP essentially maintains the quality of fresh-cut products by matching the oxygen transmission rate (OTR) of the packaging film to the respiration rate of the packaged product; $O_2$ and $CO_2$ levels within the package can also change as a function of area of the film as well as ambient temperature (Jacxsens *et al*., 2000; Al-Ati and Hotchkiss, 2003).

In order to prolong the longkong shelf-life, low temperature and modified atmospheric packaging (MAP) was introduced (Piyasaengthong *et al*., 1997; Meenune and Chanthachum, 2004; Sangkasanya and Meenune, 2010). Longkong stored at 18°C could extend the shelf life of 21 days with 60% fruit loss. Longkong raceme which was kept under the combination of low temperature and modified atmosphere packaging (MAP) has prolonged shelf-life than that at atmospheric condition. However, the formation of off-flavour can be occurred by using MAP with nylon package (Meenune and Chanthachum, 2004; Sangkasanya and Meenune, 2010). Little information is known about the changes of longkong quality during MAP storage. The objective of this study was to determine the effect of physical and chemical quality changes of longkong during passive MAP storage.

## Materials and Methods

*Corresponding author.
Email: *mutita_meenune@yahoo.co.uk*
Tel: 66-7428-6335 Fax: 66-7455-8866

*Fruit preparation*

Longkong fruit at 13th weeks after anthesis were purchased in a contact garden in Songkhla province, Southern Thailand. The fruits were separated from racemes and selected uniformly matured, yellow peel colour, and lack of defects. The fruits were dipped in 500 ppm benomyl and 1.5% citric acid solution for 5 min and dried for 15 min at room temperature to minimize postharvest disease and enzymatic browning.

*Modified atmospheric package and storage condition*

The 20 individual fruits in each replication was taken onto a polypropylene (PP) tray and passively MAP with two different gas transmission rate (Oxygen ($O_{2)}$ and Carbon dioxide ($CO_2$)) (GTR) and water vapour transmission rate (WVTR) package as described in Table 1. All bags were 8 x 15 inches size and 25 µM thicknesses and purchased from Thantwan Industry Public Company limited, Thailand. The fruits were sealed in bags and stored at 18°C and 25°C and at a relative humidity of 85%. The changes in the physical (colour, weight loss) and chemical (pH, total soluble solids (TSS), titratable acidity (TA), total sugar and reducing sugar) quality criteria were determined in the fruits stored in passive MAP at every 3 day interval until the end of storage. The storage was terminated when any fruits showed visible mold growth on fruit skin.

**Table. 1.** Different GTR ($O_2$ and $CO_2$) and WVTR package

| Package | $O_2$ transmission rate ( $cm^3/m^2.d$) | $CO_2$ transmission rate ( $cm^3/m^2.d$) | WVTR ($g/ m^2.d$) |
|---|---|---|---|
| M1 | 11,000-12,000 | 72,000-73,000 | 30.6 |
| M2 | 12,000-13,000 | 64,000-65,000 | 27.6 |

*Physical quality changes*

Surface colour changes on two opposite sides of an individual fruit was measured by using Hunter Lab colourimeter in term of CIE L*, a* and b* values. Weight loss during storage was determined by monitoring the weight of the fruit package initially and every 3 day of storage and was expressed as the percentage of the loss of initial weight.

*Fruit respiration gas*

Determination of headspace $CO_2$ and $O_2$ concentration in the fruit package was measured by gas chromatography. A gas sample (1 ml) from the headspace inside the package was injected directly into Poro pack N column with a helium carrier flow of 50 ml/min and a thermal conductivity detector. External standard gas was used to identify and quantified the internal package atmosphere.

*Chemical quality changes*

Longkong fruits were hand peeled, deseeded and the homogenate was prepared by blending and filtered and then used for chemical analysis. pH was measured by using Sartorius PB-20 (Germany) digital pH meter. TSS was determined by using an Atago 1E (Japan) hand refractometer at 25ºC. The results were expressed as ºBrix. TA was determined by titrating 5 ml of the homogenate to an end point of pH 8.2 with 0.1 N NaOH using 1% phenolphthalein as an indicator. The result was calculated as percentage of citric acid content (Sangkasanya and Meenune, 2010). Total sugar and reducing sugar content was quantified by titration with Fehling reagents according to Ranganna (1986) volumetric method.

*Statistical analysis*

The data were analyzed statistically by one-way ANOVA. Significant differences between means were estimated by Duncan's new multiple range test (DMRT), with a level of significance of 0.05. Statistical analyses will be performed using the Statistical Package for Social Science (SPSS 11.0 for windows, SPSS Inc., Chicago, IL, USA).

## Results and Discussion

*Fruit colour and respiration*

Fruit colour is very important for consumers. The parameters L*, a*, and b* values were measured for colour determination. The initial L* value of longkong was 70.48 and decreased during storage in all treatments (Figure 1A). The interaction between temperature and storage time was significantly affects L* value. Meanwhile the initial b* value was 38.91 and significantly decreased in all treatments during storage (Figure 1B). Conversely the initial a* value of longkong was 7.18 and increased throughout the storage and the package and temperature was significantly ($P$<0.05) affects a* value in all treatments (Figure 1C.). The results revealed that not only L* but also a* and b* closely related with the browning of the peel of fruit because in all treatments, the decreased in L* and b* values and the increased a* values were similarly observed during the storage. The Increased in weight loss could lead to the breakdown of membrane and consequently, resulted in the increase of permeability, thus allowing enzymes and substrates to bind together and initiate browning reactions (Weller *et al.,* 1997; Huang *et al.,* 2005; Lichanporn *et al.,* 2008, Venkatachalam and Meenune, 2012).

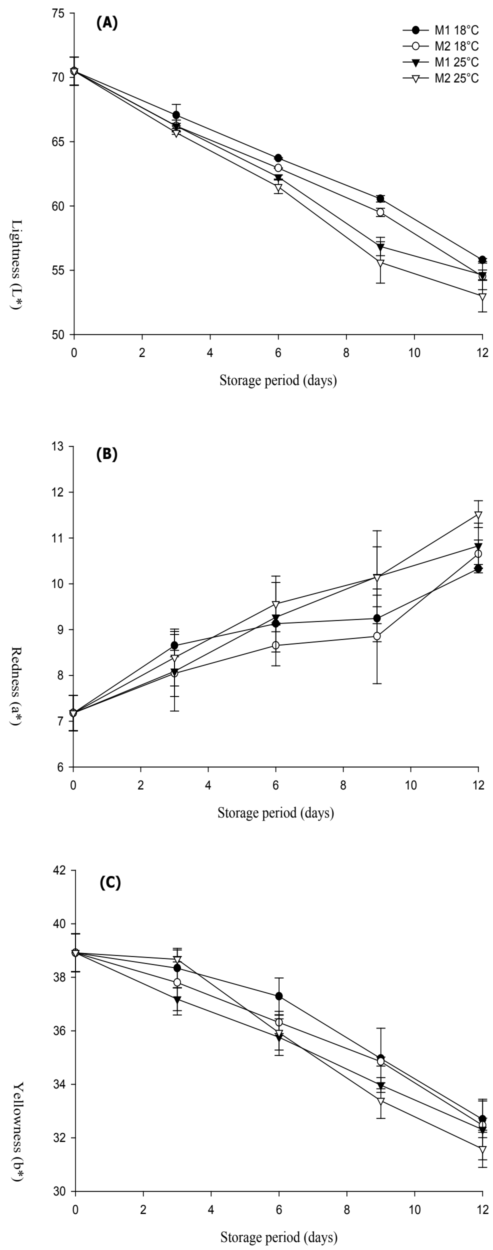



**Figure 1.** Changes in L* (A), a*(B) and b*(C) values on the peel of longkong fruit in passive MAP during storage at 18°C and 25°C with RH 85%. Data shown are mean ± standard deviation (SD). The vertical bar indicates SD.

Fruit respiration gas changes were shown in figure 2. The increased accumulation of $CO_2$ was found inside the M1 and M2 bags (Figure 2A). However, the significant accumulation of $CO_2$ was found more in M2 bags. Conversely, the decreased level of $O_2$ was found in both packages throughout the storage (Figure 2B).

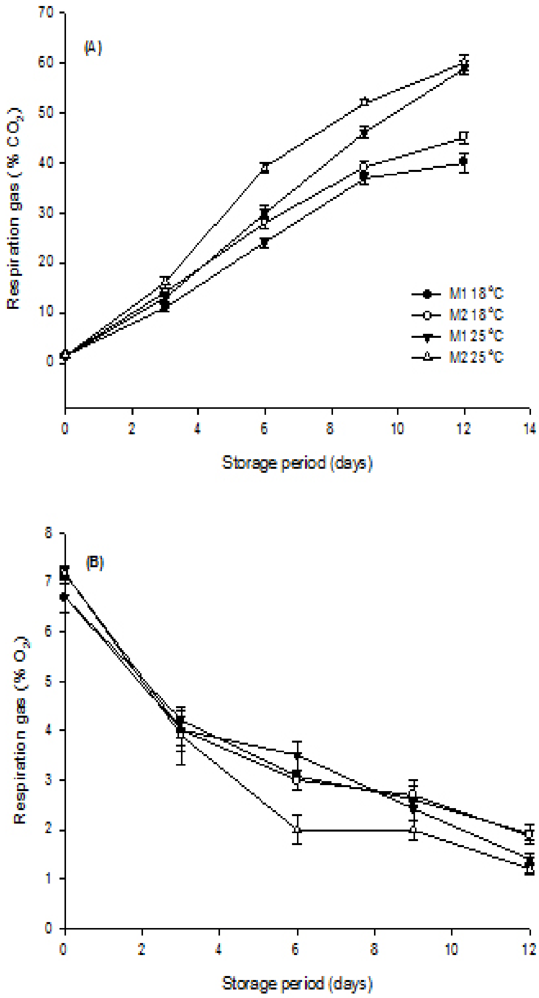



**Figure 2.** Changes of in package atmosphere such as $CO_2$ (A), $O_2$ (B) values of longkong fruit in passive MAP during storage at 18°C and 25°C with RH 85%. Data shown are mean ± standard deviation (SD). The vertical bar indicates SD.

A rapid deterioration of the fruit concerned an increase in respiration rate and enzymatic processed that led to a loss of quality of the fruit involving browning reactions among others (Ferrer *et al.,* 2002).

*Fruit weight loss and TSS*

The significant increased in fruit weight loss found throughout the storage (Figure 3A). At the end of the storage, fruits were stored at 18°C attained the weight loss of 2.61% (M1) and 3.66% (M2) and longkong stored at 25°C attained the weight loss of 4.05% (M1) and 4.22% (M2). The difference in weight loss between M1 and M2 package at same temperatures were indicated M2 package has more weight loss that was showed high OTR stimulates more respiration that leads transpiration inducing weight loss in longkong. This is in an agreement with other results of non-climacteric fruits such as strawberries and raspberries (Jacxens *et al.,* 2003).

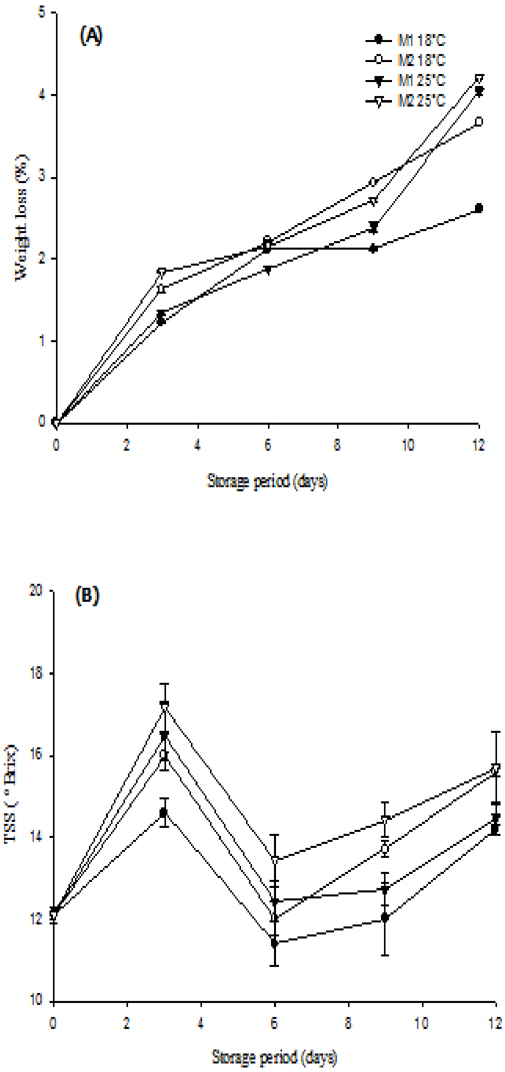



**Figure 3.** Weight loss (A) and TSS (B) of longkong fruit in passive MAP during storage at 18°C and 25°C with RH 85%. Data shown are mean±standard deviation (SD).

The WVTR of the package was did not affect the longkong weight loss as compared to OTR and temperature during storage. The results pointed out that longkong stored at 18°C have less weight loss than the one that stored at 25°C. Low temperature can retard a metabolism of living organs thus the transpiration process reduced (Lichanporn *et al.,* 2008). An increased in TSS was found in the initial stage and then it slightly decreased on 6$^{th}$ day of storage after that TSS was gradually increased until the end of the storage in all treatments (Figure 3B). Interaction between package and storage time and storage time and temperature was significantly ($P$<0.05) affecting TSS during storage. Increase in TSS closely related to increased in weight loss.

*pH and TA*

The initial pH value was 4.43 and during the storage pH was decreased in all treatments. At the end of storage pH decreased at 18ºC in M1 (4.12) and M2 (4.13) was found compared to other treatments (Figure 4A). The interaction between package and temperature and storage time and temperature was significantly ($P$<0.05) affects on pH during storage. The initial TA level was 0.55% and the decrease in TA was found in longkong during storage (Figure 4B).

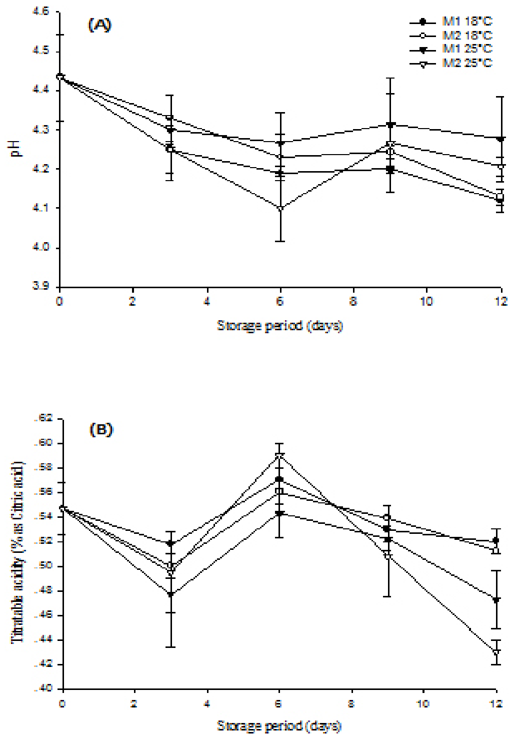


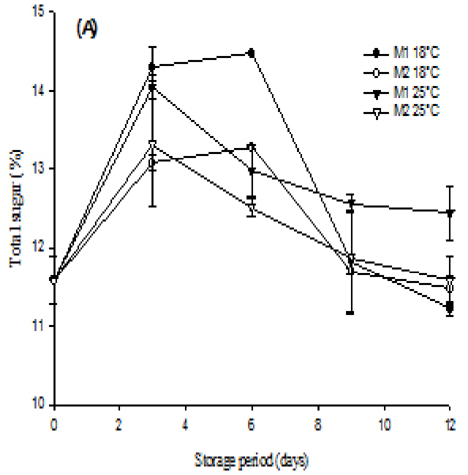

**Figure 4.** PH (A) and Titratable acidity (B) of longkong fruit in passive MAP during storage at 18°C and 25°C with RH 85%. Data shown are mean±standard deviation (SD). The vertical bar indicates SD.

The interaction between storage time and temperature was significantly ($P$<0.05) affects on the TA during storage. Reduction of TA in longkong in all treatments was caused by using sugars as a substrate in respiration process. Increased the accumulation of carbon dioxide could be impaired the Krebs cycle function and increased the addition of organic acid was found in longkong (Sangkasanya and Meenune, 2010).

*Total sugar and reducing sugar*

An initial value of total sugar was 11.6% and it increased at the initial stage of storage. During the 6$^{th}$ day of storage, longkong stored at 18ºC in M1 bag (14.5%) attained the higher total sugar value than other treatments and after that total sugar was tend to decreased in all treatments until the end of the storage

(Figure 5A). While the initial value of reducing sugar was 5.89% and it increased up to 6th day of storage after that reducing sugar was tend to decreased until the end of the storage. At the end of the storage reducing sugar of the stored longkong at 18ºC was decreased to 5.6% (M1) and to 5.4% (M2) and fruits stored at 25ºC were decreased to 4.5% (M1) and to 4.2% (M2) (Figure 5B).



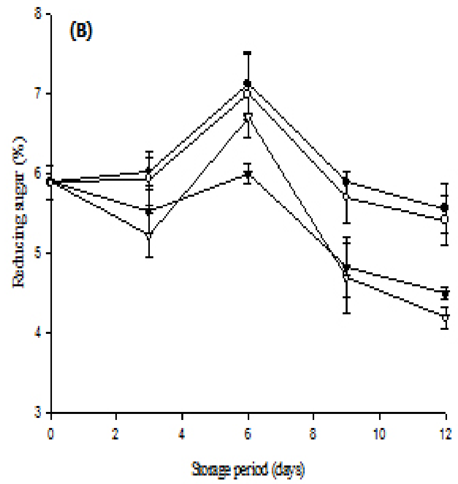




**Figure 5.** Total sugar (A) and reducing sugar (B) of longkong fruit in passive MAP during storage at 18°C and 25°C with RH 85%. Data shown are mean±standard deviation (SD). The vertical bar indicates SD.

The interaction between storage time and temperature was significantly ($P<0.05$) affects the total sugar and the reducing sugar during storage. The effect of different OTR packages on the changes in total sugar and reducing sugar was affected non-significantly during storage. Decrease in sugars caused by oxidation of substrate in respiration process in high oxygen content (Sangkasanya and Meenune, 2010). The reduction in the percentage of reducing sugar in fruit due to the quick consumption of sugars (Sharaf and El-Saadery, 1996).

## Conclusion

MAP storage was generally recommended for prolonging the shelf life of longkong after harvest. Longkong stored under at two different GTR and WVTR polyethylene bags, storage temperature and storage time was significantly changed the fruit quality. However longkong fruit stored at 18ºC in M1 bag (11,000-12,000 $cm^3/m^2$.d) was found to be better control in metabolic process compared to M2 bag (12,000-13,000 $cm^3/m^2$.d) and ambient temperature as evidenced by less weight loss, less browning and gradual changes in total sugar and reduced sugar contents.

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