CHAPTER 3

EFFECTS OF SODIUM METABISULFITE ON POSTHARVEST QUALITY AND STORAGE LIFE OF INDIVIDUAL LONGAN FRUITS CV. LONG

3.1. Introduction

The longan market has always been limited by the highly perishable nature of the fruit, its short storage life and its susceptibility to postharvest diseases, as well as the rapid pericarp browning that takes place during storage (Tongdee, 2001; Jiang *et al*., 2002). Postharvest longan fruit discolor rapidly due to desiccation when stored at temperatures that are either too low or too high (Apai, 2010). Browning is associated with dehydration, heat stress, senescence, chilling damage and disease, and is caused by the oxidation of phenolic compounds by endogenous polyphenol oxidase (Pan, 1994; Jiang *et al*., 2002). Sulfiting agents such as sulfur dioxide and sodium metabisulfite have been used as preservatives in food (Tongdee, 1993). When mixed with water, sodium metabisulfite releases sulfur dioxide (SO_2). These sulfities have a wide range of uses in food, including as inhibitors of non-enzymatic browning, as antioxidants, as reducing agents inhibiting various enzymatic catalyzed reactions (notably enzymatic browning which involves the oxidation of phenolic compounds present in food), plus they inhibit and control the growth of microorganisms (Tongdee, 1993).

In this experiment, individual ‘Long’ longan fruits were treated with various concentrations of sodium metabisulfite, in order to develop a suitable postharvest handling technique for the commercial longan market.

3.2. Material and Methods

3.2.1. Plant material

Mature 'Long' longan fruits from the 2010 crop of a commercial orchard in Hung Yen Province, Vietnam, were used for this research. Fruit age at harvesting date was 180 days after full bloom. The fruits were harvested in the morning and then packaged in 20 kilogram (kg) plastic baskets lined with leaves, and then transported to the laboratory within 2 to 3 hours. Individual fruits were then selected for uniformity of shape and color prior to use in this study (**Figure 3.1**). Their initial qualities were assessed and the results of the experiment averaged out over18 replications. The averaged results are as follows: (i) thickness of the pericarp was 0.69 ± 0.02 millimeters (mm), (ii) thickness of the flesh was 4.0 ± 0.6 mm, (iii) diameter of the fruit was 26.04 ± 2.1 mm, (iv) weight of the fruit was 8.25 ± 0.6 grams, (v) weight of the seeds was 1.33 ± 0.2 grams, (vi) the soluble solids content was 18.97 ± 1.4 %Brix, and (vii) the color of the fresh fruit, when expressed as L* value (lightness) was 47.8 ± 2.1; a* value (redness) was 7.5 ± 1.1; b* value (yellowness) was 27.7 ± 1.4.


A

B

Figure 3.1 The morphology of bunches of fruit (A) and individual 'Long' longan fruits (B) at harvesting date.

3.2.2. Methods

- Measurement of fruit weight and diameter

A digital balance (Cityzen, USA) was used to measure the weight of the fruit and the seed.

The thickness of the pericarp, flesh and the diameter of the fruit were measured using a digital caliper (Coral, Japan).

- Observation of the changes in visual appearance

The visual appearance was expressed using a browning index (BI) and a flesh color index (FCI). Pericarp browning was estimated by observing the extent of the total browned area on each fruit's surface, on the following scale: 1 = 0% (no browning); 2 = 1-25% (slight browning); 3 = 26-50% (moderate browning); 4 = 51-75% (moderate – serious browning); and 5 = 76-100% (serious browning) pericarp browning area. A browning index was calculated using the following formula: (browning scale x percentage of corresponding fruits in each class). Fruits with a BI above 2.0 were considered to be unacceptable for sales and marketing purposes. Flesh color was assessed visually by observing the changes in chromatic level of each fruit and the following scale was used: 1 = normal color; 2 = slightly abnormal color, but still acceptable; 3 = moderately abnormal color but unacceptable; and 4 = severely abnormal color. A flesh color index was calculated using the following formula: (flesh color scale x percentage of corresponding fruits in each class). Fruits with an FCI above 2.0 were considered to be unacceptable (Jiang and Li, 2001).

- Measurement of longan fruit pericarp color

The outer pericarp color of the 'Long' longan fruit was measured using a colorimeter (Konica Minolta, Japan), and 18 longan fruits in total were measured for pericarp color in each treatment, with the pericarp color values for L*, a* and b* recorded. The L* value indicates lightness, ranging from black = 0 to white = 100; the a* value illustrates chromaticity on a green (-) to red (+) axis, and the b* value denotes chromaticity on a blue (-) to yellow (+) axis (MacGuire, 1992).

- Determination of total soluble solids content

The total soluble solids content was determined using a digital refractometer (PAL-1, Atago, Japan).

- Evaluation of sensory properties

The odor emitted by the longan fruit was evaluated by a board of tasters, and an average score produced, as follows: 1.0 - 1.5 = normal, above 1.5 to 2.0 = abnormal.

The flavor of the longan fruit was assessed by a board of tasters, and an average score produced, as follows: 1.0 - 1.5 = normal, above 1.5 to 2.0 = abnormal.

- Assessment of fruit decay

Fruit decay was assessed and then expressed as a percentage, as follows:

$$\text{Percentage of fruit decay} = \frac{\text{Number of decay fruit}}{\text{Total fruit}} \times 100$$

- Determination of storage life

Using the above indices, the quality of the longan fruit was deemed to be unacceptable:

- When fruits had a BI or FCI above 2.0
- When fruits had fruit decay above 10% present
- When fruits had an odor or flavor score above 1.5

- Statistical analysis

Statistical analysis was carried out using SPSS software (version 13), and Duncan's multiple range test was used to analyze the significant differences between treatments.

3.2.3. Experimental design

Fruits were cut from the bunch using scissors, with only uniform fruits collected. After that the fruits were soaked in 2.5% or 5% or 7.5% sodium metabisulfite solutions for 5 and 10 minutes at room temperature (25 ± 2ºC), while the control fruits were not soaked. Thereafter, the fruits were air dried for 10 minutes at room temperature and packaged in polypropylene bags (203 x 305 mm in size, and 0.035 mm thick) with 0.5 kg placed into each bag. Each treatment, plus the control, had three replications, and the bags were then stored at 5±1ºC in a cold room and samples analyzed at 7 day intervals.

A completely randomized design was used for the experiment. The E_0 fruit (control) was not treated, while the E_1 and E_2 fruits were treated with 2.5% sodium metabisulfite (SMB) for 5 and 10 minutes respectively; the E_3 and E_4 fruits were

treated with 5% SMB for 5 and 10 minutes respectively, and the E_5 and E_6 fruits were treated with 7.5% SMB, also for 5 and 10 minutes respectively.

3.3. Results and Discussion

3.3.1. Changes in visual appearance of individual fruits during the storage period

The changes in visual appearance, expressed as pericarp color of the individual 'Long' longan fruit during the storage period, are shown in **Figure 3.2** and **Appendix Table A1**. For the pericarp color, expressed as a browning index (BI), those fruits with a BI above 2.0 (more than 25% pericarp browning area) are considered as unacceptable for marketing purposes; therefore, in this research, the storage life was determined in terms of both marketing and consumer acceptance. As shown in **Figure 3.2**, fruits under the E_0 and E_1 treatments were not acceptable (BI > 2.0) and were significantly different to fruits undergoing the other treatments by day 7 of storage. These relative results have also been reported in Thai longan fruits. For the untreated longan fruits (cv. Daw), pericarp browning occurred after 5 days in storage, with a BI above 2.0 (Apai, 2010). Jaitrong (2006) also found that both sides of untreated longan fruit pericarp (cv. Daw) brown when stored at 2-7ºC for 5 days. In this experiment, the BI of the E_0 and E_1 treatments reached 4.7 by day 28 in storage. The control showed pericarp browning development at BI = 4.23 after 27 days in storage at 5ºC (Apai, 2009). Whangchai *et al*. (2006) reported that pericarp browning increases with increased storage period. Our results are consistent with the findings of Nguyen *et al*. (2001) regarding the BI of the pericarp of longan fruit. The E_2 treatment was not acceptable after 14 days in storage. While the E_3 and E_4 treatments were not

acceptable (BI > 2.0) after 21 days in storage, the BI scores of the E_5 and E_6 treatments were below 2.0 and which were not significantly different after the same period. The BI of the E_6 treatment was significantly different to that of the other treatments and showed the best pericarp color and the longest storage life after 28 days. These results demonstrate the effectiveness of the SMB concentration and the importance of dipping time in maintaining the BI of longan fruit. Our results are in accordance with other studies in which the BI was found to be below 2.0 (Joas *et al*., 2005; Whangchai *et al*., 2006; Apai, 2010), and the same results were also reported by Apai (2009) that longan fruits treated with 1% citric acid in combination with 1.2% chitosan and stored at 5ºC for 27 days display significantly delay pericarp browning.

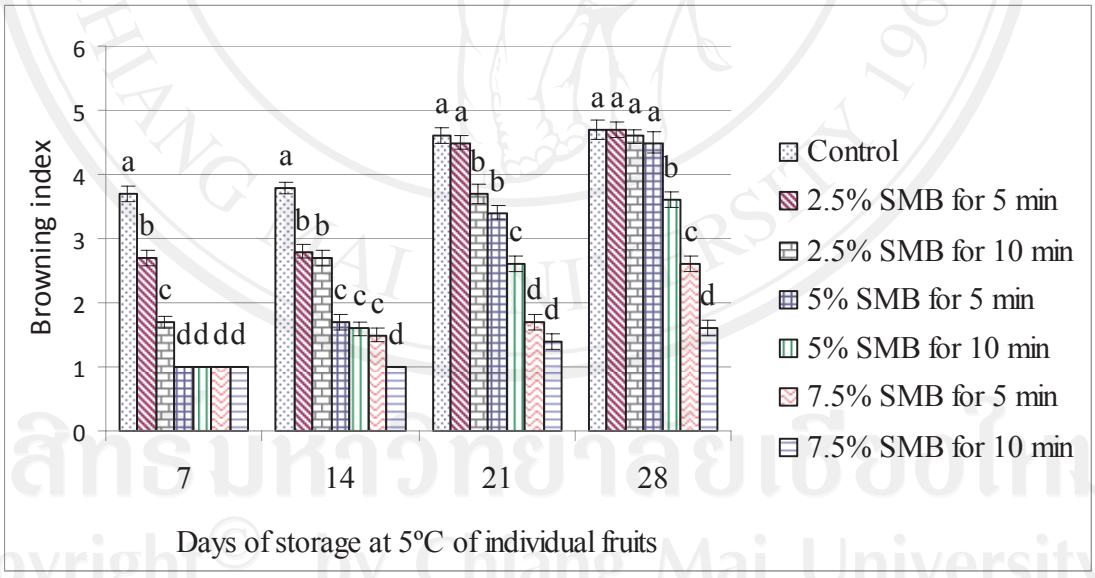


Figure 3.2 Changes in pericarp browning index (BI) of individual longan fruits either treated or not, during storage period at 5ºC.

BI: 1 = 0%; 2 = 1-25%; 3 = 26-50%; 4 = 51-75%, and; 5 = 76-100% pericarp browning area. Fruits with BI above 2.0 were considered as unacceptable. Vertical bars represent standard errors. Columns with different letters indicate significant differences by Duncan's multiple range test ($P \leq 0.05$).

Changes in visual appearance, expressed as flesh color of the individual 'Long' longan fruit during the storage period, are shown in **Figure 3.3** and **Appendix Table A2**. The flesh color value was expressed as a flesh color index (FCI), and fruits with an FCI above 2.0 (moderately abnormal color and unacceptable) were considered unacceptable. It can be seen that the FCI of the longan fruits remained acceptable for all treatments after 14 days in storage, after which the FCI of the E_2–E_6 treatments was below 2.0, and the FCI of the E_0 and E_1 treatments was above 2.0 plus did not vary after 21 days in storage. The control fruit showed pulp rot in accordance to the highest browning index (Apai, 2009). After 21 days in storage, the FCI values for the E_3, E_5 and E_6 treatments were not different, and the E_2 and E_4 treatments also did not differ ($P \leq 0.05$). There was a significant difference between the FCI of control and the E_1–E_4 treatments, however the FCI of them was above 2.0, while the E_5 and E_6 treatments maintained an acceptable flesh color (FCI < 2.0) for 28 days (**Figure 3.3**). These results show the effectiveness of SMB concentrations at maintaining the quality of flesh in fruit, and our results are consistent with the findings of Nguyen *et al*. (2001) with regard to the quality of 'Long' longan fruit flesh.

Overall, the E_6 treatment had the best visual appearance after 28 days in storage, and as a result, it can be said that SMB concentrations similar to those used in this research are able to prevent the pericarp browning of longan fruit.

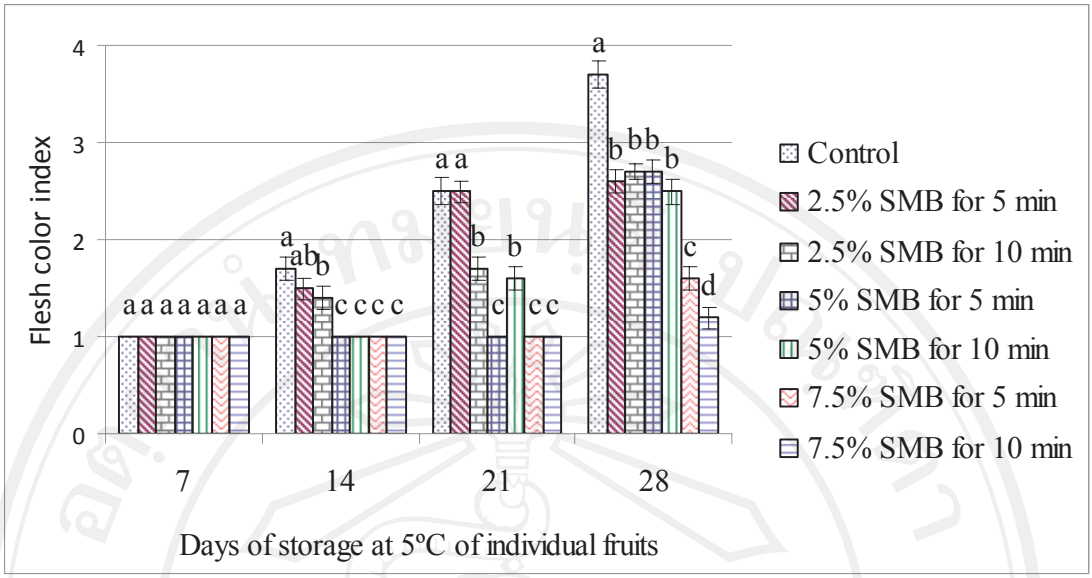


Figure 3.3 Changes in flesh color index (FCI) of whole individual longan fruits, either treated or not, during 28 days in storage at 5ºC.

The index shown is: 1 = normal color; 2 = slightly abnormal color, but still acceptable; 3 = moderately abnormal color and unacceptable, and; 4 = severely abnormal color. Fruits with FCI above 2.0 were considered as unacceptable. Vertical bars represent standard errors. Columns with different letters indicate significant differences by Duncan's multiple range test ($P \leq 0.05$).

3.3.2. Changes in L*, a*, and b* values of individual fruits during the storage period

Table 3.1 shows the changes in L* values (lightness) for the pericarp of individual 'Long' longan fruits treated with various concentrations of SMB solutions, when compared with the control fruits. It can be seen that during the storage period, the L* values ranged from 42.3 to 54.4 by day 7; 40.6 to 52.5 by day 14; 40.7 to 52.8 by day 21; and 40.4 to 51.2 by day 28. There was a significant difference between the L* values of the fruit pericap for all the treatments and that of the control during the storage period (except for the E_1 - E_3 treatments by day 7, and the E_4 and E_6 treatments by day 14, the E_0 and E_2 treatments by day 28) ($P \leq 0.05$). Generally, the

control fruits had lower L* values than the treated fruits, and the L* values of both the treated and the control fruits tended to decrease with increased storage time. The L* values of the fruit pericarp decreased from 53.5 to 45.1 for the control and from 53.5 to 42.3 for the treated fruits when stored at 5ºC for 24 days (Thavong, 2009). Jaitrong (2006) reported that the L* values for the outer longan pericarp of cv. Daw and cv. Biew Kiew fruits decreased from 53.2 to 41.6 and from 43.6 to 34.9 respectively during storage for 14 days at 5ºC. It has been found that the L* value of longan fruit pericarp also decreases over a storage period (Rattanapone *et al*., 2001; Shodchit *et al*., 2008; Apai, 2009 and 2010). According to **Table 3.1**, the fruits soaked in 7.5% SMB for 10 minutes had the highest L* values, when compared with both those which had undergone other treatments during the storage period, and the control. This means that the above treatment tended to inhibit the browning of pericarp more effectively than the other treatments. Overall, the L* value tended to increase for the E_1 - E_6 treatments at each checking point, when compared to the control. This could mean that the chemical concentrations used in the experiment affected changes in the L* value; thus, it can be concluded that the chemicals used in this research significantly inhibited the browning reaction of longan pericarp ($P \leq 0.05$).

Table 3.1 The L* values of pericarp of individual fruits during storage period.

Treatment	Days of storage at 5ºC[1]			
	7	14	21	28
E_0	42.3 ± 0.6d	40.6 ± 0.8e	40.7 ± 0.6f	40.4 ± 0.7cd
E_1	47.0 ± 1.1c	44.6 ± 0.6d	43.6 ± 1.0c	42.1 ± 0.9e
E_2	46.8 ± 0.7c	49.7 ± 1.0b	46.4 ± 0.6de	42.9 ± 0.5cd
E_3	46.2 ± 0.6c	47.4 ± 0.6c	45.3 ± 0.8e	44.3 ± 0.6c
E_4	50.7 ± 0.8b	51.7 ± 0.5a	47.8 ± 0.8cd	49.9 ± 1.0ab
E_5	51.7 ± 0.8bc	48.8 ± 0.6bc	50.7 ± 0.5b	49.1 ± 0.6b
E_6	54.4 ± 0.6a	52.5 ± 0.5a	52.8 ± 0.4a	51.2 ± 0.5a

[1]Means within a column with the same letter are not significantly different at 95% (P≤0.05) level by least significant difference comparison. Data are mean value ± SE. The average L* value of fruit pericarp at initial date was 47.8 ± 2.1.

Changes in the a* values (redness) for the pericarp of individual 'Long' longan fruits treated with various concentrations of SMB solutions, as compared to the control, are shown in **Table 3.2**. It can be seen that there were significantly different a* values for the treated fruits and control fruit after 21 and 28 days in storage at 5ºC ($P \leq 0.05$), and after 28 days in storage the a* values ranged between 7.2 and 11.1. The study of Shodchit *et al*. (2008) found that a* values tend to increase over storage time, ranging between 5.1 and 6.59 by day 6 in storage at 15ºC. In T**able 3.2**, the a* value of for E_6 treatment is lowest at 28 days in storage (7.2), close to the a* value of 'Long' longan fruit at harvesting time (average a* = 7.5). It can thus be stated that the use of SMB solution in this study prevented pericarp browning of the longan fruit ($P \leq 0.05$).

Table 3.2 The a* values of pericarp of individual fruits during storage period.

Treatment	Days of storage at 5ºC[1]			
	7	14	21	28
E_0	10.0 ± 0.3ab	11.1 ± 0.5a	9.9 ± 0.3ab	11.1 ± 0.3a
E_1	10.6 ± 0.4a	10.6 ± 0.5a	10.7 ± 0.4a	10.3 ± 0.2ab
E_2	9.3 ± 0.3bc	9.1 ± 0.4bc	9.5 ± 0.3b	9.9 ± 0.3b
E_3	9.6 ± 0.3bc	10.3 ± 0.4ab	10.9 ± 0.3a	10.8 ± 0.3ab
E_4	8.7 ± 0.4c	8.7 ± 0.5c	9.2 ± 0.6b	8.7 ± 0.4c
E_5	10.1 ± 0.4ab	8.8 ± 0.3c	7.9 ± 0.4c	8.4 ± 0.4c
E_6	7.3 ± 0.3d	6.9 ± 0.4d	7.9 ± 0.4c	7.2 ± 0.4d

[1]Means within a column with the same letter are not significantly different at 95% ($P \leq 0.05$) level by least significant difference comparison. Data are mean value ± SE. The average a* value of fruit pericarp at initial date was 7.5 ± 1.1.

Changes in the b* values (yellowness) for the pericarp of individual 'Long' longan fruits treated with various SMB concentrations, when compared to the control, were recorded, and the results are shown in **Table 3.3**. After 28 days in storage, the b* values ranged from 19.2 to 31.5 higher than the values found in the research of Sodchit *et al*. (2008), who recorded b* values for longan fruit pericarp cv. Daw ranging between 8.87 and 14.89 after 6 days in storage at 15ºC. According to **Table 3.3**, the b* values for the E_0–E_3 treatments were not significantly different after 28 days in storage; whereas, the b* values for the E_4–E_6 treatments were similar and much higher than those of the E_0–E_3 treatments ($P \leq 0.05$). Overall, the b* value of all the fruits tended to decrease with increased storage time. Our results are consistent with the findings of previous research studies regarding the b* values of longan

pericarp (Sodchit *et al*., 2008; Apai, 2009 and 2010). The fruits soaked in 7.5% SMB for 10 minutes had a higher b* value than the fruits which had undergone other treatments during the same storage period. Boonin *et al*. (2006) found that longan fruit cv. Daw soaked in 5% oxalic acid prior to 7.5% sodium metabisulfite, plus a sodium metabisulfite and oxalic acid solution mix, are able to better maintain b* values when compared to the other treatments and the control.

Table 3.3 The b* values of pericarp of individual fruits during storage period.

Treatment	Days of storage at 5ºC[1]			
	7	14	21	28
E_0	21.3 ± 0.9d	19.1 ± 1.2e	20.9 ± 0.8d	19.9 ± 0.8b
E_1	25.2 ± 1.0c	23.4 ± 1.0d	25.5 ± 1.1bc	19.2 ± 0.6b
E_2	27.3 ± 0.6c	30.4 ± 1.1b	23.9 ± 0.9c	19.7 ± 0.8b
E_3	27.3 ± 1.1c	26.7 ± 1.0c	23.2 ± 1.3cd	20.8 ± 0.9b
E_4	30.6 ± 1.1b	32.1 ± 1.2ab	28.0 ± 1.5b	30.5 ± 1.3a
E_5	30.5 ± 0.7b	30.9 ± 0.8b	31.1 ± 0.5a	29.5 ± 1.2a
E_6	33.5 ± 0.5a	34.8 ± 0.7a	32.2 ± 0.5a	31.5 ± 0.8a

[1]Means within a column with the same letter are not significantly different at 95% ($P \leq 0.05$) level by least significant difference comparison. Data are mean value ± SE. The average b* value of fruit pericarp at initial date was 27.7 ± 1.4.

3.3.3. Changes in total soluble solids content of individual fruits during storage period

Changes in the total soluble solids (TSS) content of the individual fruits treated with various concentrations of SMB were assessed, and the results are shown

in **Table 3.4**. After 28 days in storage at 5ºC, the TSS content ranged from 18.5 to 20.4 %Brix, and there was no significant difference in the TSS content for the treated fruits and the control fruits ($P \leq 0.05$). It was also found that the TSS content was close to that found in fresh longan (17 and 21 %Brix), and these findings are similar to the findings of Tran (1999) and Nguyen *et al*. (2001). These TSS content are in accordance with data in the literature, in which the values shown range from 19.3 to 20.4 for Thai longan cv. Daw (Apai, 2009 and 2010). It can thus be assumed that the SMB concentrations used in this research had no effect on the TSS content of the 'Long' longan fruit.

Table 3.4 Changes in total solube solids content (%Brix) of individual fruits during storage period.

Treatment	Days of storage at 5ºC[1]			
	7	14	21	28
E_0	16.9 ± 0.6c	17.5 ± 0.4b	17.9 ± 0.3c	19.5 ± 1.8a
E_1	19.1 ± 0.2ab	19.4 ± 0.5ab	18.5 ± 0.8c	19.4 ± 0.6a
E_2	19.1 ± 0.6ab	19.8 ± 0.5a	20.3 ± 0.1a	20.4 ± 0.7a
E_3	17.7 ± 0.8bc	18.3 ± 0.3ab	19.2 ± 0.1b	19.6 ± 0.3a
E_4	19.8 ± 0.6a	18.5 ± 1.3ab	18.6 ± 0.2c	19.5 ± 0.3a
E_5	19.6 ± 0.4a	17.4 ± 0.5b	18.6 ± 0.3c	18.5 ± 0.5a
E_6	19.5 ± 0.3a	18.0 ± 0.2ab	19.8 ± 0.5a	19.2 ± 1.0a

[1]Means within a column with the same letter are not significantly different at 95% (P≤0.05) level by least significant difference comparison. Data are mean value ± SE. The average TSS content of fruit at initial date was 18.9 ± 1.4 %Brix.

3.3.4. Changes in sensory quality of individual fruits during storage period

The sensory quality of the individual 'Long' longan fruits expressed in terms of odor and flavor during the 28 days in storage at 5ºC was assessed, and the results are shown in **Figure 3.4**, **Appendix Table A3**, and **Figure 3.5**, **Appendix Table A4**. An odor or a flavor score above 1.5 is considered to be abnormal and means that fruit are unacceptable for marketing purposes; therefore, for this research, storage quality was determined in terms of marketing and consumer acceptance. It can be seen from **Figure 3.4** that the odor values of the longan fruits tested were normal, and were the same as all treatments when compared to the control fruit after 14 days in storage ($P \leq 0.05$). After 21 days in storage, the odor scores of the E_4–E_6 treatments were below 1.5; whereas those for the E_0–E_3 treatments were above 1.5, which is considered abnormal. While the odor scores of for the E_5 and E_6 treatments were similar and had maintained a normal odor up to day 28 in storage, the E_4 treatment did not maintain a normal odor. Unlike the odor value, the flavor of the control was abnormal and by day 14 in storage was significantly different to the fruits treated with various concentrations of SMB ($P \leq 0.05$). After 21 days in storage, there was no significant difference in flavor scores for the E_5 and E_6 treatments, and they had a normal flavor (flavor scale below 1.5). The flavor scores for the E_5 and E_6 treatments were significantly different, but they maintained a normal flavor up to 28 days in storage (**Figure 3.5**). Overall, those individual 'Long' longan fruits soaked in 7.5% SMB for 5 and 10 minutes maintained sensory quality for 28 days when stored at 5ºC. Our results are different to those reported by Nguyen *et al*. (2001), who found that 'Long' longan fruit can maintain sensory quality for 20 days in storage at 10ºC; though, it has been found that sensory quality expressed in terms of aroma and taste reduces with

storage time (Thavong, 2009), plus that the eating quality of all treated fruits decreases gradually with storage period (Whangchai *et al*., 2006).

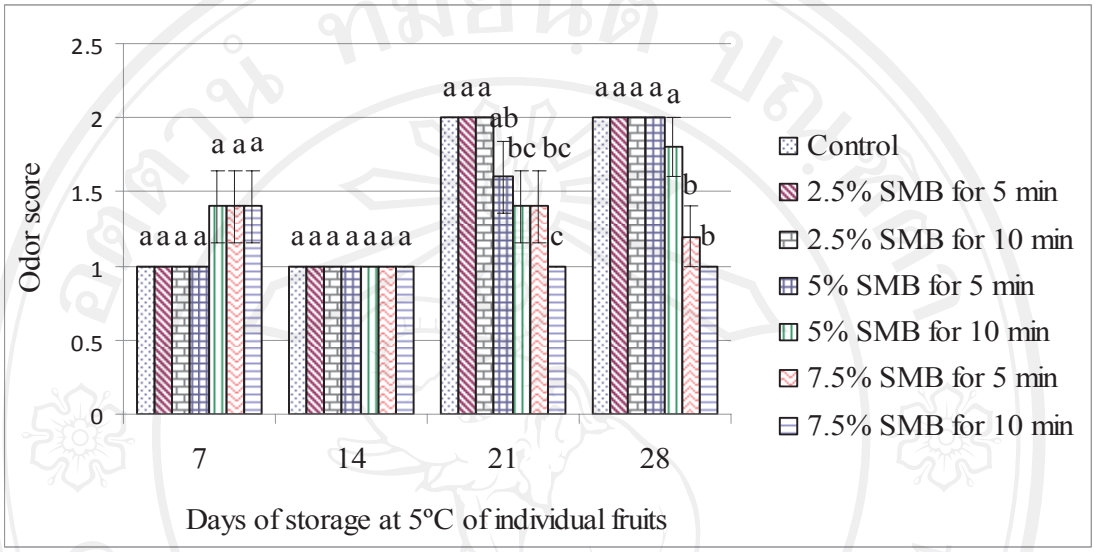


Figure 3.4 Changes in odor score of individual 'Long' longan fruits during storage period at 5ºC.

Fruits with odor score above 1.5 were considered as unacceptable. Vertical bars represent standard errors. Columns with different letters indicate significant differences by Duncan's multiple range test ($P \leq 0.05$).

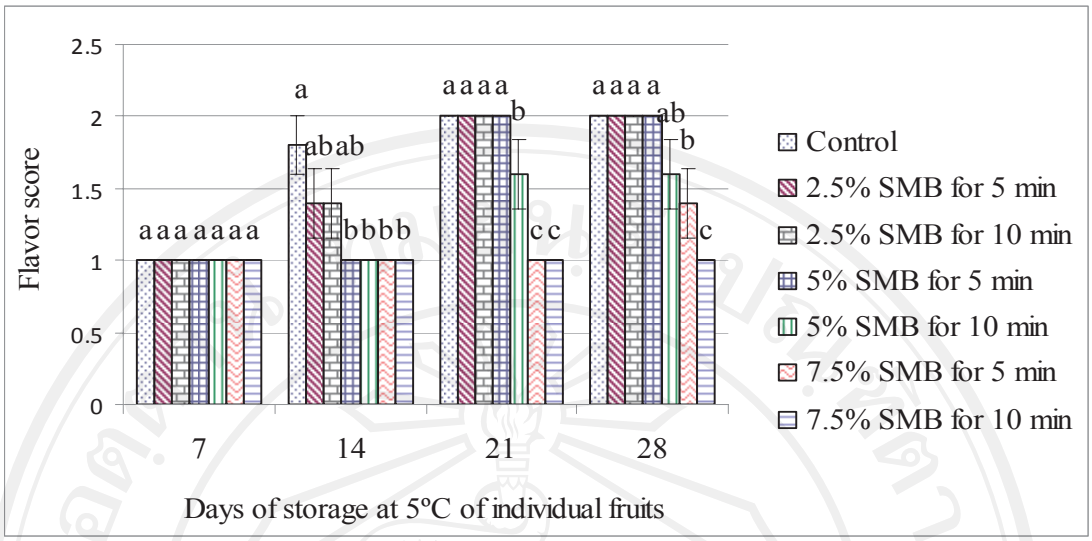


Figure 3.5 Changes in flavor score of individual longan fruits during storage period at 5ºC.

Fruits with flavor score above 1.5 were considered as unacceptable. Vertical bars represent standard errors. Columns with different letters indicate significant differences by Duncan's multiple range test ($P \leq 0.05$).

3.3.5. The percentage of fruit decay of individual fruits during storage period

Table 3.5 shows the effects of SMB on the percentage of fruit decay for individual longan fruits during storage period at 5ºC. The rate of fruit decay in the control was 7.5% after 14 days in storage; thereafter increasing with the time spent in storage (after 21 days it was 21.6% and after 28 days it was 100%). The control showed the highest rate of decay, in accordance with the highest browning index score (Apai, 2009), with the rate of decay by day 24 in storage at 5ºC being 57% (Thavong, 2009). Along with the control, the E_1 treatment had decayed significantly by day 21 in storage (9.1%), plus the rate of decay increased for the E_1 to E_5 treatments from 13.6 to 91.7% by day 28 in storage. Apai (2009) reported that disease increases with increased storage time. There was a significant difference in the rate of fruit decay for treated fruits and the control during storage period ($P \leq 0.05$). Apai

(2009) found that treating longan fruits with 1.2% chitosan in combination with 0.3% potassium sorbate controls fruit decay when stored at 10ºC for 15 days. According to **Table 3.5**, after 28 days in storage the E_6 treatment showed no fruit decay, which is significantly different to the results of Nguyen *et al*. (2001), who found that 'Long' longan fruit decay ranges about 10% after 20 days in storage. Our results also differ from other studies on the incidence of disease in longan fruit (Whangchai *et al*., 2006). As a result, it can be concluded that the SMB concentration, combined with the dipping time, significantly prevents fruit decay in longan fruit.

Table 3.5 The percentage of fruit decay of individual fruits during storage period.

Treatment	Days of storage at 5ºC[1]			
	7	14	21	28
E_0	0.0 ± 0.0	7.5 ± 0.5a	21.6 ± 0.7a	100.0 ± 0.0a
E_1	0.0 ± 0.0	0.0 ± 0.0b	9.1 ± 0.1b	91.7 ± 0.6b
E_2	0.0 ± 0.0	0.0 ± 0.0b	0.0 ± 0.0c	74.7± 1.1d
E_3	0.0 ± 0.0	0.0 ± 0.0b	0.0 ± 0.0c	78.3 ± 0.8c
E_4	0.0 ± 0.0	0.0 ± 0.0b	0.0 ± 0.0c	61.2 ± 0.6e
E_5	0.0 ± 0.0	0.0 ± 0.0b	0.0 ± 0.0c	13.6 ± 0.4f
E_6	0.0 ± 0.0	0.0 ± 0.0b	0.0 ± 0.0c	0.0 ± 0.0g

[1]Means within a column with the same letter are not significantly different at 95% (P≤0.05) level by least significant difference comparison. Data are mean value ± SE.

3.3.6. Storage life of individual fruits

Individual fruits under the control and E_1 treatments were not acceptable by day 7 in storage; the E_2 treatment was not acceptable after 14 days in storage, and the

fruits under the E_3-E_4 treatments were not acceptable after 21 days in storage. While fruits under the E_6 treatment showed the best results after 28 days in storage, the E_5 treatment was not acceptable after this time (**Table 3.6**).

Table 3.6 The storage life of individual longan fruits at 5ºC.

Treatment	Storage life (days)	Cause of limitation in storage life
E_0	Less than 7	BI above 2.0, flavor score above 1.5
E_1	Less than 7	BI above 2.0
E_2	7	BI above 2.0
E_3	14	BI above 2.0, odor and flavor scores above 1.5
E_4	14	BI above 2.0, flavor scores above 1.5
E_5	21	Fruit decay was 13.6%
E_6	28	Maintained acceptable visual appearance and sensory quality, and no fruit decay.

BI: Browning index

3.4. Conclusion

Soaking individual 'Long' longan fruits in 7.5% SMB solution for 10 minutes and storing them at 5ºC obtained the highest L*and b* values, and the fruit showed no signs of severe pericarp browning during the first 28 days in storage when compared with fruits given other treatments and the control. In addition, there was no fruit decay evident. The visual appearance and sensory quality of the fruits were acceptable. Moreover, the quality of the flesh expressed as the total soluble solids content was not different when compared to fresh longan fruit.

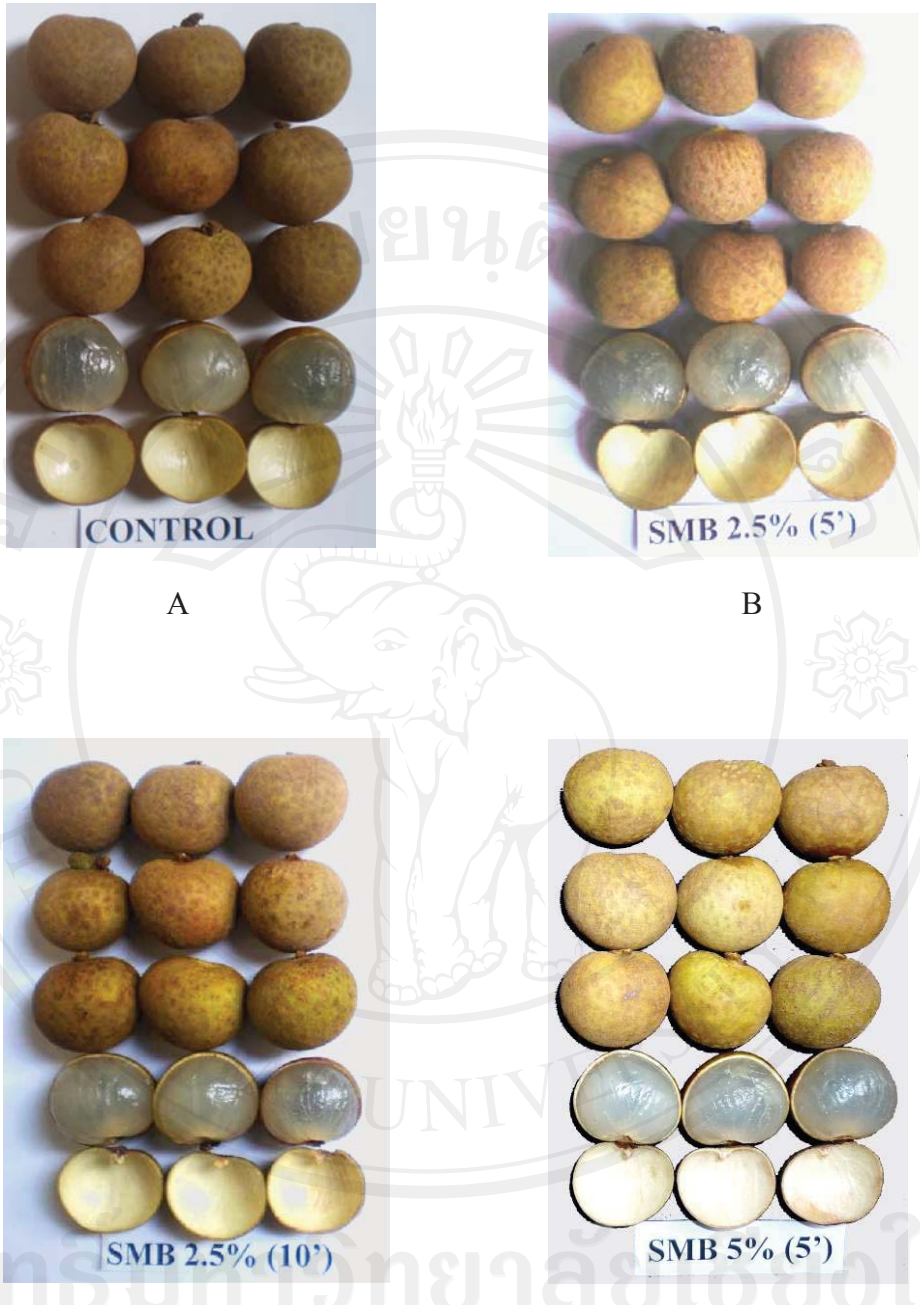


Figure 3.6 The storage life of individual longan fruits during storage period at 5ºC.

A: Control fruit by day 7 in storage

B: 2.5% SMB for 5 minutes by day 7 in storage

C: 2.5% SMB for 10 minutes by day 7 in storage

D: 5% SMB for 5 minutes by day 14 in storage

E

F

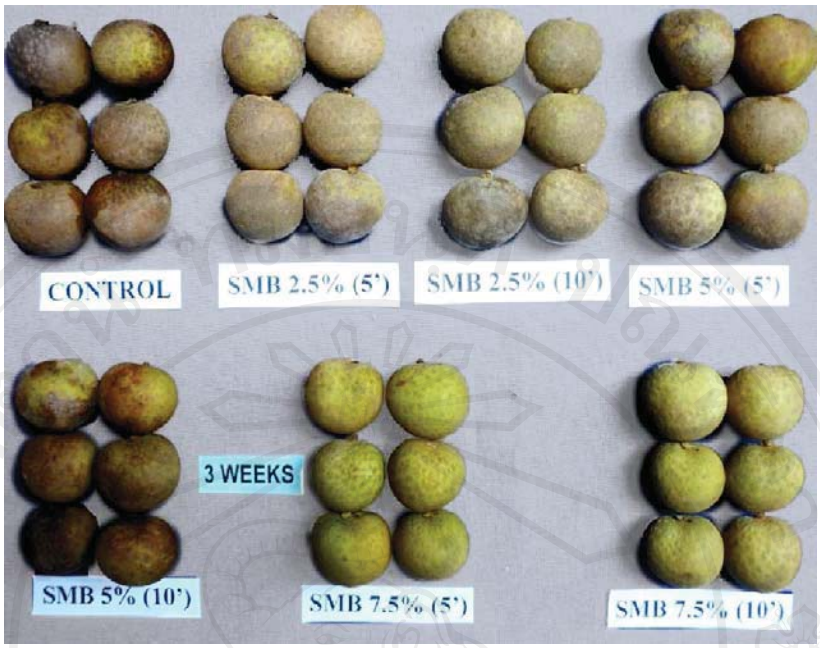
G

Figure 3.6 The storage life of individual longan fruits during storage period at 5ºC (Continued).

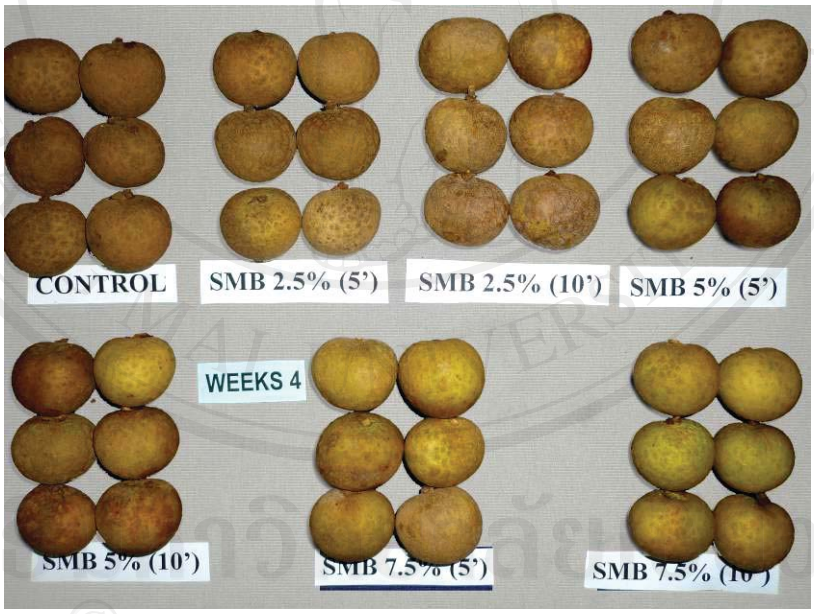
E: 5% SMB for 10 minutes by day 14 in storage

F: 7.5% SMB for 5 minutes by day 21 in storage

G: 7.5% SMB for 10 minutes by day 28 in storage



A



B

Figure 3.7 Individual longan fruits cv. Long after 21(A) and 28 (B) days in storage.