CHAPTER 6

THE EFFICACY OF SO_2 TREATMENT IN COMBINATION WITH STORAGE CONDITIONS ON ULTRASTRUCTURE, POSTHARVEST QUALITY AND POLYPHENOLIC COMPOUNDS CHANGE DURING STORAGE

6.1 Abstract

The experiment was aimed to evaluat the freshly harvested longan fruits (*Dimocarpus longan* Lour.) were stored in no SO_2 and SO_2 treatment various under storage temperatures, either 2±2, or 7±2 degree Celsius for 8 weeks. Physical and chemical properties were recorded initially and two weeks interval during storage. The post-harvest quality was depended on cultivars and the post-harvest management. The SO_2 treatment in combination with cold storage temperature could maintain the good peel and aril color that correlated to inhibited polyphenol oxidase (PPO) enzymatic activity. Unfortunately, the excessive of SO_2 treatment reduced fruit quality, especially under high storage temperature (7±2 degree C). It lost membrane integrity, increased the membrane electrolyte leakage. The membrane damage allowed PPO to be activated that revealed the coloration or browning. In addition, these condition significantly reduced the content of ellagic acid content in both peel and aril tissues. However, gallic acid could not be found in this experiment that may be related to a severe cellular disruption in these fruit, which was produced by released of the PPO linked to cell wall, which led to decrease of ellagic acid and gallic acid content. Moreover, the sulphite residues could be detected immediately after SO_2

treatment in all part of longan fruit, especially on peel tissue, but the residues was significantly decreased along the storage durations. The data obtained from this study suggested that the optimum of SO_2 concentration and cold storage temperature could prolong the post-harvest quality and extend shelf life of longan fruits.

Microscopic anatomy was of SO_2 treated longan pericarp cv. Daw and Biew Kiew were assessed using a stereomicroscope, light microscope (LM), scanning electron microscope (SEM) and transmission electron microscope (TEM). The pericarp of both cultivars had similar ultrastructure and consisted of three layer including exocarp, mesocarp and endocarp. Microscopic anatomy of SO_2 treated longan fruits during storage 8 weeks damaged pericarp showed flaking of cuticle, damaged trichromes on the surface and parenchyma cell walls in mesocarp.

6.2 Introduction

Longan (*Dimocarpus longan* Lour.) is a member of the Sapindaceae family. This family including several fruits were litchi (*Litchi chinensis* L.), rambutan (*Nephelium lappaceum* L.), and horse chestnut (*Aesculus hippocastanum* L.). Longan is subtropical fruit, which is widely grown in China, and South East Asia including; Vietnam, Philippines, and especially Thailand. Longan is a most extensive production and one of the most economically important fruits that has been exported fresh longan to China, Hong Kong, Malaysia, Singapore, Indonesia and Canada (Tongdee, 1997). The cultivated areas are in the Northern region of Thailand which located at Chiang Mai and Lum phun provinces. In the year 2008, dried and especially fresh fruit of longan were mostly marketed locally, and export of the fruit had been increasing rapidly, the exported of fresh longan is about 168,286 tons and frozen longan at 346

tons (Lin *el al*., 2001b). In Thailand, the matured fruit can be harvested from July to September. The fruit peel is brown or light – brown with white translucent fresh. The seed is round and dark – brown or black with a circular white spot at the base. The fresh fruit is sweet and juicy; therefore, it can be consumed in either fresh fruit or processed products such as canned in syrup or as especially dried fruit. However, more than 65% of longan fruits were eaten fresh. Post-harvest of longan fruit were highly perishable losses without appropriate storage managements, and deterioration is mainly characterized by fruit browning, fungal rot, fruit drop, loss of hardness, moisture or weight loss, alterations in flavor, and reduction of antioxidant activity, especially on loss of phenolic compounds (Lydakis and Aked, 2003). Presently, the most common commercial method to manage deterioration of longan fruit is by the SO_2 generators or fumigation with SO_2 during cold storage. Meanwhile, storage in the high SO_2 has recently been suggested as an innovation of controlled atmosphere fro fruits post-harvest management, to maintain fruit quality, and extend shelf life (Allende *et al*., 2004). Gross (1996) suggested that SO_2 treatment as an effective means for inhibiting both aerobic and anaerobic microbial growth, enzymatic browning activity, discoloration, and prolong fruit shelf life. Nevertheless, in the recent year, there has been increasing concern about sulfite residue in fruit. The excessive of SO_2 fumigated resulted in the injury of rachis and especially in fruits. The seriously effects of SO_2 was caused corrosion of metals, and can be dangerous to consumer allergic to sulfite residues (Gabler *et al*., 2005). Additionally, in Chinese medicine, the fresh of longan was used as stomachic, febrifuge, vermifuge, and also as an antidote for poison (Mortin, 1987). The longan fruit contained some bioactive compounds, especially on antioxidative compounds as phenolic compounds. In

longan aril and seed have previously been shown to contain gallic acid and ellagic acid as major phenolic compounds (Nuchanart *et al*., 2005). However, they are easy or sensitive to loss during post-harvest management. For this reasons, it is important to study the post-harvest management as the efficacy of SO_2 treatment, storage temperatures, and storage duration to prolong longan fruit quality, and especially on phenolic compounds, gallic acid, and ellagic acid content as the aim of this study.

6.3 Results and Discussions

As shown in Table 6.1, longan fruits cv. DAW had a higher weight loss percentage than cv. Biew Kiew. There was no significant difference (P>0.05) in the weight loss percentage between storage temperatures. On the other hand, the SO_2 treatment could inhibit the increasing of weight loss percentage. Additionally, SO_2 teratment decreased the weight loss percentage significantly in both varieties of longan fruit (Figure 6.1). The activity of PPO of longan fruits cv. Biew Kiew was higher than cv. DAW. after SO_2 treatment or stored longan fruit under cool condition (2 degree C), and the activity of PPO was sharply decreased. As shown in Figrue 5.2, they were positive correlation between SO_2 treatment and storage duration on the increasing of PPO activity. The activity increased sharply in no SO_2 treatment, but after SO_2 treatment, the activity of PPO dramatically decreased. For pH value, there were different in the pH value between varieties and part of fruit tissues. In peel tissue, DAW variety had a higher pH value than Biew Kiew variety. However, it was opposited in the aril tissue. Moreover, the high storage temperature increased the pH value significantly, especially in the aril tissue. On the other hand, the SO_2 treatment decreased pH value in both peel and aril tissue (Table 6.1). Interestingly, the storage

period was the main factor affected on the declining of longan fruit quality. PPO activity increased significantly after long term of storage. The long term of storage did not increase significantly only PPO activity but also weight loss of longan fruit and pH value of peel and aril tissue (Table 6.1).

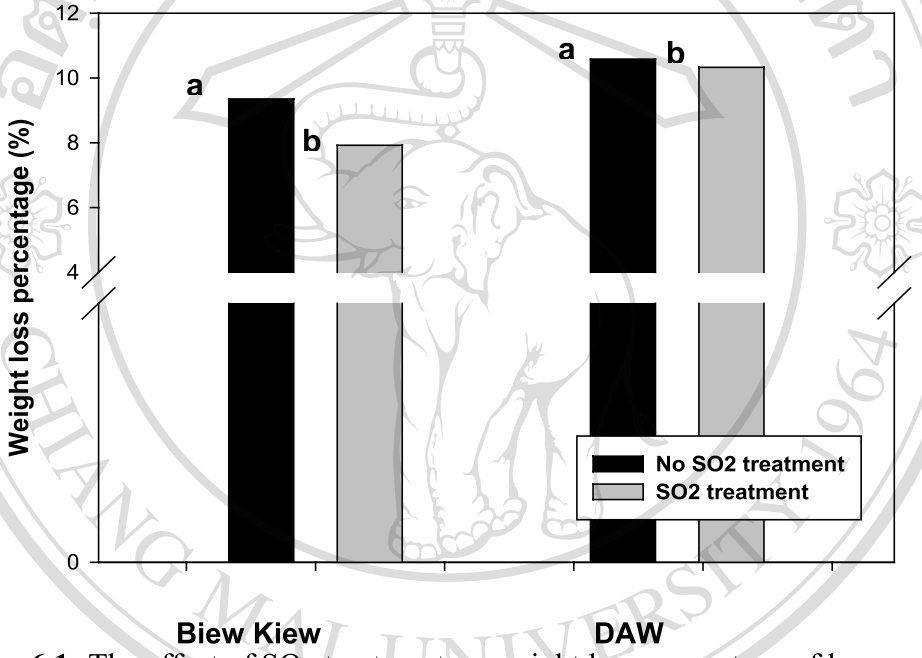

Figure 6.1: The effect of SO_2 treatment on weight loss percentage of longan fruits cv. "Biew Kiew" and "DAW"

***:** The different letters indicate the statistically significant difference by LSD at 5% level.

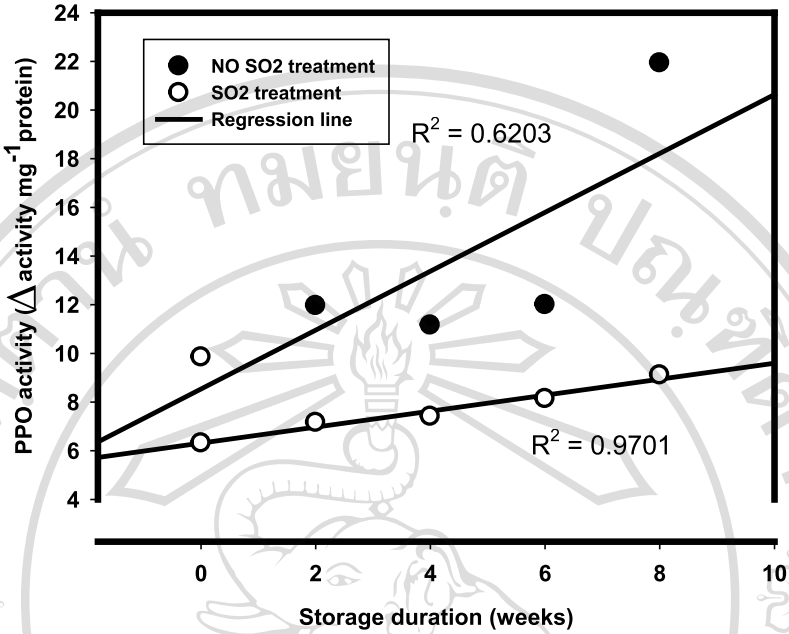

Figure 6.2: The effect of SO_2 treatment on polyphenol enzymatic activity changed during long term of storage

Table 6.1: The effects of SO_2 treatment, storage temperatures, and storage duration on longan fruits cv. "Biew Kiew" and "DAW" qualities

Treatment	Weight loss (%)	PPO (Δactivity mg-1protein)	pH	
			Peel	Aril
Fumigation treatment				
No SO_2 treatment	9.96a	11.93a	5.24a	6.80a
SO_2 treatment	9.10b	9.10b	4.31b	6.74b
Varieties				
"Biew Kiew"	8.63b	12.34a	4.72b	6.82a
"DAW"	10.46a	8.87b	4.83a	6.72b
Storage temperatures (degree C)				
2±2	9.77a	8.74b	4.78a	6.72b
7±2	9.31a	12.27a	4.77a	6.82a
Storage duration (weeks)				
0	0.25e	6.87c	4.73b	6.47d
2	7.91d	7.65c	4.77b	6.77c
4	10.15c	10.50b	4.75b	6.79c
6	13.41b	10.56b	4.72b	6.87b
8	16.00a	16.94a	4.92a	6.93a

*: The different letters indicate the statistically significant difference by LSD at 5% level.

According to Table 6.2, the color in both sites inner and outer part of peel tissues, of no SO_2 treatments were more scarlet than orange-red (hue angle; H^*, decreased), became darkened (L^* decreased), and less intensely red (chroma; C^*, decreased) in comparison to the SO_2 treatments. For SO_2 treatments, inner and outer peel color was more green (a^* decreased) and yellowish (b^* increased). The storage temperature was a main factor that affected the change of peel color. Under high storage temperature (7 degree Celsius), the outer peel color was less intensely color (C^*, decreased), more purple-red (H^*, decreased), became darkened (L^* decreased), and showed blue-yellowish (b^* decreased). Moreover, the storage temperatures affected on the changing of inner peel color, which appeared less intensely color (C^*, decreased), became darkened (L^* decreased), and showed blue-yellowish (b^* decreased), and became orange – red color (H^* increased). The clearly changes of peel color were observed as affected by long-term of storage durations. The peel color in both inner and outer became dark brown – scarlet dark browning color rapidly when the storage duration increased (all of C^*, H^*, L^*, a^*, and b^* values were increased). The color appearance of two varieties of longan fruits cv. “Biew Kiew” and “DAW” were significantly different, while cv. “DAW” showed more brightness, intensely orange – red, and clearly yellowish (high of C^*, H^*, L^*, a^*, and b^* values) than cv. “Biew Kiew”. The SO_2 treatments resulted more yellow, and bright appearances (significantly increased in H^*, and b^* value) better than no SO_2 treatments. The storage duration also the main factor affected aril color change. The aril color was changed to yellow and cloudy fruit, which was similar with aril color under cool storage temperature (2 ± 2 degree C) (L^*, a^* and b^*, C^*, and H^* increased), while the

aril color became more red – dark cloudy yellowish color under high storage temperature (7 ± 2 degree C).

The measurement of tissue or membrane electrolyte leakage has been used as an indicator of tissue membrane integrity and is closely related to the quality and shelf life of fruits and other agricultural products. As shown in Figure 6.3, membrane permeability of longan fruits cv. “DAW” higher than cv. “Biew Kiew”. Moreover, the membrane permeability of all longan fruits increased gradually in SO_2 treatment. During long – term of storage, the leakage rate of longan fruits sharply increased, especially under high storage temperature (7 ± 2 degree C), while longan cv. “DAW” stored at 7 ± 2 degree C was highest of electrolyte leakage. The lowest of leakage was observed in longan cv. “Biew Kiew” stored at 2 ± 2 degree C. Interestingly; these results indicated that the cool storage temperature delays the increase of membrane permeability and could maintain membrane integrity. Moreover, SO_2 treatment increased membrane leakage significantly. The high membrane integrity was accelerated the separation of polyphenol substrates which were localized in the vacuole, from the PPO which was localized in the cytoplasm and various organelles. The contact of polyphenol substrates and PPO enzyme showed the dark or browning color. The SO_2 treatment may significantly affect on tissue electrolyte leakage and browning color until it reaches a critical concentration that depends on both fruit species or varieties and storage environments (Deng *et al*., 2005). Browning is associated with loss of membrane integrity that can occur during tissue deterioration and senescence (Toivonen, 2008). In SO_2 treatment induced the membrane or tissue deterioration, at the prior or starting of storage longan fruits browning was not

detected, and only slight browning occurred after shelf life. However, the longan fruits showed moderate – severe browning after long – term of storage (Table 6.2), consistent with high electrolyte leakage rates (Figure 6.3 and 6.4) and high water losses or weight loss (Table 6.1 and Figure 6.1). Duan (2004) reported that SO_2 treatment controlled the concentration of O_2 level, which high level of O_2 might cause substrate inhibition of PPO or alternatively, high levels of colorless quinines subsequently formed might cause feedback product inhibition of PPO. However, the mechanism of this inhibition is still not well understood and is deserved of further investigation.

Table 6.2: The effects of SO_2 treatment, storage temperatures, storage duration on color changed of aril, inner of peel, and outer of peel tissue of longan fruits cv. "Biew Kiew" and "DAW"

	Color parameters														
	C*			H*			L*			a*			b*		
		Peel			Peel			Peel			Peel			Peel	
Treatment	Aril	Inner	Outter	Aril	Inner	Outter	Aril	Inner	Outter	Aril	Inner	Outter	Aril	Inner	Outter
Fumigation treatment															
No SO_2 treatment	6.32a	22.25a	27.87b	64.90b	79.30b	64.43b	39.34a	65.84b	50.55b	2.36a	4.23a	12.02a	5.69b	21.72a	25.04b
SO_2 treatment	6.39a	22.47a	35.32a	66.67a	85.68a	70.10a	39.77a	77.85a	57.22a	2.34a	1.69b	11.86a	5.82a	22.31a	33.20a
Varieties															
"Biew Kiew"	5.40b	22.84a	32.68a	64.73b	85.33a	66.40b	38.38b	75.15a	49.60b	1.90b	1.98b	12.83a	4.85b	22.70a	29.91a
"DAW"	7.33a	21.88b	30.50b	66.83a	79.63b	68.13a	40.73a	68.55b	58.16a	2.80a	3.94a	11.04b	6.66a	21.35b	28.33b
Storage temperatures (degree C)															
2±2	6.56a	22.55a	34.02a	65.82a	82.06b	68.23a	39.84a	72.95a	53.90a	2.43a	3.13a	12.51a	5.93a	22.18a	31.50a
7±2	6.17b	22.18a	29.17b	65.74a	82.91a	66.26b	39.30b	70.75b	53.86a	2.30b	2.80b	11.40b	5.58b	21.85a	26.74b
Storeage duration (weeks)															
0	5.09d	20.85b	30.43c	58.88d	77.77d	68.82a	36.74d	66.98d	52.27c	1.89c	1.13c	10.85d	4.44e	20.52b	28.10c
2	5.61c	22.09ab	31.10b	59.80d	81.66c	68.24ab	38.13c	69.86c	52.60c	2.06b	2.59b	11.67c	5.08d	22.02a	28.37bc
4	6.79b	22.68a	31.51b	65.54c	82.72b	67.60b	39.05b	72.88b	53.43b	2.13b	2.88b	11.97bc	5.76c	22.37a	28.94b
6	6.83b	22.98a	32.35a	70.05b	83.22b	66.43c	39.14b	72.98b	53.57b	2.20b	2.96b	12.13b	6.40b	22.45a	29.93a
8	7.50a	23.21a	32.59a	74.64a	87.02a	65.20d	44.73a	76.54a	57.60a	3.50a	5.24a	13007a	7.10a	22.71a	30.28a

*: The different letters indicate the statistically significant difference by LSD at 5% level.

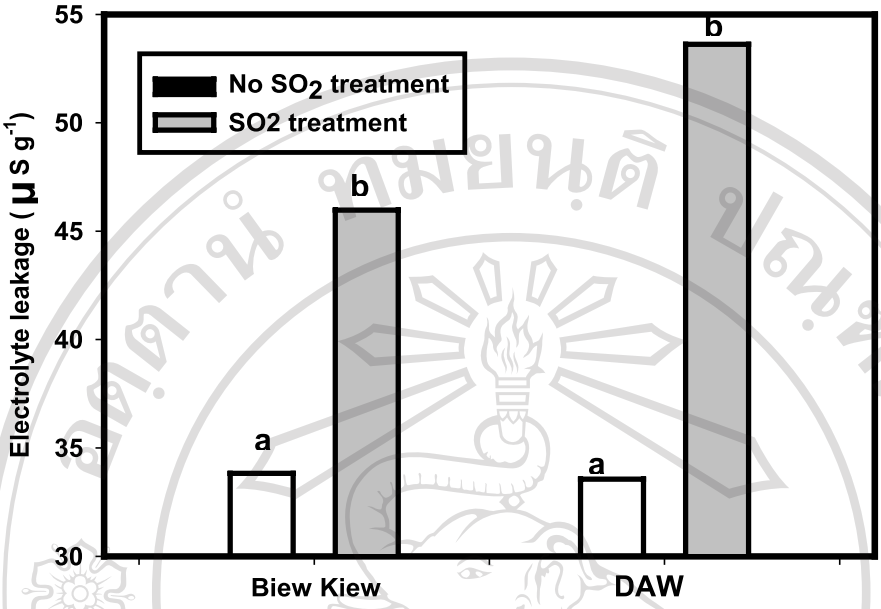

Figure 6.3: The effect of SO_2 treatment on electrolyte leakage of longan fruits cv. "Biew Kiew" and "DAW"

***:** The different letters indicate the statistically significant difference by LSD at 5% level.

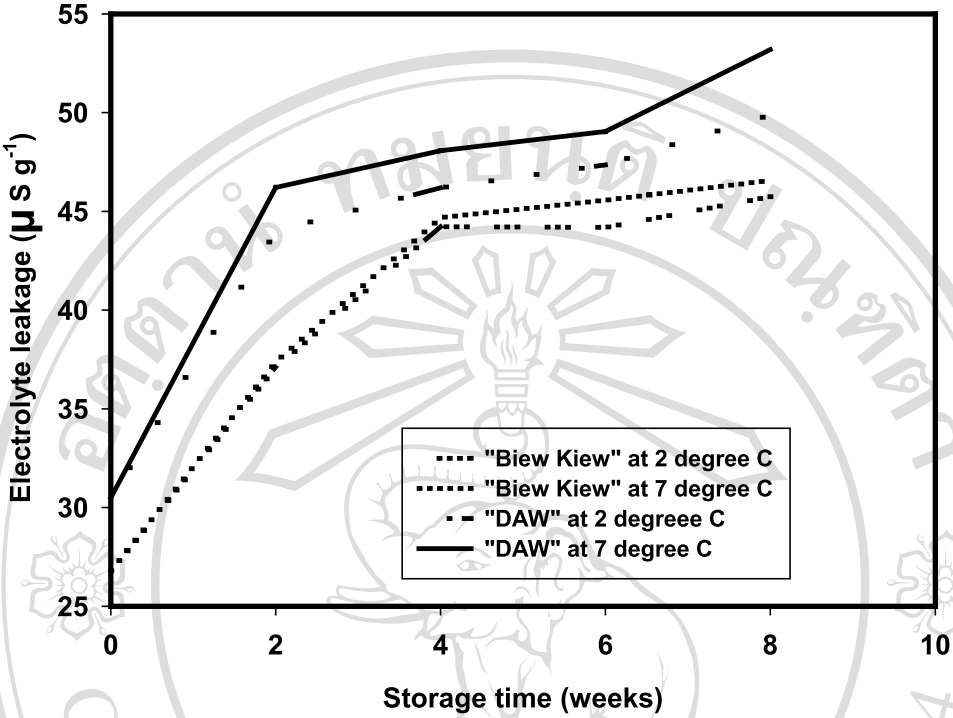

Figure 6.4: The effect of storage temperatures on electrolyte leakage of longan fruits cv. "Biew Kiew" and "DAW"

The percentage recoveries for gallic acid, and ellagic acid were 99.97%, and 99.67%, respectively. The combination of extraction and HPLC assays was consistent for the separation of these two phenolic compounds from the different tissues of longan fruits as showing the example of HPLC Chromatograms of different standard of gallic acid and ellagic acid at various concentrations. The calibration curves were linear with R^2 were 0.9995 and 0.9940 for gallic acid and ellagic acid, respectively. The detection limit of gallic acid and ellagic acid was 0.01 mg mL^{-1} which showed RT = 7.881 and 15.628 min, respectively (Figure 6.5). There was a large variation in the content of the two phenolic compounds amount the varieties and treatments. The experiment found only ellagic acid content in the peel and aril tissue, while gallic acid

was not be detected in both tissues (Table 6.3). According to Table 6.3, the content of ellagic acid was higher in “Biew Kiew” variety, especially in peel, while aril tissue was no significant different. The postharvest management and storage environments were major factor affecting ellagic acid content in longan fruits. Ellagic acid content in aril tissue was significantly decreased after SO_2 treatment, while the content was not different in peel tissues. However, the ellagic content in both peel and aril tissues had a reverse correlation along the storage duration. The ellagic acid content was highest in fresh tissues, while the content was decreased significantly during long – term of storage (Figure 6.6A and 6.6B). Moreover, the cool storage condition (2 ± 2 degree C) could maintain the high content of ellagic acid in both peel and aril tissue, while the content of ellagic acid decreased significantly under high storage temperature, especially in aril tissue. Ellgic acid was not detected when stored under high storage temperature (Table 6.3). During storage, the content of ellagic acid in peel tissue decreased significantly, and was not detected after stored for 6 weeks. The reduction of ellagic acid content was observed especially under high storage temperature (Figure 6.7A). In aril tissue, the ellagic acid content completely declined when stored longan fruits under high storage temperature (7 ± 2 degree C) at the prior of storage, while the ellagic acid content completely declined after stored for 2 weeks under cool storage temperature (2 ± 2 degree C) (Figure 6.7B). This situation also found in the combination of SO_2 treatment and storage temperatures. The ellagic acid content significantly decreased as affected by SO_2 treatment and high storage temperature in both peel (Figure 6.8A) and aril tissue (Figure 6.58B). Phenolic compounds were reported as strong antioxidants that play an important role in the quality of many fruits (Montealegre *et al*., 2006). In this study, the application of SO_2

treatment and postharvest management resulted in decreased content of ellagic acid, and gallic acid, possibly because of thermal or high storage temperature degradation or oxidation of phenolic compounds to some extent (Moreno *et al*., 2006). High temperature and long – term of storage easily causes of membrane integrity and oxidation degradation. No gallic acid was detected in either peel or aril tissues. The results was in agreement with the report of Chu *et al*. (2001) and Nuchanart *et al*. (2005), who did not detect gallic acid in longan pericarp and aril tissue. However, the content of ellagic acid was significant, which were the derivatives of gallic acid. Under stress conditions, browning is associated with loss of membrane integrity, inducing of oxidation degradation responding to tissue deterioration and senescence, the stress-resistant cultivars can retain the high fruit quality, preserving in PPO activity, declining of membrane integrity and could maintained the high content of phenolic compounds in the fruit tissues. Moreover, the decreasing of phenolic compounds may be due to an enzymatic browning (PPO) reaction when plant cell was broken under various storage environments or SO_2 treatment (all part of fruit turned brown). The greater losses of phenolic compounds observed, were also found to be related to a severe cellular disruption in these fruit, which was produced by a release of the PPO linked to cell wall (Ancos *et al*., 2000). The high storage temperature and SO_2 treatment might have damaged plant cell walls, which led to decrease of ellagic acid content or declined the gallic acid compound. On other reasons may be due to the distribution of ellagic acid from inner part of the fruit, which ellagic acid may bind with some polysaccharides (e.g. pentose etc.) or proteins in longan aril tissue to form insoluble derivatives that are then lost by precipitation or cannot be detected at the wavelength (270 nm) used in this method (Wolfe and Liu, 2003).

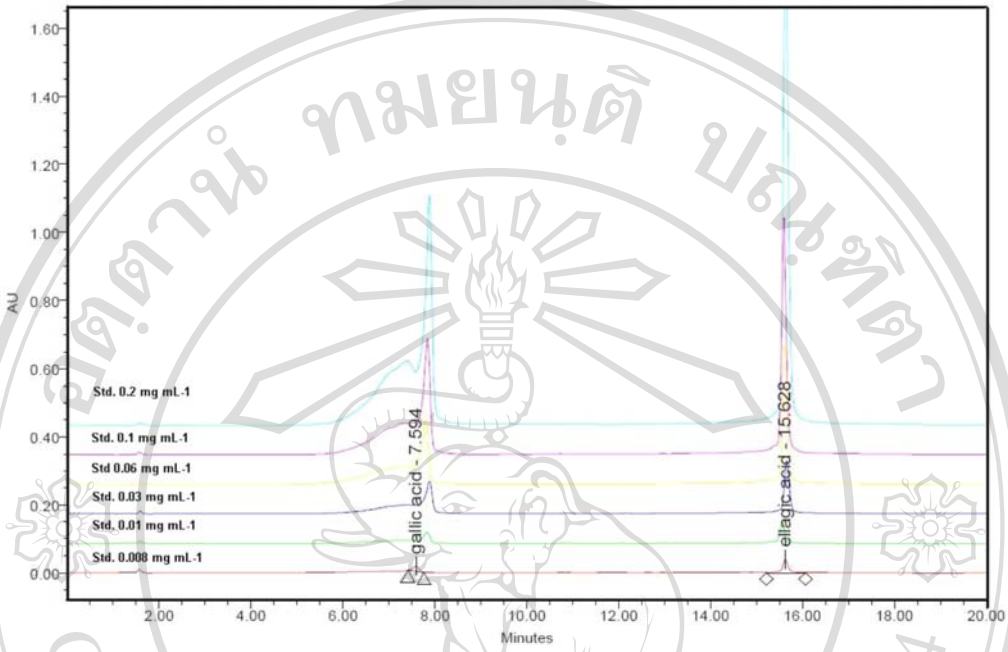

Figure 6.5: The HPLC chromatograms of standard gallic acid and ellagic acid at various concentrations. Retention time *(t_R)* of gallic acid = 7.594 min., and ellagic acid = 15.628 min.

—: standard concentration at 0.008 mg mL^{-1}, — : standard concentration at 0.01 mg mL^{-1},

—: standard concentration at 0.03 mg mL^{-1}, — : standard concentration at 0.06 mg mL^{-1},

—: standard concentration at 0.1 mg mL^{-1}, and — : standard concentration at 0.2 mg mL^{-1}

Table 6.3: The effects of SO_2 treatment, storage temperatures and storage durations of phenolic compounds; ellagic acid and gallic acid content in longan fruits cv. "Biew Kiew" and "DAW"

Treatment	Ellagic content (mg mL^{-1})		Gallic acid	
	Peel	Aril	Peel	Aril
Fumigation treatment				
No SO_2 treatment	**2.00a**	**0.040a**	**0**	**0**
SO_2 treatment	**1.95a**	**0.015b**	**0**	**0**
Varieties				
"Biew Kiew"	**2.93a**	**0.030a**	**0**	**0**
"DAW"	**1.02b**	**0.025a**	**0**	**0**
Storage temperatures (degree C)				
2±2	**2.32a**	**0.055a**	**0**	**0**
7±2	**1.63b**	**0b**	**0**	**0**
Storeage duration (weeks)				
0	**5.93a**	**0.138a**	**0**	**0**
2	**2.15b**	**0b**	**0**	**0**
4	**0.86c**	**0b**	**0**	**0**
6	**0.64cd**	**0b**	**0**	**0**
8	**0.30d**	**0b**	**0**	**0**

***:** The different letters indicate the statistically significant difference by LSD at 5% level.

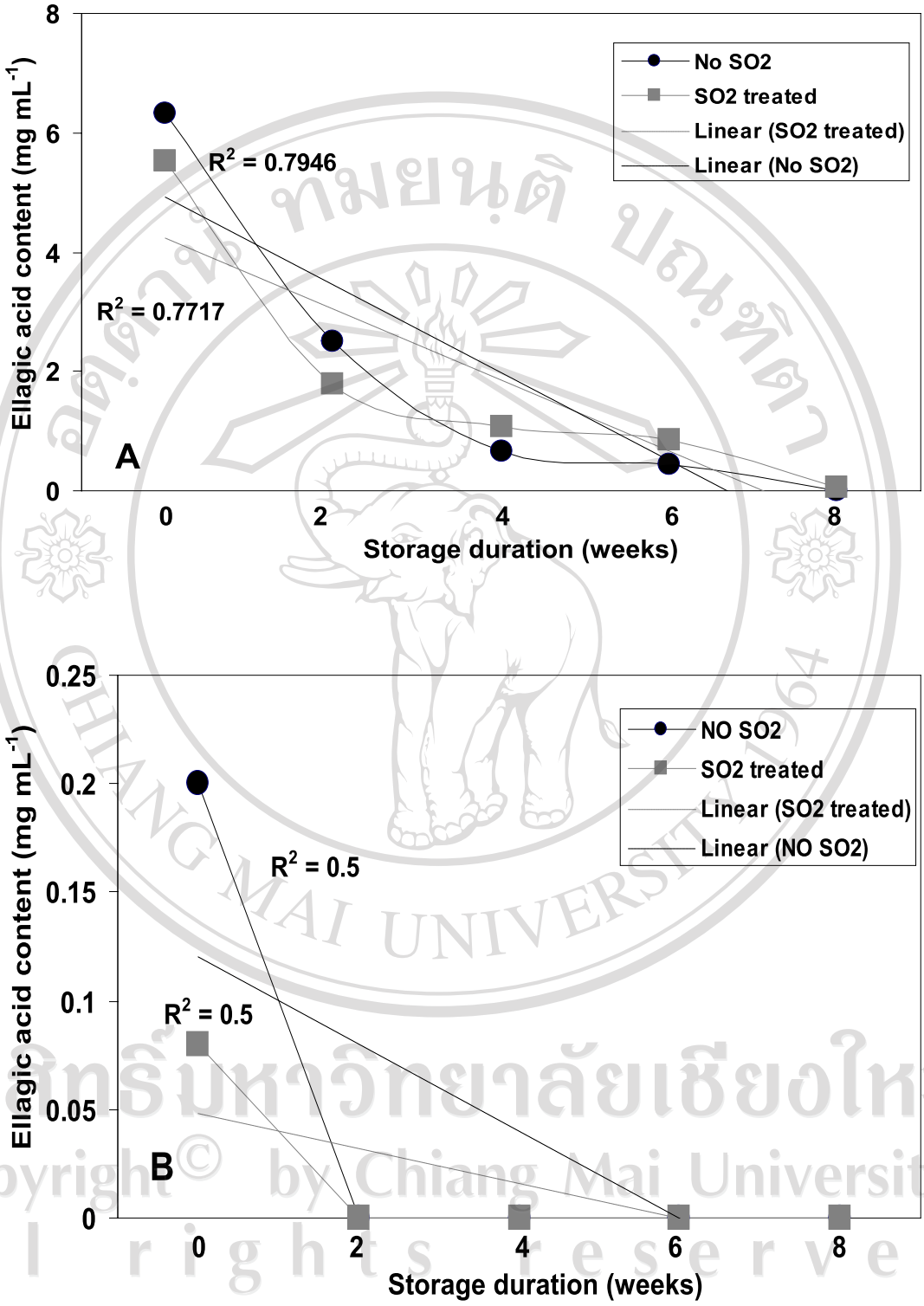

Figure 6.6: The effect of SO_2 treatment and duration of storage on ellagic acid content in peel (A) and aril (B) part of longan fruits

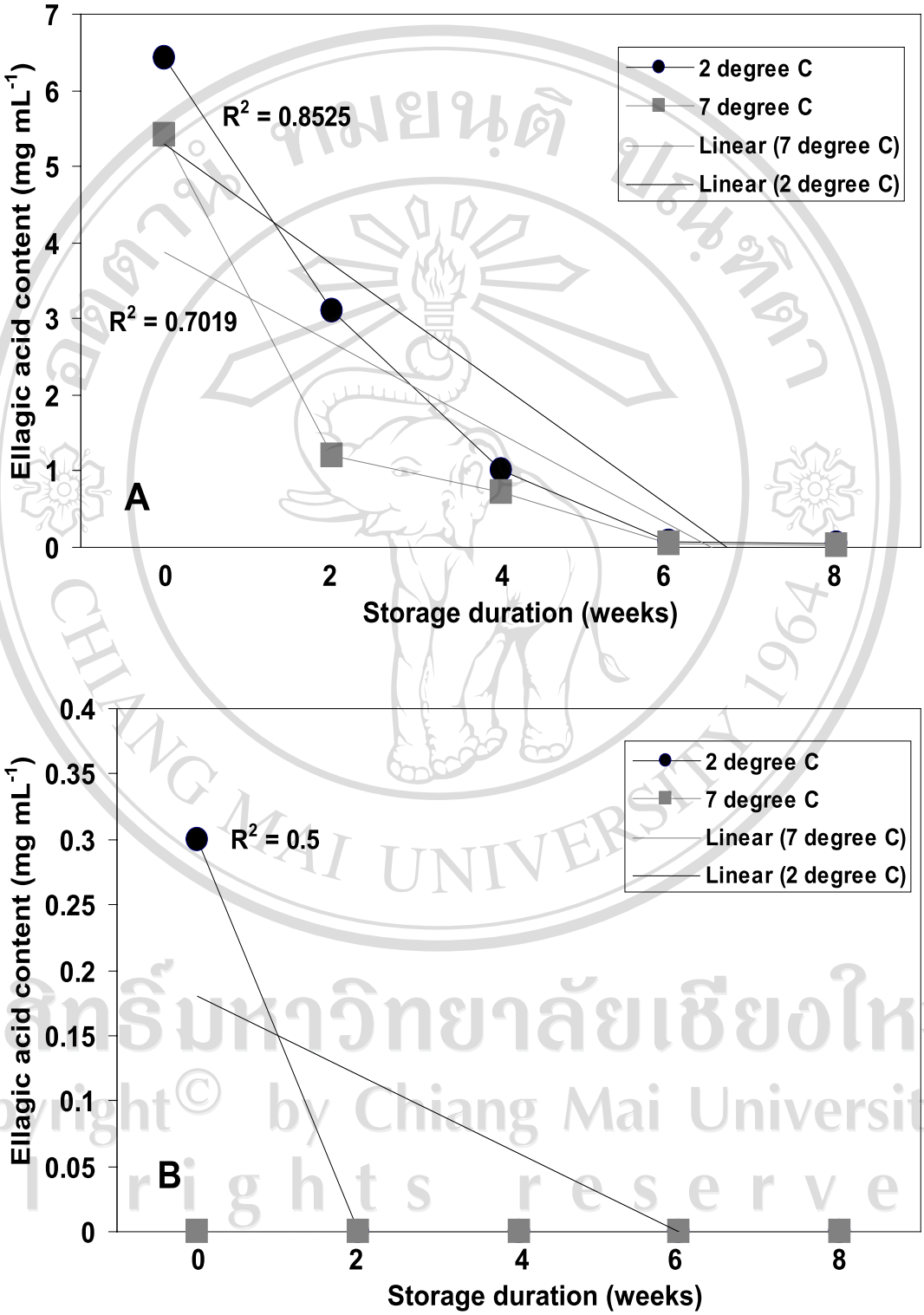

Figure 6.7: The effect of storage temperatures and duration of storage on ellagic acid content in peel (A) and aril (B) part of longan fruits

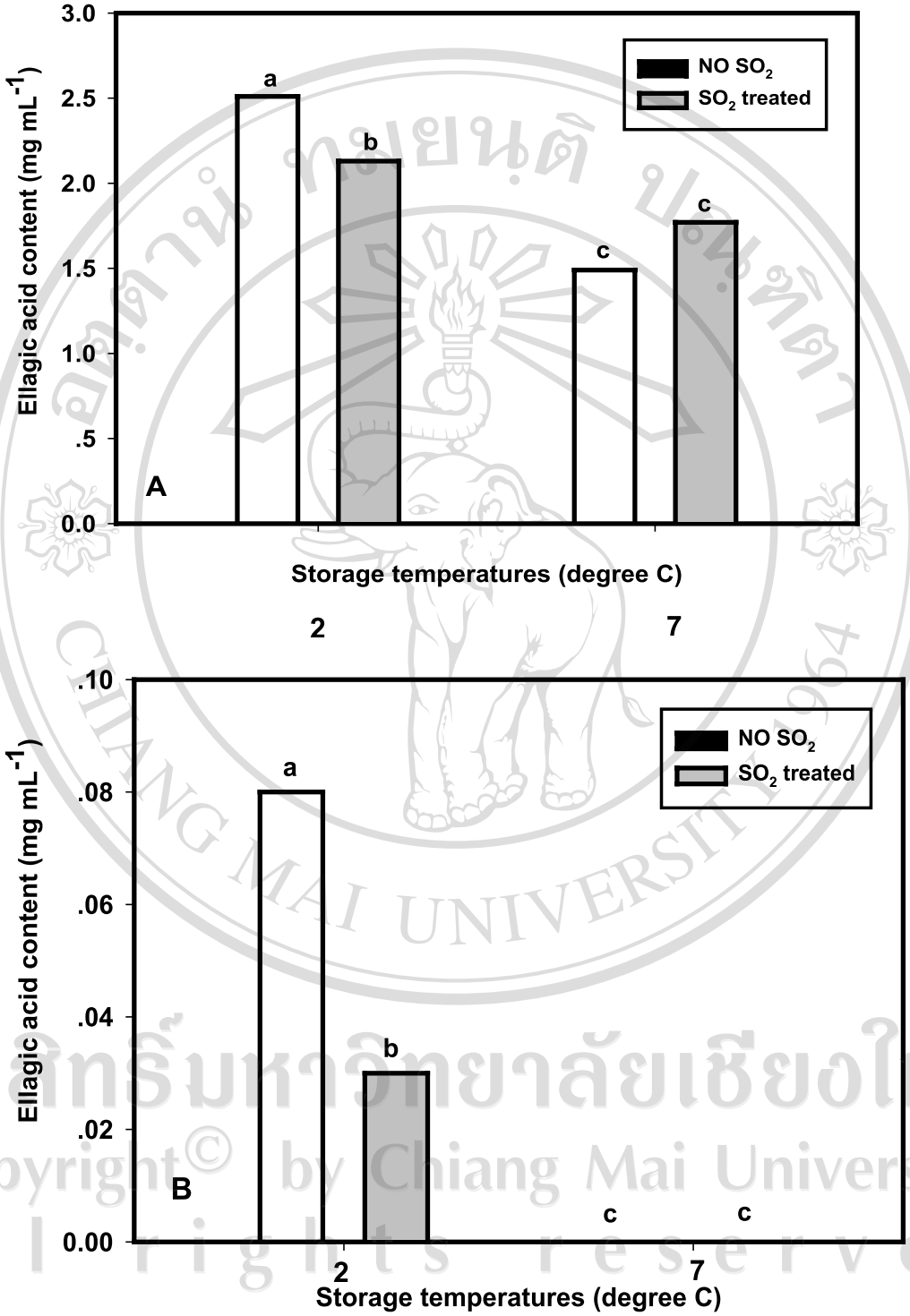

Figure 6.8: The effect of SO_2 treatment and storage temperatures on ellagic acid content in peel (A) and aril (B) part of longan fruits

***:** The different letters indicate the statistically significant difference by LSD at 5% level.

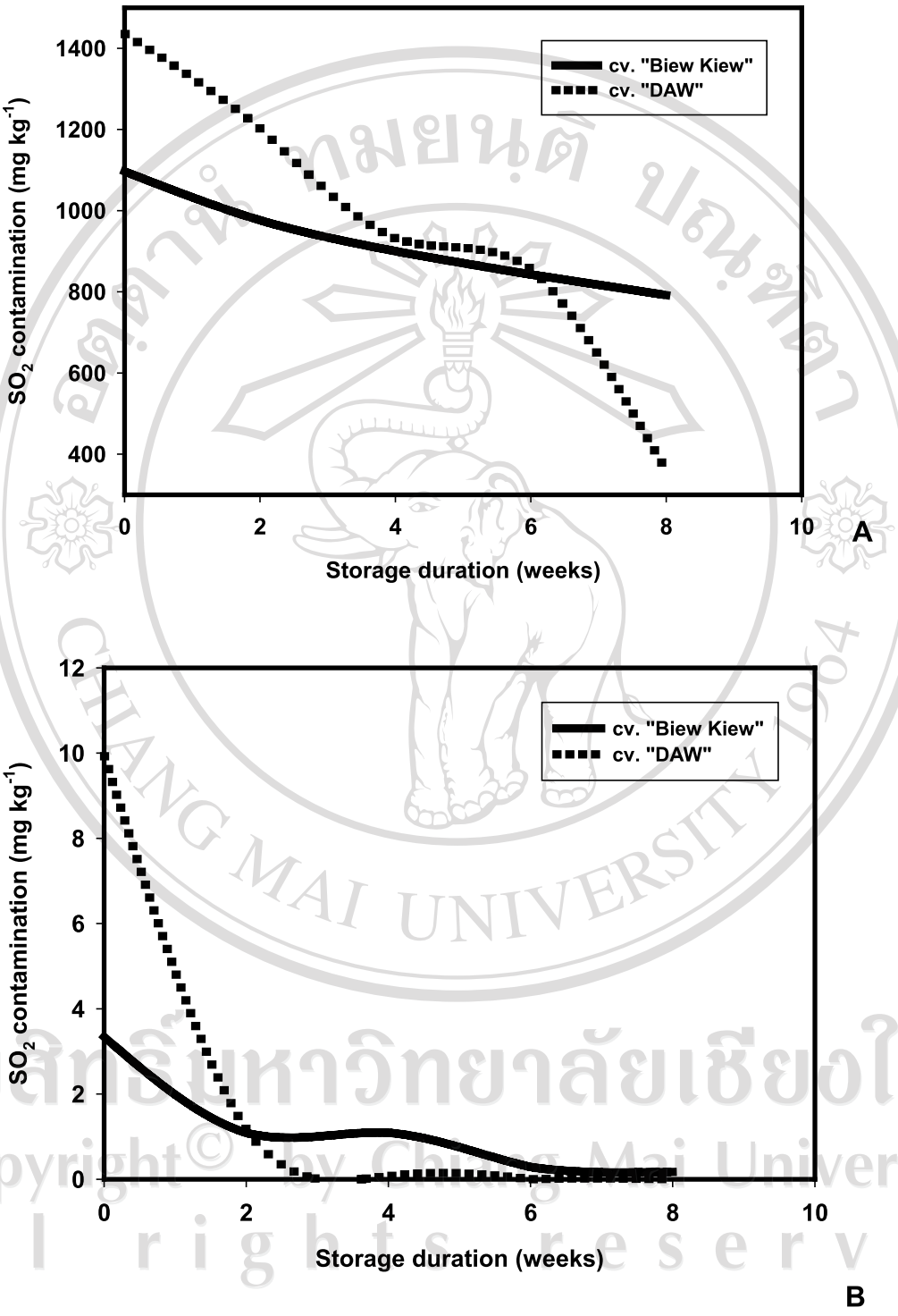

Figure 6.9: The effect of storage durations on SO_2 contamination in peel (A) and aril (B) tissue of longan fruits cv. “Biew Kiew” and “DAW”

The longan fruit cv. Daw was compressed round and lob-sided with thick skin and rather tough. The outer surfaces of pericarps were quite rough with a number of brown patches and yellowish brown color (Figure 6.10 A). The SO_2 treated longan fruit showed yellowish outer. The inner surface of fruit pericarp was a waxy with creamy white color and with clearly visible network of vascular strands (Figure 6.10 C-D), when the inner side of pericarp was pelled off (Figure 6.10 E-F). However, the inner surface of SO_2 treated longan was clearly visible network vascular strands during storage 8 weeks.

The anatomy of normal longan fruit pericarp from cv. Daw and Biew Kiew were different in pericarp thickness but similar in ultrastructurre. The LM observation revealed that the pericarps of both cultivars had similar structure and consisted of three layers. The layers differed by cell type, shape and arrangement (Figure 6.11 A and 6.12)

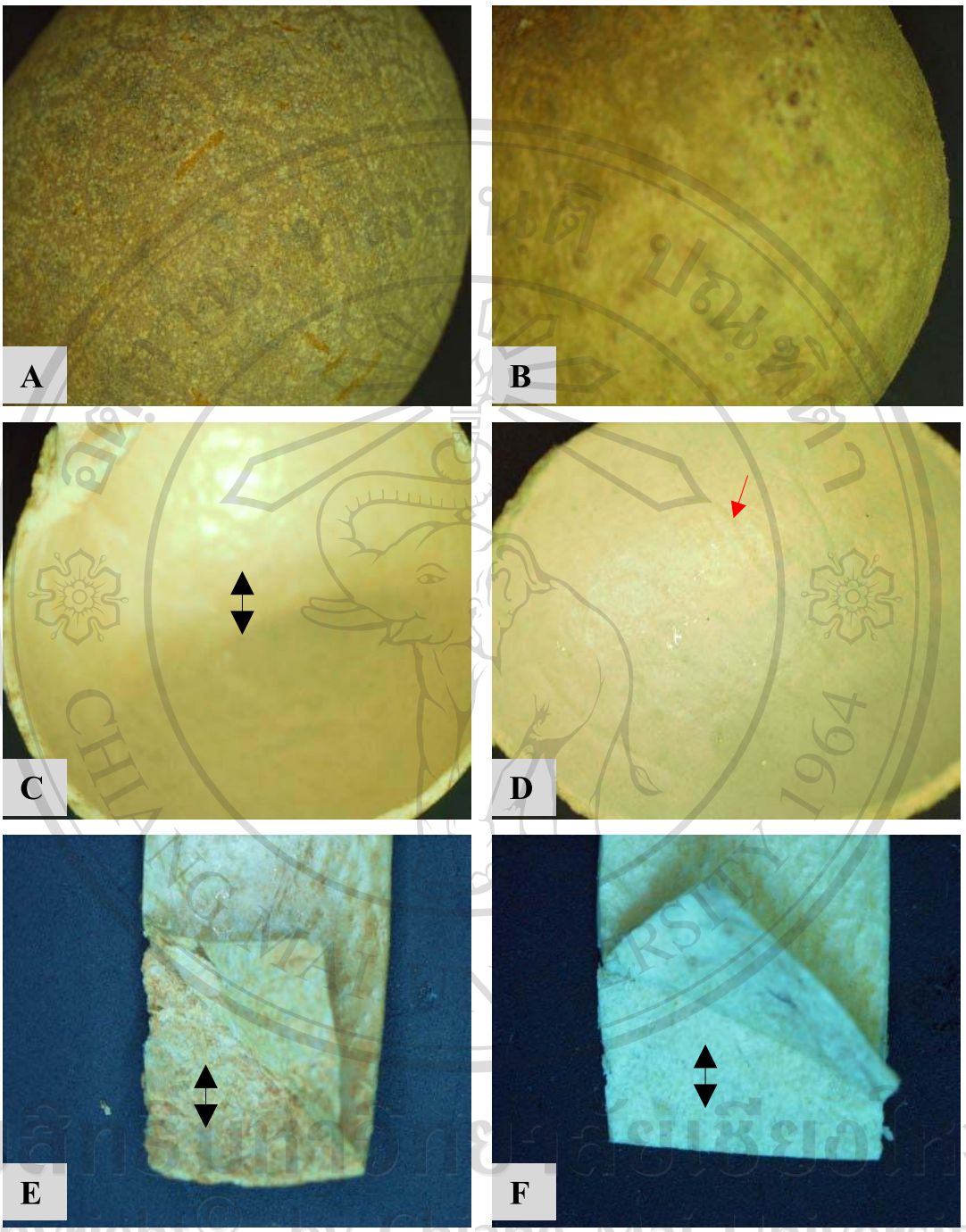

Figure 6.10: The longan fruit cv. Daw after harvest and SO_2 treated longan during storage

A= Stereomicrograph of outer surface pericarp

B= Stereomicrograph of outer surface pericarp on SO_2 treated longan fruit

C= Stereomicrograph of inner surface pericarp showed the waxy with creamy white color

D= Stereomicrograph of inner surface pericarp showed the waxy with creamy white color on SO_2 treated longan fruit

E= Stereomicrograph of longan pericarp when the waxy with creamy white part was peeled, it showed not clear

F= Stereomicrograph of SO_2 treated longan pericarp when the waxy with creamy white part was peeled, it very clear vascular strand

▲▼= Vascular strands on the inner surface pericarp

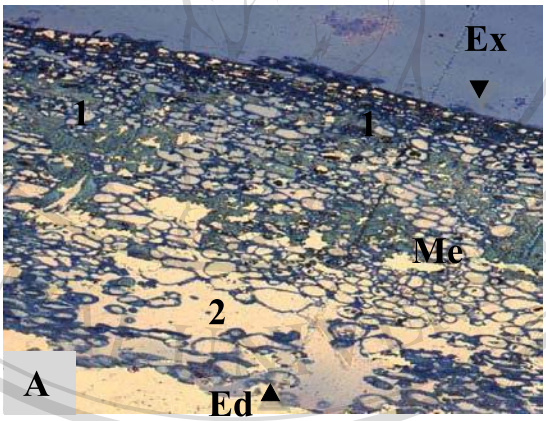

Figure 6.11: Transverse section micrographs of normal longan fruit pericerp cv.Biew Kiew

A=LM micrograph of longan pericarpn cv.Biew Kiew (Mag. × 10)

1=stone cell, 2=intercellular space, 3=vascular tissue

Ex=exocarp, Me=mesocarp, Ed=endocarp

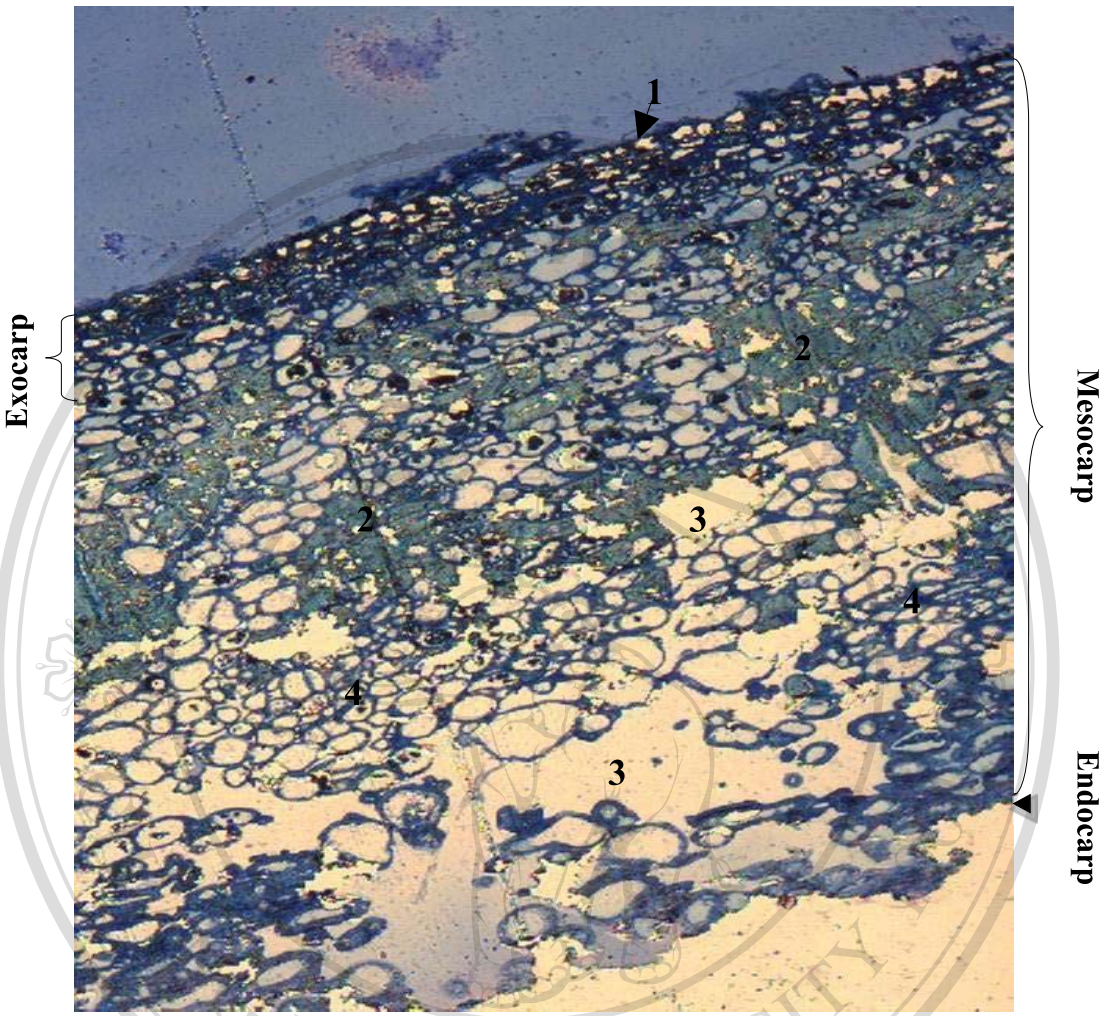

Figure 6.12: Transverse section micrograph of normal longan fruit pericarp cv. Biew Kiew consists of three layers; exocarp, mesocarp, and endocarp
1=cuticle layer, 2=stone cell
3=intercellular space, 4=vascular tissue,

Anatomy and ultrastructure of SO_2 treated longan fruit pericarp. The SEM observation showed a layer of injured cells in pericarp. It was found that the natural cracking, discontinuous cuticle that covered the pericarp and trichomes were damaged in treated longan fruit pericarp (Figure 6.13) Medeira *et al*., (1999) found that the surface cracking of longan pericarp also helped the chilled air to penetrate through the pericarp during low temperature storage. This could impair the physiological function of the cuticle and increased water permeability.

Transverse sectional micrographs of SO_2 treated longan pericarp cv. Daw and Biew Kiew during storage were damaged microcollapsed (Figure 6.14)

Somkit (2007) stated that the mesocarp thickness was about 70% of total pericarp thickness. It was found out that the various cell sizes and shapes were rather round and elliptical with thick cell walls, large intercellular spaces between adjacent cells and contained vascular tissue and some stone cells. The parenchyma cells in the mesocarp contained intact plasmalemma tightly appressed to the wall. They were rather elliptical shape cells (Figure 6.15 A) when observed by TEM, contained many vacuoles and cell organelles. Therefore, this statement supports the result of this experiment.

The TEM observation revealed the damage to mesocarp cells. The SO_2 treated on longan fruit had damaged of cell membrane (Figure 6.15 B)

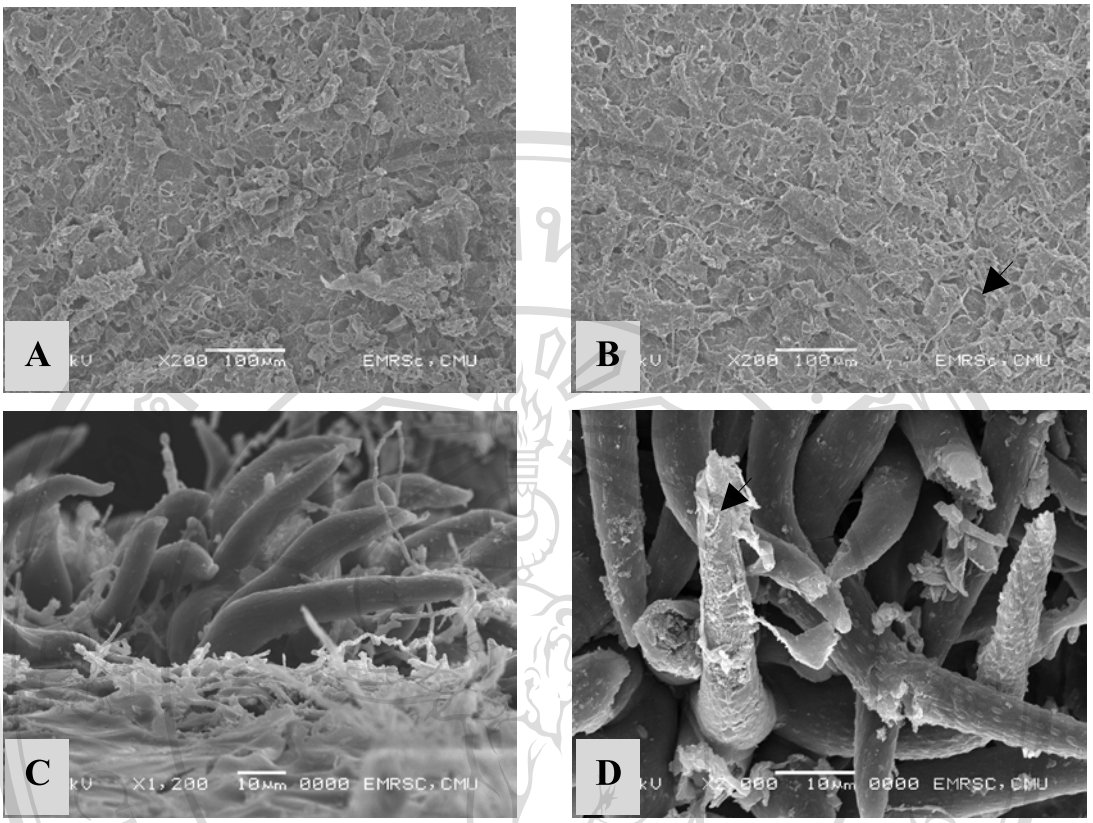

Figure 6.13: SEM micrographs of normal (left) and SO_2 treated (right) outer pericarp surface of longan fruits during storage.

A= Normal pericarp showed healthy cuticle layer (Mag. x 200)

B= SO_2 treated pericarp showed damaged cuticle layer (Mag. x 200)

C= Normal trichomes (Mag. x 1,200)

D= Damaged trichomes on SO_2 treated injured pericarp

Arrows indicate regions of tissue damage

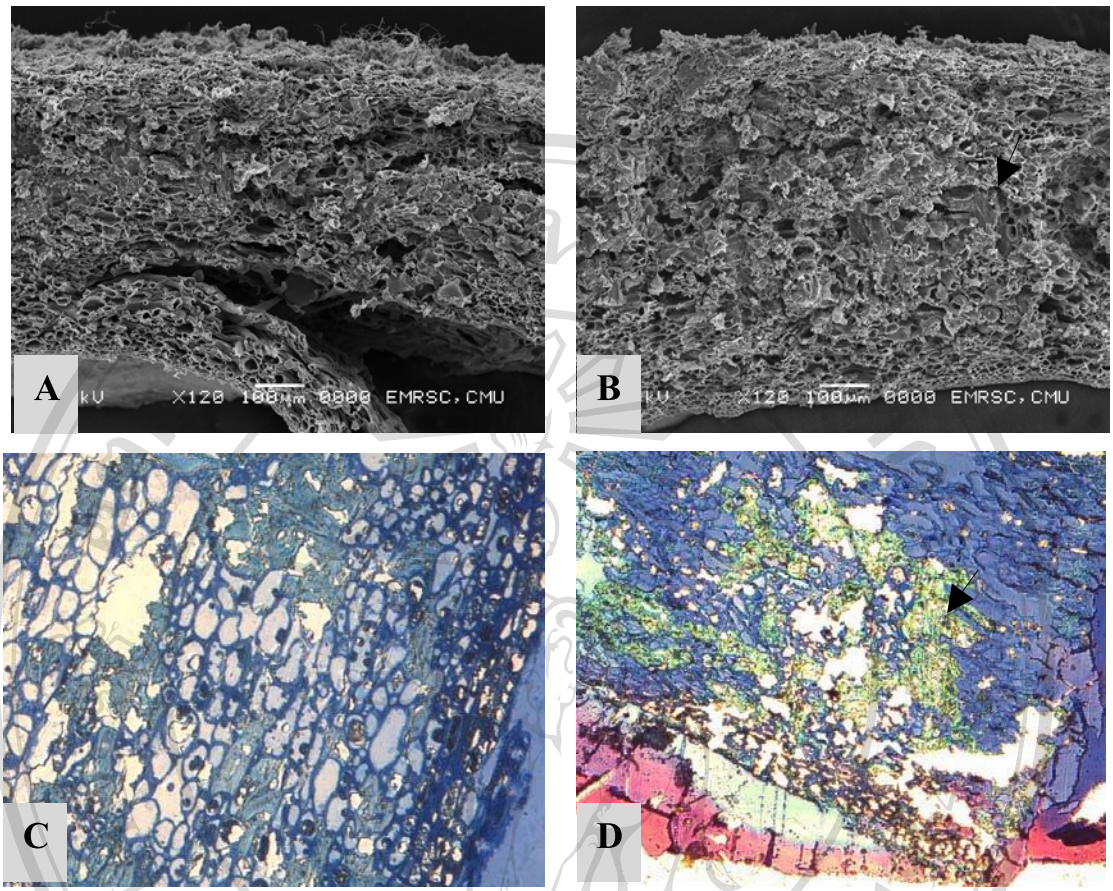

Figure 6.14: Transverse sectional micrographs of normal (left) and SO_2 treated (right) longan fruits pericarp during storage cv.Biew Kiew.

A= Normal pericarp (Mag. x 120)

B= SO_2 treated damaged pericarp (Mag. x 120)

C= LM micrograph of normal pericarp (Mag. x 20)

D= LM micrograph of SO_2 treated injured pericarp (Mag. x 20)

Arrows indicate regions of cell damaged and had collapsed in mesocarp and endocarp layers.

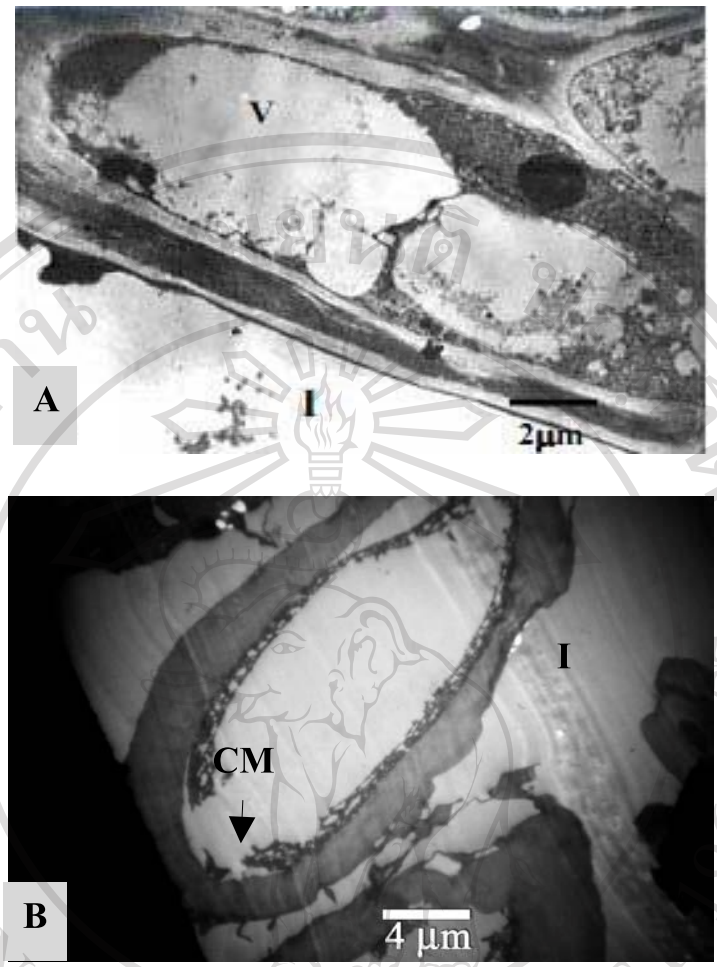

Figure 6.15: TEM micrographs of cell in mesocarp layer.

A= TEM micrograph of elliptical shape cell contained large vacuole with a number of organelles (Mag. x 4,000) (Somkit, 2007).

B= SO_2 treated damaged cell membrane (Mag. x 4,000)

CM= cell membrane

I = intercellular space

V= vacuole

6.4 Conclusions

The sulphite residue of peel and aril tissue of longan fruits cv. “DAW” were higher than cv. “Biew Kiew” Moreover, the contamination of sulphite residue was found highest immediately after treatment. On the other hand, the contamination of sulphite significantly decreased along the storage durations. However, sulphite contamination was still high in peel tissue (Figure 6.9A), while in aril tissue the residue was declined after stored for 3 weeks in cv. “DAW” and 6 weeks in cv. “Biew Kiew” (Figure 6.9B). Therefore, the fumigation time and concentration were the most important factors affecting the SO_2 residues. Higher concentration and longer fumigation time resulted in higher SO_2 residue, which was mainly located in the peel and much less in the aril and gradually decreased with prolonged storage. If SO_2 concentration and fumigation time were strictly controlled, lower residue and longer storage life could be achieved.

The pericarp of both cultivars had similar ultrastructure and consisted of three layer including exocarp, mesocarp and endocarp. Microscopic anatomy of SO_2 treated longan fruits during storage 8 weeks damaged pericarp showed flaking of cuticle, damaged trichromes on the surface and parenchyma cell walls in mesocarp.