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USE OF CALCIUM CARBONATE-NANOPARTICLE-LONGKONG PEEL EXTRACT IN EDIBLE COATING TO DELAY LONGKONG FRUIT BROWNING

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ABSTRACT

The effect of calcium carbonate ($CaCO_3$)-nanoparticle-longkong peel extract (LPE) coating on quality and browning of longkong after harvesting were evaluated. Edible coating (carrageenan) was used as a component of 1 mM $CaCO_3$ and 2.00 mg LPE. Longkongs were coated with 0 (control), 1 and 2% carrageenan and storing them at 13°C and 90-95% RH for 14 days. Longkong were analyzed for changes in browning pigment, L* value, pH, total phenolic content, polyphenol oxidase (PPO) and total sugar. The results showed longkong coating with 1 and 2% carrageenan (CGN) lower browning pigment, which correlated with a decrease in PPO and total phenolic content than control. However, longkong coating with 1% CGN delayed browning more than longkong coating 2% CGN during ten days of storage. While the sugar was significantly higher in control compared to 1 and 2% CGN. Longkong treated with 1 and 2% CGN showed no significantly a decrease in pH when compared to the control fruit.

Key words: Calcium carbonate, longkong peel extract, coating, browning, polyphenol oxidase

INTRODUCTION

The major problems of longkong are rapid pericarp browning and desiccation a few days after harvesting. Because of its sensitivity to browning and desiccation, it is hard to keep longkong in good presence at room temperature without particular postharvest conditions. Among noble-metal nano-materials, silver nanoparticles have received positive attention because their desirable physicochemical properties. It is well known that nanomaterials from plants have received greater importance to their wide application in food industry (Wang *et al.,* 2004). Polymer of nano-$CaCO_3$ decreased gaseous permeability and revised packaging operation (Avolio *et al.,* 2013; Luo *et al.,* 2014). Longkong peels that are naturally abundant in polymers, including lignin, phenolic and antioxidants could be apply in the synthesis of nanoparticles. Even though the coating has been studied extensively to increase the storage time of many fresh fruits, this research provides the only information regarding the application of nano-$CaCO_3$ longkong peel extracts coating for longkong fruits. This research thus investigates the effects of calcium carbonate ($CaCO_3$)-nanoparticle-longkong peel extract (LPE) coating on quality and browning of longkong after harvesting stored at 13°C.

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MATERIALS AND METHODS

Longkong peels extract (LPE) powder preparation

Longkong peel was prepared longkong peels (*Aglaia dookkoo* Griff.). 120 fruit were received, cleaned and boiled in H_2O at 90°C for 30 min. Then, the sample was grounded with 100 mL of H_2O. The sample was filtered via a cheesecloth. This filtrate was adjusted with chilled acetone and then centrifuged at 1000 rpm for 5 min. After that, the filtrate was dried at room temperature as a powder and applies for additional experiments (Bankar *et al*., 2014).

Prepare $CaCO_3$ and coating

$CaCO_3$ was prepared by dissolving 1 mM $CaCO_3$ (10g) in 100 mL (w/v) H_2O with heating (70°C) for 30 min.

Calcium carbonate-nanoparticle longkong peel extract by LPE powder (2 mg) was dissolved in 1mM $CaCO_3$ solution in 100 mL at pH 3.0. This reaction condition included incubation with the water bath for 3 min (80°C).

Carrageenan coating was dissolving by the following concentrations: 0 (control), 1 or 2% (w/v) in 100 mL in distilled water, respectively.

Carrageenan coating solutions at the following concentrations: 0 (control), 1.0 or 2.0% of carrageenan coating solutions were added to a calcium carbonate-nanoparticles longkong peel extract. The longkong was coated by immersing for 1 min. They were dried at room temperature for 60 min and then immediately transferred to refrigeration storage at 13°C. Data was recorded every two days for 14 days. Each treatment contained 120 fruits/three replicates.

Determination of fruit browning pigment

Pericarp browning was carried out according to the method with spectrophotometrically (Jiang *et al*., 1999): five peeled fruits (5g) were shredded, crushed and mixed to 17 mL with 60% methanol (v/v) of sodium phosphate buffer (0.1 M, pH 6.8) and then polyvinylpyrrolidone (PVP) (0.5 g) were added. The mixture was then centrifuged at 4500 rpm (20 min) at room temperature and filtered via filter paper, and the supernatant was collected and combined with a phosphate buffer (1:4, v/v) and measured in a UV-Vis spectrophotometer at 410 nm (Jiang & Fu, 1999).

Determination of peel color changes

Peel color changes in the middle part of longkong was determined by measuring the L value with a Minolta colorimeter and the results were expressed in a lightness value (L*).

Determination of pH

The pH of the pericarp tissue was determined by the method according to Underhill and Critchley (1994).

Estimation of total phenolic content

The total phenolic content was measured according to methods proposed by Singleton *et al*. (1999). The extraction was separately prepared from the middle part of longkong peel. 2 g of each fruit peel, which was homogenized in 20 mL of ethanol (80%) for 1 min. The mixture was filtered via two layers of cheese cloth and then centrifuged for 15 min at 10,000 rpm. The supernatant (1 mL) was mixed with Folin-Ciocalteu reagent (1 mL) and 7% sodium carbonate (10 mL). The reaction mixture was increased to 25 mL with H_2O and after incubation for 60 min at ambient temperature. The absorbance was taken at 760 nm with a UV-Vis spectrophotometer. A standard curve of aqueous solutions gallic acid was used for quantification of total phenolic.

Extraction and assay of PPO activities

Peel of longkongs (2 g) were mixed and homogenized in 0.05 M phosphate buffer (20 mL) (pH 7), and polyvinylpyrrolidone (insoluble) (0.2 g) at 4°C. The mixture was filtered through a cheesecloth; the filtrate was centrifuged for 20 min at 12,500 rpm, 4°C. The supernatant was collected (enzyme extracting solution for PPO activity assays). For PPO activity was determined according to the method of Jiang (2000) by measuring the oxidation of 4-methylcatechol as the substrate. The absorbance of the supernatant was taken at 410 nm by a spectrophotometer. PPO activity of one unit was assigned as a change of 0.001 in absorbance per minute.

Estimation of total sugar content

The total sugar was assayed using the method offered by Phenol-sulfuric method (Dubois *et al*., 1956). One gram of a tissue longkong was mixed with 10 mL 80% ethanol and then incubated for 60 min at 60°C in the water bath. After that, the solution was filtered with Whatman No. 4. One mL of the reagent solution was added with 5% phenol (1 mL) and 100% sulfuric acid (1 mL) and left to settle for until cool. The total sugar content was then read at 490 nm by a spectrophotometer. D-glucose as a standard was used to express the total sugar content.

Statistical analysis

The experimental was repeated three times, and all data were analyzed using SPSS program at the significant differences of 95% confidence level.

RESULTS AND DISCUSSION

The browning of the longkong peel from all treatments increased gradually over ten days of storage, then rapidly decreased until the final day of storage (Figure 1). Brown pigment size of longkong peel may be related to change from red peel color to brown peel color (George *et al*., 2004). After 10 days of storage, browning pigment of all treatments had rapidly decreased because of phenolic compound are oxidized into quinines and induced fruit surface brown (Martinez & Whitaker, 1995).

A browning of control fruit was higher than 1.0 and 2.0% CGN of fruit although the storage. Browning of the longkong coated with carrageenan at 1.0 and 2.0% delayed the browning of longkong after two days of storage. The browning pigment of longkong coated with carrageenan at 1.0% was 0.67, significantly lower than the control on eight day of

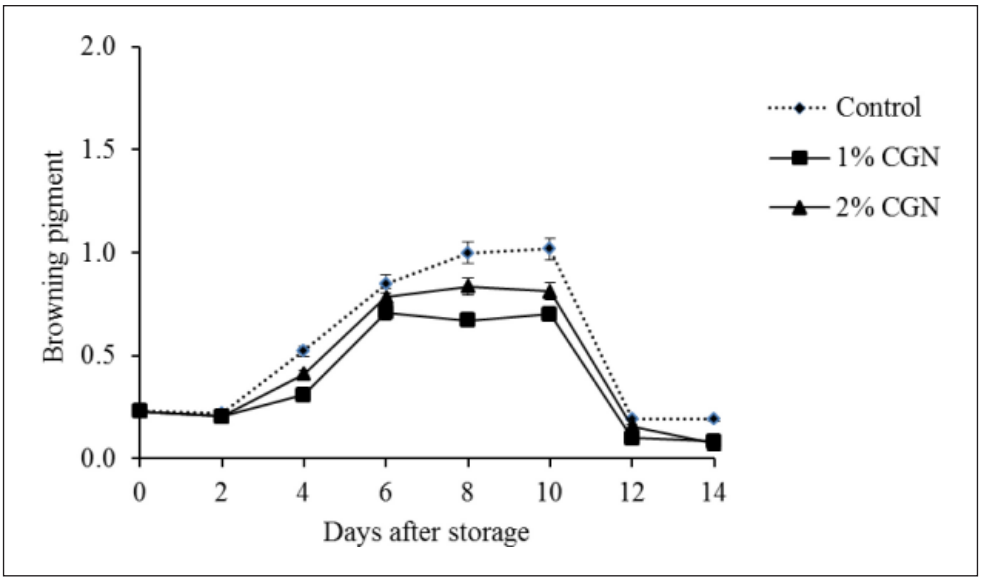

Fig. 1. Browning pigment of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

storage. Edible film made carrageenan possess good in protecting the qualities and reduces oxygen permeability, which carrageenan could be protect moisture barrier because of their high hydrophilic nature (Fabra *et al*., 2009).

The longkong peel of control fruit had lower L* value than 1.0 and 2.0% CGN of fruit during storage (Figure 2). L* of all treatments were decreased with relation in browning pigment was increased during storage time. Longkong fruit of control featured an expansion in the browning, as evidenced by a decreased in the lightness (L*) (Sapii *et al*., 2000). The results showed an increase in browning of longkong might be due to the active PPO content of the tissues, phenolic and oxygen induced fruit surface wounding (Lichanporn *et al*., 2009).

The pH of the longkong fruits decreased in all treatments during the eight days and then there maintained until to 14 days of storage (Figure 3).

Total phenolic from all treatments decreased in the first four days, followed by a rapid increase until to 12 days and decreased on 14 day of storage

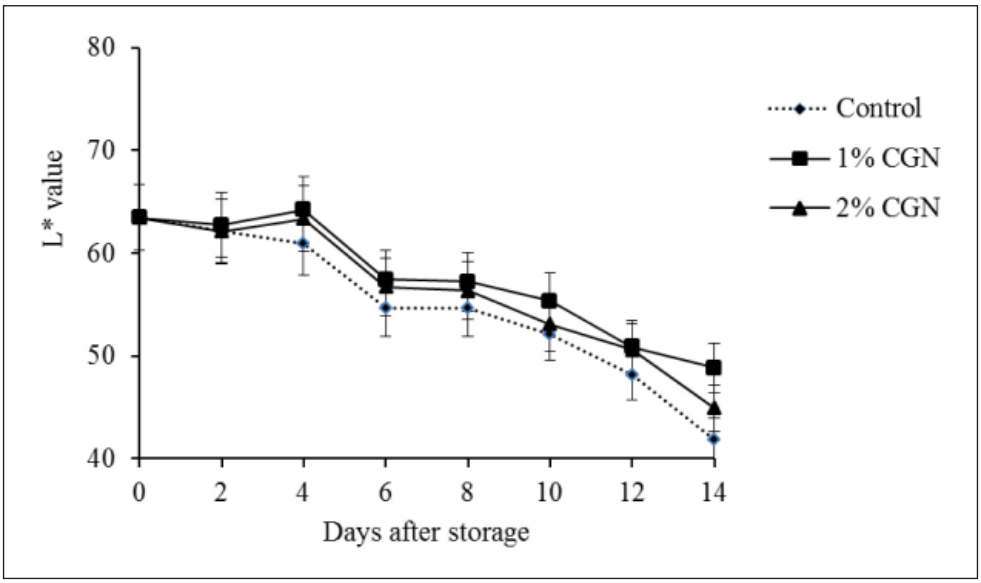

Fig. 2. L* value of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

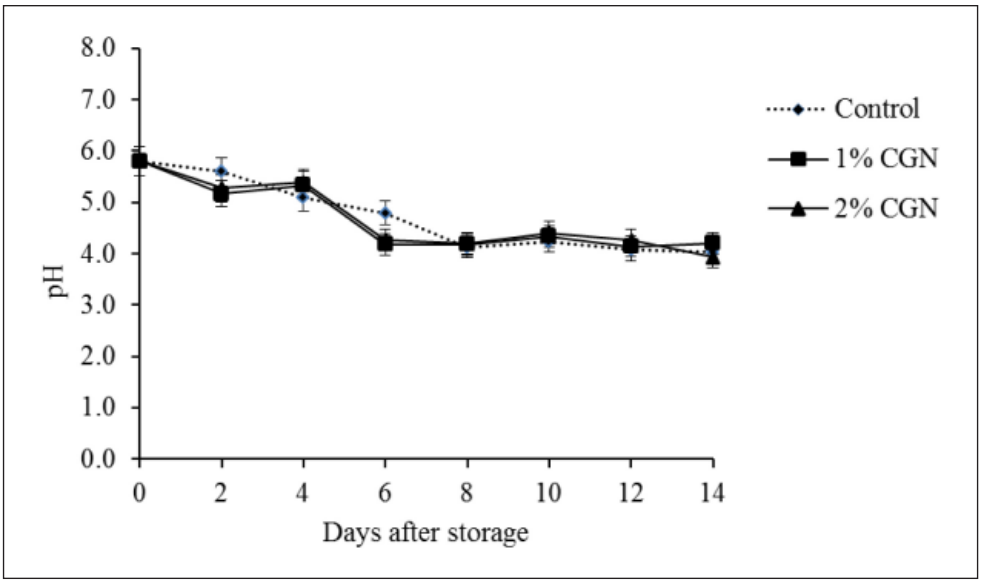

Fig. 3. pH of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

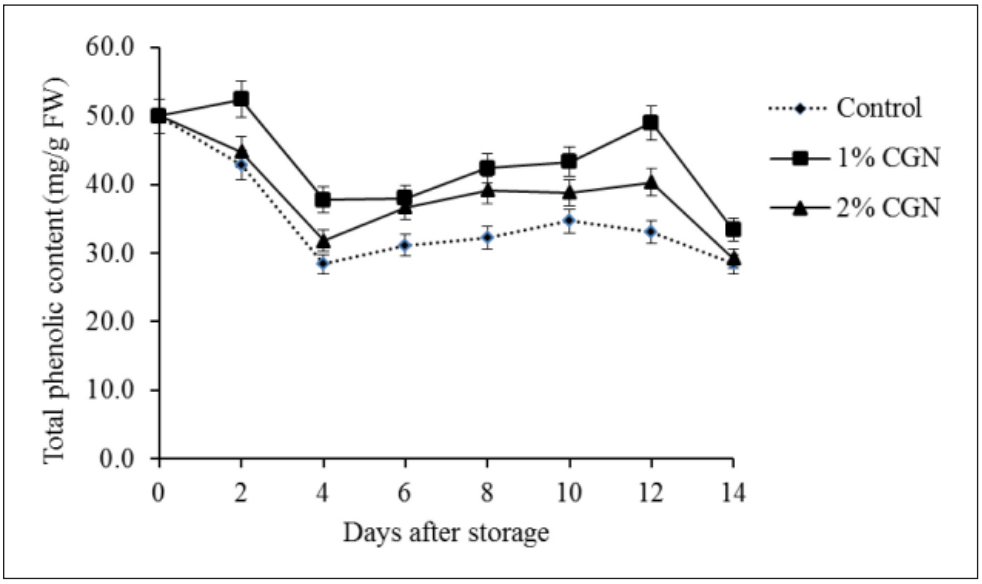

Fig. 4. Total phenolic content of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

(Figure 4). Total phenolic of the longkong fruits coated with 1% CGN was significantly higher than that of fruits coated with at the onset of the experiment. Browning of fresh produce (fruit and vegetables) was reported the mechanism of browning occur from the phenolic compounds are changed to quinines, which are polymerized into brown polymers (Martinez & Whitaker, 1995). Figure 4, the initial total phenolic content of the longkong fruits coated with 1% CGN was considerably higher than that in the uncoated (control) ($p < 0.05$); after two days of storage time, the longkongs coated with 1% CGN had the highest total phenolic content (52.40 mg/g FW).

The reaction of enzymatic browning is a consequence of phenolic compounds (substrates) oxidation by POD, PPO and oxygen. PPO is a major enzyme about browning reaction, which can change the phenols to o-quinones (Richard & Gauillard, 1997). The PPO activity in the treatments with 1.0

and 2.0% was lower than that of the control samples throughout the storage time (Figure 5).

PPO is an important enzyme and related to browning in many fruits such as apple, avocado and potato. PPO activity is usually activated when the senescence such as ripening or stress conditions, which membrane is damaged and then results in an increase of activities of PPO (Mayer, 1987). PPO activity in longkong fruits increased at 0-4 days of storage. At the end of storage period of 14 days, PPO activity in the treatments with 1.0% CGN was lowest at 0.76 units/mg protein.

The total sugar of control fruit was significantly increased more than 1 and 2% CGN of longkong fruit (Figure 6). According to Beirao-da-Costa *et al.* (2006), the increase in sugar was constant due to the solubilization of neutral sugar from carbohydrate polymer residues.

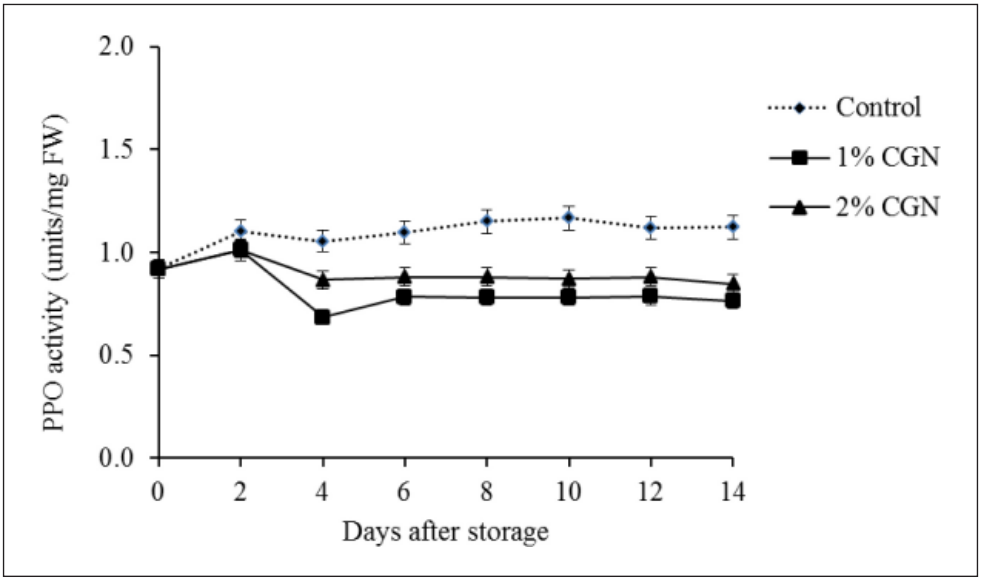

Fig. 5. PPO activity of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

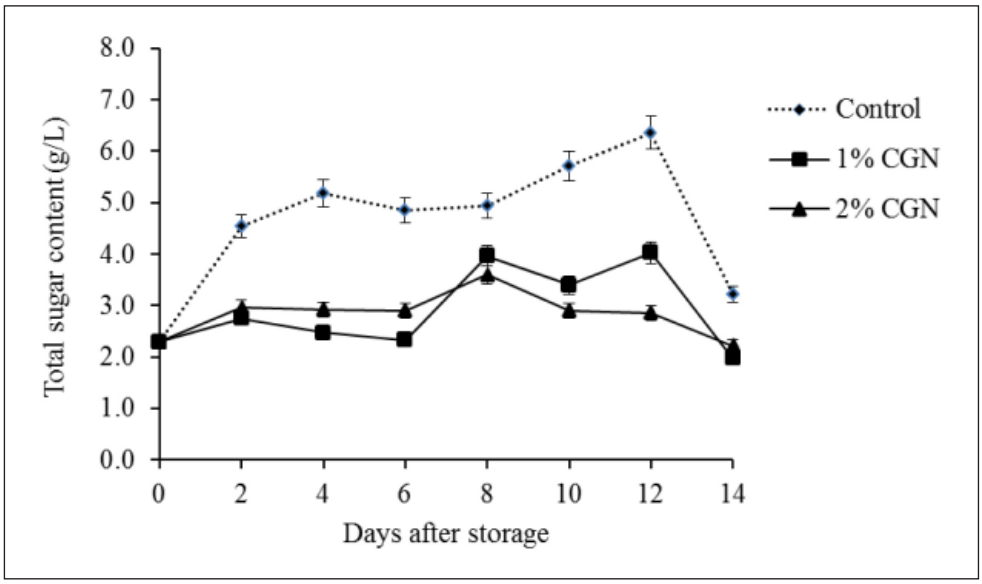

Fig. 6. Total sugar content of longkong coated with 0, 1 and 2% carrageenan LPE of reaction mixtures containing 1.0 mM $CaCO_3$ and 2.0 mg LPE powder, followed by storage at 13°C and a relative humidity of 90±5%.

CONCLUSION

Longkong fruits coated (1.0 and 2.0% CGN) delayed browning and decreasing the activities of PPO throughout the storage time. Longkong fruits coated with 1.0 and 2.0% CGN had a higher total phenolic content than that of the control. Longkong fruits coated with 1.0% CGN delayed browning more than longkong coating 2% CGN during storage.

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REFERENCES

Avolio, R., Gentile, G., Avella, M., Carfagna, C. & Errico, M.E. 2013. Polymereller interactions in PET/CaCO nanocomposites: chain ordering at the interface and physical properties. *European Polymer Journal*, **49**: 419-427.

Bankar, A., Joshi, B., Kumar, A.R. & Zinjarde, S. 2014. Banana peel extract mediated novel route for the synthesis of silver nanoparticles, *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, **368**: 58-63.

Beirao-da-Costa, S., Steiner, A., Correia, L., Empis, J. & Moldão, M.M. 2006. Effects of maturity stage and mild heat treatments on quality of minimally processed kiwifruit. *Journal of Food Engineering*, **76**: 616-625.

Dubois, M., Gilles, K.A., Hamilton, J.K., Rebers, P.A. & Smith, F. 1956. Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, **28**: 350-356.

Fabra, M.J., Talens, P. & Chiralt, A. 2009. Microstructure and optical properties of sodium caseinate films containing oleic acid-beeswax mixtures. *Food Hydrocolloids*, **23(3)**: 676-683.

George Chu, C.L., Eric Leung, S.K. & Masahiro Kawaji. 2004. Reversibility of lychee pericarp red color in relation to pericarp pH, activity of polyphenol oxidase, and particle size of brown pigment. *Fruits*, **59(1)**: 17-23.

Jiang, Y.M. & Fu, J.R. 1999. Postharvest browning of litchi fruit by water loss and its prevention by controlled atmosphere storage at high relative humidity, *Lebensmittel-Wissenschaft und Technologie*, **32**: 278-283.

Jiang, Y.M., Fu, J.R., Zauberman, G. & Fuchs, Y. 1999. Purification of polyphenol oxidase and the browning control of litchi fruit by glutathione and citric acid, *Journal of the Science of Food and Agriculture*, **79**: 950-954.

Jiang, Y.M. 2000. Role of anthocyanins, polyphenol oxidase and phenols in lychee pericarp browning. *Journal of the Science of Food and Agriculture*, **80**: 305-310.

Lichanporn, V., Srilaong, C., Wongs, A. & Kanlayanarat, S. 2009. Postharvest physiology and browning of longkong (*Aglaia dookkoo* Griff.) fruit under ambient conditions. *Postharvest Biology and Technology*, **52**: 294-299.

Luo, Z.S., Wang, Y.S., Wang, H.H. & Feng, S.M. 2014. Impact of nano-CaCO – LDPE packaging on quality of fresh-cut sugarcane. *Journal of the Science of Food and Agriculture*, **94**: 3273-3280.

Martinez, M.V. & Whitaker, J.R. 1995. The biochemistry and control of enzymatic browning. *Trends in Food Science and Technology*, **6**: 195-200.

Mayer, A.M. 1987. Polyphenoloxidase in plants-recent progress. *Phytochemistry*, **26**: 1-20.

Richard, F.F. & Gauillard, F.A. 1997. Oxidation of chlorogenic acid, catechins, and 4-methylcatechol in model solutions by combinations of pear (*Pyrus communis* cv. Williams) polyphenol oxidase and peroxidase: a possible involvement of peroxidase in enzymatic browning. *Journal of Agricultural and Food Chemistry*, **45**: 2472-476.

Sapii, A.T., Norlia, Y., Muda, P. & Lin, T.S. 2000. Postharvest quality changes indokong (*Lansium domesticum* Corr.) harvested at different stages of ripeness. In: *Quality assurancein agricultural produce*. G.I. Johnson, L.V. To, N.D. Duc & M.C. Webb (Eds.). ACIAR Proceedings 100, Australia. pp. 201-205.

Singleton, V.L., Orthofer, R. & Lamuela-Raventos, R.M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu Reagent. *Methods in Enzymology*, **299**: 152-178.

Underhill, S.J.R. & Critchley, C. 1994. Anthocyanin decolorisation and its role in lychee pericarp browning. *Australian Journal of Experimental Agriculture*, **34**: 115-122.

Wang, K., Liang, S., Du, R.N., Zhang, Z. & Fu, Q. 2004. The interplay of thermodynamics and shear on the dispersion of polymer nanocomposite. *Polymer*, **45**: 7953-7960.