BorneoScience
The Journal of Science & Technology
Volume 42 Issue 2 : Sept 2021
Online ISSN : 2231-9085 | ISSN : 1394-4339

PRESERVATION COATING EFFECT OF ACID-SOLUBLE CHITOSAN ON THE SHELF LIFE OF BANANA IN SABAH

Flornica A. Ahing. and N. Wid.

Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Jalan UMS, 88400, Kota Kinabalu, Sabah, MALAYSIA

Corresponding author : Newati, Wid Email: newati@ums.edu.my

Received 13th November 2021; accepted 22nd November2021
Available online 20th May 2022

ABSTRACT. *Chitosan, a biopolymer that consist of various properties, has multiple applications throughout industries where one of the promising applicarion of chitosan is its preservative effect. Chitosan, a bioactive natural edible coat can be considered a promising alternative to overcome the freshness of bananas during storage. Throughout this study, observations were made on weight loss, peel colour changes and titratable acidity for the effect of chitosan coating. In terms of weight loss, among four different concentration of chitosan coating solution, the 2.0% chitosan coating solution showed the lowest weight loss percentage which is 22.6% compare to others which were 1.0% (26.00%), 0.5% (26.20%) and 1.5% (34.24%) significantly. The result marked variations between the uncoated banana and coated banana at different concentrations of chitosan coating solution (ASC) which are 0.50, 1.00, 1.50 and 2.00%. The peel color changes were significantly different during the first and final day of observation for each concentration. A significant variation was observed for the titratable acidity of the banana fruit where the lowest value obtained was 0.812% during coating with 2.0% chitosan coating solution while the highest titratable acidity was observed during the coating with 1.5% chitosan solution which is 2.11%. To summarize, banana coating with chitosan can decreased the weight loss of the banana fruit as well as improve the peel color changes during 12 days of storage. Besides that, banana coating with chitosan can also lower the value of titratable acidity of the banana fruit compared to uncoated bananas.*

KEYWORDS: chitosan, shelf life, coating, titratable acidity.

INTRODUCTION

Throughout the past decades, the modern food industry is facing challenges associated with food packaging with short shelf life period. The recent packaging materials or storage forms were unsophisticated and there is a need to a betterment and innovations. Ideally, food packaging materials that can protect food quality over time, portability, convenient to use, inexpensive, renewable, biodegradable, and produce no municipal solid waste accumulation should be what consumers need. By far, the most utilized and best choice for food packaging applications are plastics and polymers.

However, on the other hand, they are non-biodegradable and increase municipal solid waste accumulation. Thus, the issue has grown in importance to the initiation of research on biopolymers which is not only biodegradable, but exhibits antimicrobial and antifungal properties (Priyadarshi and Rhim, 2020).

Recently, researchers have been showing an increasing interest in the improvement and use of bio-based active films based on antimicrobial and antifungal properties to improve the food preservations without using chemical preservations. Chitosan which can be obtained from the exoskeletons of crustaceans, insect and cell walls of fungi is a natural polysaccharide consisting of glucosamine copolymers *N*-acetylglucosamine. It has been widely used in various industrial and biomedical fields such as pharmaceutical and biotechnology, making it a suitable candidates for this matter (Priyadarshi & Rhim., 2020). Additionally, chitosan is enclosed with reactive amino group, reactive hydroxyl group, linear polyamine, and can chelates many transitional metal ions whereas the biological properties of chitosan comprise biocompatible, binds to mammalian and microbial cells, hemostatic, fungistatic, antimicrobial, spermicidal, antitumor, anticholesteremic, accelerates bond formation, immunoadjuvant, and depressant for the central nervous system (Dutta *et al*., 2004).

The potential of chitosan to act as fruit preservative of natural origin has been widely reported an excellent film forming material and coating (Duan *et al*., 2019). Some researchers also reported that the results indicated that chitosan has more advantages because of its antibacterial activity and bivalent minerals chelating ability where it can affect several physical characteristics of the fruits and these can be used to evaluate the quality of the fruit directly. Several characteristic of fruits that can be affected are weight loss, peel colour changes and titratable acidity (Duan *et al*., 2019).

In Sabah fruit industry, banana was considered one of quite popular tropical fruit that contain a lot of nutrients and minerals that are very beneficial for health. Therefore, the need for tropical fruits coating can be considered an essential procedure. The short shelf life of banana is common because the quick ripening process leads to browning incidence thus lower the quality of banana during harvest or shelf life storage. These major postharvest problems significantly affect the quality of banana thus result in a decline of its market value. Therefore, a postharvest technique is necessary to develop or keep banana fruit quality stable during marketing. Thus the study was undertaken to investigate the effect of acids soluble chitosan on the shelf life of banana in term of weight loss, peel color changes and titratable acidity.

MATERIALS AND METHODS

Production of Chitosan

Deproteination (DP)

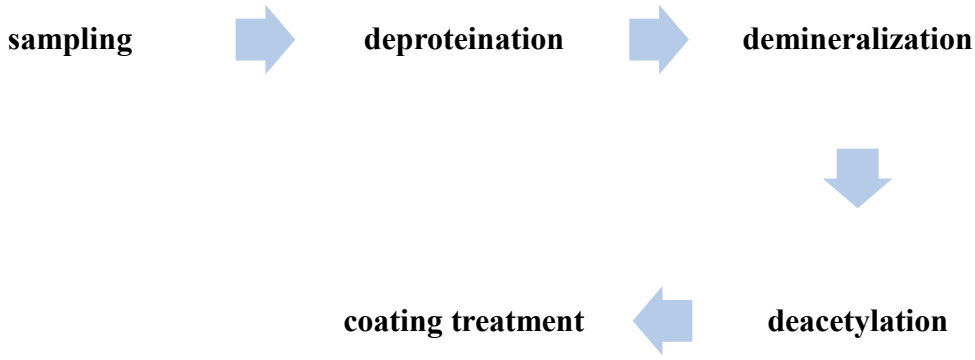
A total of 20 g sample of flakes shrimp shell were placed in a 1000 mL beakers and soaked in 2.0 M NaOH in the ratio of 1:16 (w/v) for one hour at room temperature (~25ºC) according to Patria (2013). Then the solution was filtered and the residue was washed with tap water until neutral pH was achieved. The residue was re-dried under the sun for 4 hour or more for samples decolouration (Youn *et al*., 2007).

Demineralization (DM)

The dried saample from the deproteination process was added with 1.0 M HCl in the ratio 1:16 (w/v) to remove minerals such as calcium carbonate, ($CaCO_3$) to produce carbon dioxide, (CO_2). The process was allowed to stand for one hours at room temperature (~25ºC). After that, the sample was separated from the solution by vacuum filtered and washed with distilled water until neutral pH was achieved. The sample obtained known as chitin was re-dried using the same drying method.

Deacetylation (DA)

A total of 10 g of dried chitin flakes will be further undergone deacetylation process where the chitin sample was immersed in 48 % NaOH with ratio 1:16 (w/v) and the treatment was carried out at 70ºC for 48 hours.



Preparation of Acid Soluble Chitosan (ASC) Solution

The chitosan solution was prepared by dissolving 0.0, 0.5, 1.0, 1.5, 2.0 g of chitosan in 1000 mL distilled water and added 10 mL of glacial acetic acid to dilute the chitosan to produce different concentrations of chitosan solution which is 0(control), 0.5, 1.0, 1.5, 2.0% (Batista Silva *et al*., 2018).

Coating Treatment

Banana samples were selected with about the same size and weight as well as free of visual defects. A complete randomized with three replicates will be establish. The treatment was carried out by dipping samples into each concentration for 1 minute following by air drying for about 1 hour. All samples were weighted and stored in a perforated cardboard carton for 12 days. Observation was made for 2, 4, 6, 8, 10 and 12 days of experiment for peel color changes while weight loss and titratable acidity were obtained during the final day of investigation.

Quality of Sabah Banana fruit

The quality of the banana fruit will be determine in terms of weight loss, peel colour changes, and titratable acidity.

a) Weight Loss

The total fruit weight loss was calculated on initial weight basis and expressed in percentage.

Weight loss = $\frac{initial\ weight\ (g) - final\ weight(g)}{initial\ weight\ (g)}\ x\ 100\%$

b) Peel Colour Changes

Peel colour changes score were according to Al-Qurashi *et al*. (2017) method with modification. The peel colour changes were recorded with the help of a chart (1-10 scale; 1-green, 2- green with trace of yellow, 3- more green than yellow, 4- more yellow than green,

5- yellow with trace green, 6- full yellow, 7- yellow with brown spots, 8- more yellow than brown, 9- more brown than yellow, and 10- full brown).

c) Titratable Acidity (TA)

A total of 10g of banana fruit pulp samples were crushed and homogenized for 1 hour with 100 mL of boiled distilled water. The mixture was titrated with 0.10 M NaOH with phenolphthalein used as an indicator. The end point of the reaction was identified as transformation of the colorless into a pale red. The TA was expressed as the percentage of malic acid (Li *et al*., 2019).

$$TA(\%) = \frac{0.067\ C1xV1xV2}{V3xW}\ x\ 100\% \quad (1)$$

Where C1 (mol/L) is the concentration of NaOH, V1 (mL) is the volume of NaOH, V2 (mL) is the total volume of apple juice, V3 (mL) is the titration volume of banana juice mixture, W (g) is the total weight of the banana.

RESULTS AND DISCUSSION

The study was conducted to investigate the effect of acid soluble chitosan on the shelf life of banana in term of weight loss, peel colour changes and titratable acidity. The findings are discussed as follow.

Weight Loss

During the 12 days of storage observations, a statistically significant variation of weight loss was found on the final day of investigation where the overall of all uncoated banana for each batch of treatment showed significant higher percentage of weight loss compared to coated banana with ASC solution. The results of weight loss percentage are shown in Figure 1.

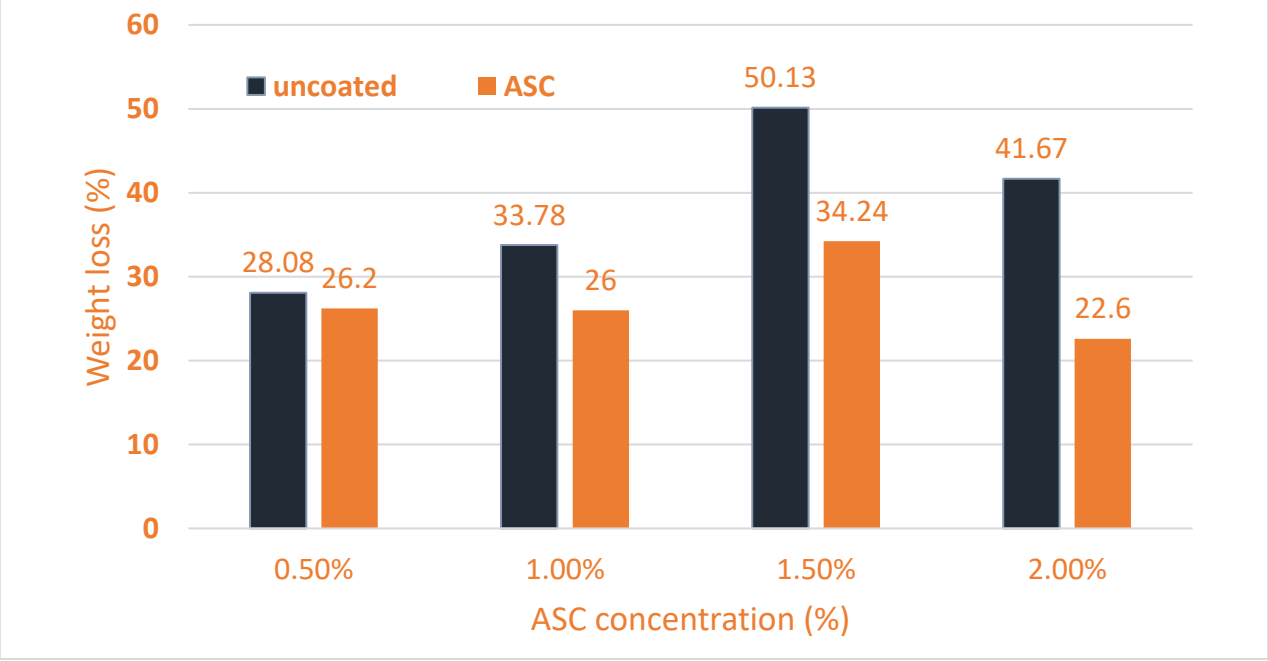


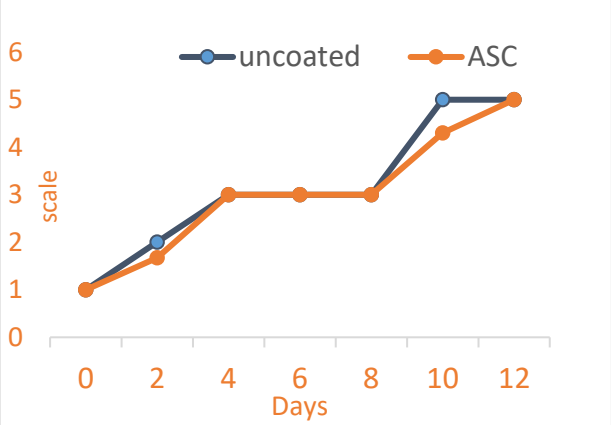
Figure 1: Weight loss of banana after 12 days at different concentration of ASC solution.

From the results show in Figure 1, the percentage weight loss for uncoated banana for all concentration was significantly higher than coated banana with ASC, ranging from 28.08 to 50.13%. While for the coated banana with ASC, the percentage weight loss ranged from 22.6 to 34.24%. The lowest percentage weight loss was recorded for 2.0% ASC solution and the highest was 1.5% ASC solution which were 22.6 and 34.24% respectively. The physiological weight loss between coated and uncoated banana was also reported by Suseno *et al*., (2014).

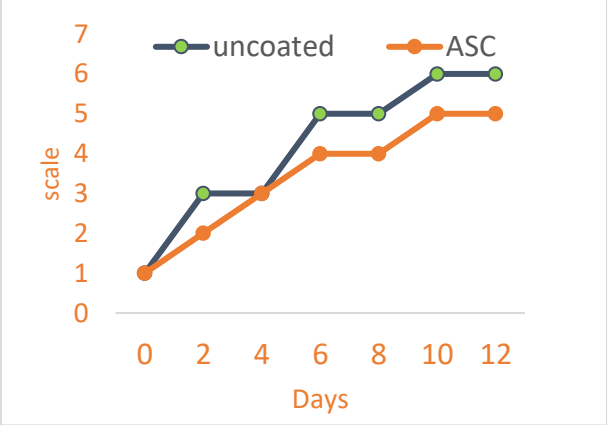
The primary reason for weight loss from banana was due to vapour-phase diffusion which was driven by a gradient of water vapour pressure between inside and outside of the banana which leads to a higher in transpiration process (Suseno *et al*., 2014). By coating banana with ASC solution, it can improved several aspects of the banana such as increased in barrier properties of the cell wall, prevention of water transfer, as well as sealing small wounds which can result in protecting the fruit skin and delaying dehydration. Between all four types of concentration, 2.0% ASC solution results showed the lowest weight loss percentage due to the higher chitosan concentration. A higher chitosan concentration will results in greater thickness of coating on the peel surface, thus increase firmness and reducing moisture loss (Suseno *et al*., 2014).

Peel Colour Changes

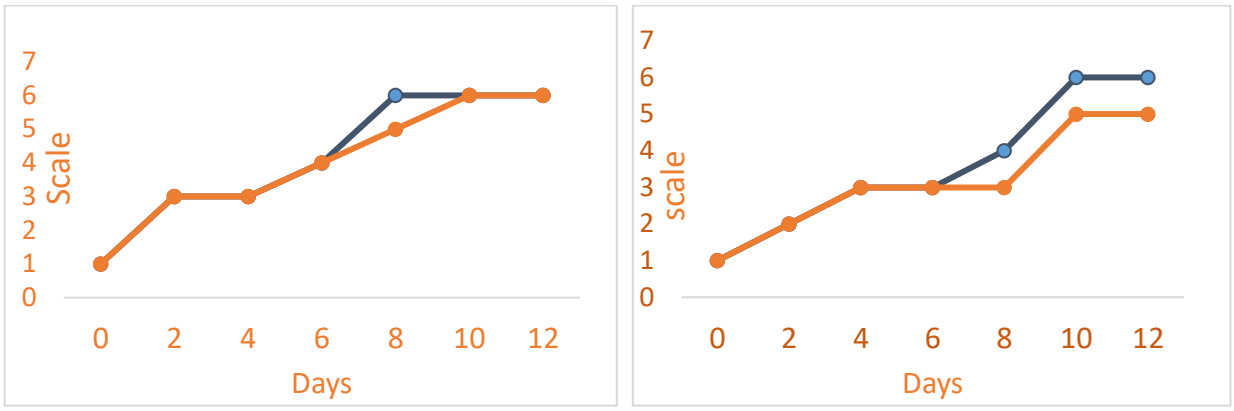
The occurrence of peel browning on banana is one of the main symptoms of postharvest problem for farmers and seller, which can significantly affect the quality of banana thus shorten the shelf life of banana. The peel colour changes were recorded with the help of a chart (1-10 scale; 1- green, 2- green with trace of yellow, 3- more green than yellow, 4- more yellow than green, 5- yellow with trace green, 6- full yellow, 7- yellow with brown spots, 8- more yellow than brown, 9- more brown than yellow, and 10- full brown). Figure 2 showed the results of peel colour changes for banana for 12 days storage.



(a)



(b)



(c) (d)

Figure 2: The peel color changes at (a) 0.50%, (b) 1.00%, (c) 1.50% and (d) 2.00% ASC solution.

From the results obtained after several days, it showed that the browning can be seen starting day 4 for every treatment for uncoated banana as well as coated banana with ASC solution. However, the uncoated banana reached fully brown, which is scale 6 starting day 10 for all concentrations except 1.50% ASC solution. For coated banana with ASC solution, the peel browning reached fully brown starting day 10 for 1.50% ASC while for 0.50, 1.00 and 2.00% ASC, the peel colour has yet to be fully brown during day 12. This showed that these concentration of ASC can delay peel colour browning up to 12 days. The coated banana with ASC showed a slight change in colour due to the higher protection against moisture cause by the barrier formed by the coating and this will decline the respiration rate of the banana. This also can alter the amount of chlorophyll which indicates the reduction in the aging of the banana (Soradech *et al*., 2017).

Titratable Acidity (TA)

The effect of different coatings on the TA of bananas after 12 days of storage are shown in Figure 3.

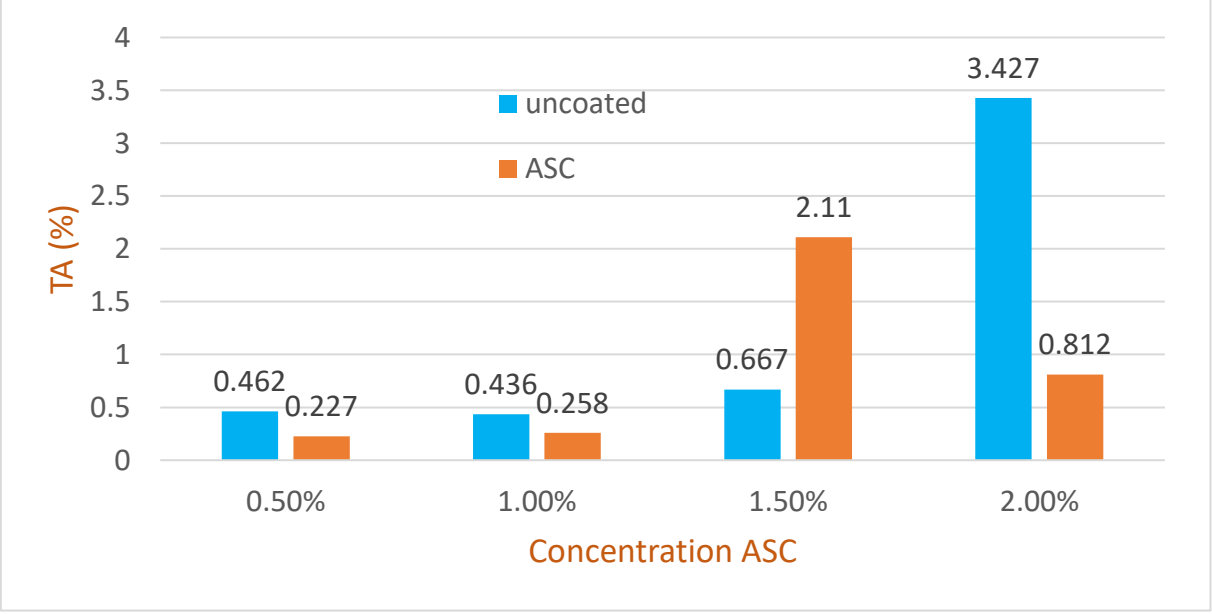


Figure 3: Titratable acidity of banana after 12 days of storage after coating with different concentration of ASC solution.

The result shows that the TA value for uncoated banana during treatment 0.5, 1.0 and 2.0% ASC was higher than the coated banana with ASC, while on the other hand 1.5% ASC TA value was lower during treatment. These results obtained also showed that lower TA value was recorded at lower concentration of ASC solution which was 0.227 and 0.258 % for 0.5 and 1.0% respectively. This indicate that lower concentration of ASC solution can reduced the amount of TA better than a higher concentration of ASC solution. The same results also has been reported by Soradech *et al*., (2017) where samples with coated film can reduce the amount of TA. This is because due to the change in the prevalent organic acids in the banana fruit such as malic acid and citric acid, where they can act as a substrates for the enzymatic reaction of respirations. Besides that, other study also reported that TA value decreased when coating fruit with chitosan where Jiang *et al*., (2005) reported that chitosan can reduced the amount of TA for litchi fruit.

CONCLUSION

In conclusion, chitosan coating could be considered as one of the commercial application to improve the shelf life of banana fruit and also maintain the quality of banana during storage. *In terms of weight loss, among four different concentration of chitosan coating solution, the 2.0% chitosan coating solution showed the lowest weight loss percentage which is 22.6% compare to others significantly. The result also revealed that between the uncoated banana and coated banana at different concentration of ASC solution where the peel colour changes were significantly different during the first day and the final day of observation for each concentration. A significant variation was observed for the titratable acidity of the banana fruit where the lowest value obtained was 0.812% during coating with 2.0% chitosan coating solution while the highest titratable acidity was observed during the coating with 1.5% chitosan solution which is 2.11%.* Some previous study have shown that chitosan can successfully inhibits postharvest diseases of fruits where chitosan can control the respiration process of the banana. Our study suggest that chitosan can effectively prolongs the quality of banana during storage as chitosan can decrease the weight loss, delay peel browning process as well as lower the titratable acidity.

ACKNOWLEDGEMENT

The authors would like to thank all the colleagues whose work has not been mentioned and thank also to the reviewer for their valuable comments and suggestion. The work was supported by UMSGREAT (GUG0454-1/2020) and EnviroClean Energy Sdn Bhd for the financial and technical support.

REFERENCES

Al-Qurashi, A. D., Awad, M. A., Mohamed, S. A. & Elsayed, M. L.2017. Postharvest Chitosan, *Trans*-Resveratrol and Glycine Betaine Dipping Affect Quality, Antioxidant Compounds, Free Radical Scavenging Capacity and Enzymes Activities of 'Sukkari' Banans During Shelf Life. *Scientia Horticulturae*. **219**: 173-181.

Duan, C., Meng, X., Meng, J., Khan, M. I. H., Dai, L., Khan, A., A, X., Zhang, J., Huq, T. & Ni, Y.

2019. Chitosan As A Preservative For Fruits and Vegetables: A Review on Chemistry and Antimicrobial Properties. *Journal of Bioresouurces and Bioproducts*. **4(1):** 11-21.

Dutta, P. K., Dutta. J. & Tripathi, V. S. 2004. Chitin and Chitosan: Chemistry, Properties and Application. *Journal of sciencetific & industrial Research*. **63**:20-31

Jiang, Y., Li, J. & Jiang, W. 2005. Effects of Chitosan on Shelf life of Cold-Stored Litchi Fruit at Ambient Temperature. *LWT* **38**: 757-761.

Li, N., Xiong, X., Ha, Xia. & Wei, X. 2019. Comparative Preservation Effect of Water-Soluble and Insoluble Chitosan from *Tenebrio molitor* Waste. International Journal of *Biological Macromolecules*. **133**: 165-171

Priyadarshi, R. & Rhim, J. W. 2020. Chitosan-Based Biodegradable Functional Films for Food Packaging Applications.

Silva, W. B., Silva, G. M. C., Santana, D. B., Salvador, A. R., Medeiros, D. B., Belghith, I., Silva, N. M., Cordeiro, M. H. M. & Misobutsi, G. P. 2018. Chitosan Delays Ripening and ROS Production in Guava (*Psidium guajava* L.) Fruit. *Food Chemistry*. **242**: 232-238.

Soradech, S., Nunthanid, J. & Limmatvapirat, S. 2017. Utilization of Shellac and Gelatin Composite Film for Coating to Extend the Shelf Life of Banana. *Food Control*. **73**: 1310-1317.

Suseno, N., Savitri, E., Sapei, L. & Padmawijaya, K. S. 2014. Improving Shelf-Life of Cavendish Banana Using Chitosan Edible Coating. *Procedia Chemistry*. **9**: 113-120.

Youn, D. K., No, H. K. & Prinyawiwatkul, W. 2007. Physical Characteristics of Decolorized chitosan Affected by Sun Drying during Chitosan Preparation. *Carbohydrates Polymers*. **69**: 707-712.