Open Access
© 2023, Centre for Advanced Research in Agricultural Sciences
Research Journal of Agricultural Sciences
Volume 14; Issue 05 (Sep-Oct 2023); pp 1332–1336
ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

Full Length Research Article

Impact of Postharvest Chitosan Edible Coating and Ascorbic Acid Treatment on Textural Profile and Colour Attributes in Guava (*Psidium guajava* L.)

Sreyashi Kashyap[1] and Pravin Prakash*[2]

[1-2] Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221 005, Uttar Pradesh, India

Abstract

The effect of chitosan alone and in combination with ascorbic acid on weight loss, textural profile and colour attributes of guava (*Allahabad safeda* L.) was investigated. The guava fruits were treated with 1% and 2% chitosan coating and their combination with 500 µM ascorbic acid, and stored at ambient storage conditions (28±2°C; 70- 80% R.H.). The experiment was laid out in completely randomized design, replicated thrice and functional parameters were recorded at 04 days interval up to 12 days of storage period. Treatment with 2% chitosan coating along with 500 µM ascorbic acid treatment significantly reduced weight loss, which is the main attribute of postharvest deterioration and acted as the best treatment combination. The textural profile including hardness and adhesiveness of guava was also maintained by chitosan coating with ascorbic acid treatment than uncoated guavas. Other textural properties including cohesiveness was minimally maintained by chitosan coating and ascorbic acid treatment. However, the fruits treated with 2% chitosan with 500 µM ascorbic acid showed uneven ripening and didn't turn yellow even at the end of twelve days of storage period.

Key words**:** *Allahabad safeda* L., Chitosan coating, Ascorbic acid, Guava, Textural profile, Weight loss

Native to tropical America, the guava (*Psidium guajava* L.) appears to have its roots somewhere between Mexico and Peru. It is the species of the Myrtaceae family. The Portuguese are thought to have brought it to India towards the beginning of the 17th century [1]. Commercial guava cultivation is carried out mainly in South Africa, Mexico, Peru, Brazil, Cuba, Hawaii, Florida, and California in the United States [2]. In India, Uttar Pradesh (22.93%) is the largest guava producing state, followed by Madhya Pradesh (16.96%) and Bihar (10.56%). After mango, banana, citrus, and apple, it is the fifth-largest cultivable fruit crop in India. The significance of guava fruit may be due to its high production, exceptional nutritional value, and alluring flavour, as well as the fact that it contains several vital bioactive chemicals and five times as much ascorbic acid as citrus fruit [3]. Compared to other fruits, guavas have higher concentrations of dietary fibre, pectin, antioxidants, vitamins, and minerals [3-4].

Guava fruit, on the other hand, is extremely vulnerable to infections, mechanical damage, and cooling stress due to its thin peel and soft texture. As a result, it has a limited postharvest life, which severely restricts its distribution to domestic markets and consumption [5]. Due to the fruit's quick ripening and tendency to bruise, there are significant losses throughout the postharvest period. To date, a variety of postharvest handling strategies have been used to control fruit ripening and minimize losses due to postharvest illnesses and physiological abnormalities. The well-known and typical way of extending the shelf life of guava fruit is low temperature storage. The browning or darkening of the peel and pulp, aberrant ripening, and a rise in the incidence of anthracnose caused by *Colletotrichum gloeosporioides* are all major chilling injury (CI) aberrations, that can occur to guava fruit when stored below 10 °C [6]. The fruit quality and shelf life of guavas can be preserved using commonly used techniques like edible coating treatments, modified atmosphere and controlled atmosphere storage, and ascorbic acid treatment [4], [7-9].

The excellent characteristics of chitosan, such as its ability to form a thin film on the fruit's surface, its ability to prevent the loss of moisture and flavour, its ability to inhibit the uptake of oxygen by plant tissue or microbial growth, and its safety for use on food, make it one of the more promising techniques [10-15]. More importantly, adding an active ingredient to a chitosan-based coating can enhance its antibacterial and anti-browning properties, which is important for the storage of fruits and vegetables [16-20]. For extending the shelf life of numerous fruits, including litchi [21], mango

Received: 02 Jun 2023; Revised accepted: 08 Sep 2023; Published online: 22 Sep 2023

Correspondence to: Pravin Prakash, Department of Plant Physiology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221 005, Uttar Pradesh, India, Tel: +91 9415812817; E-mail: prakashpbhu@gmail.com

Citation: Kashyap S, Prakash P. 2023. Impact of postharvest chitosan edible coating and ascorbic acid treatment on textural profile and colour attributes in guava (*Psidium guajava* L.). *Res. Jr. Agril. Sci.* 14(5): 1332-1336.

[22], peaches, and Japanese pears, chitosan has been tested and is advised. Because of its superior film-forming and biochemical capabilities, chitosan is frequently regarded as the optimal preservation covering for fresh fruits [23]. Ascorbic acid has been reported to control the browning process caused by oxidative stress, considered that chitosan inhibits dehydration and microbial attack and ascorbic acid as antioxidative capacity acts as good combination for fruit preservation without quality loss. Keeping these factors in mind, the present investigation was conducted to examine the effects of various chitosan concentrations alone and with ascorbic acid on weight loss, textural profile and colour of guava fruits.

MATERIALS AND METHODS

Procurement of guava fruits

Fresh guava fruits (*Psidium guajava* L.) were harvested at commercial maturity stage (peel colour break stage, when skin colour changes from dark green to light green) from the orchard of a commercial guava grower in Varanasi district. Fruits of uniform size, weight and colour with no visible blemishes were packed in cardboard boxes and transferred to the laboratory in less than an hour.

Preparation of chitosan solution

According to the method of Jiang and Li [24] chitosan solutions was prepared. Chitosan (Low MW, extrapure, 10-150m.Pas, degree of deacetylation ≥90%) was purchased from Sisco Research Laboratories Pvt. Ltd. To prepare 500 mL of 1.0 and 2.0% (w/v) chitosan solution, accurate weight of 5.0 and 10.0 g of chitosan was dispersed in 50 mL of galacial acetic acid, respectively, before 400 mL of ddH_2O was added to dissolve further the chitosan. Then, the solution was added with 1 mL Tween 80 to improve the wettability. The pH of the solution was adjusted to pH 6.0 with 1 M NaOH and the solution made up to 500 mL. Along with also prepared 500 µM of ascorbic acid solution by adding 88mg of ascorbic acid with 1000mL of ddH_2O.

Imposition of treatment

Guava fruits were uniformly treated using sodium hypochlorite (0.05%), by immersing the fruits in the solution for 3 minutes and subsequently rinsed using distilled water and air-dried to complete the process of disinfection. 50 fruits in each replication were coated with different concentrations of chitosan alone and in combination with ascorbic acid. Treatment using distilled water served as the control. After that, the fruits were air-dried at room temperature for 1 h and then stored at ambient storage conditions (28±2°C; 70-80% R.H.). The weight loss and quality attributes were recorded at 04 days interval up to 12 days of storage period.

Measurement of various functional attributes including weight loss, textural profile and color

Weight loss was calculated by the formula given as:

$$(A - B) / A \times 100$$

Where, A is the weight of fruit just before storage and B is the weight of fruit after definite period of storage.

Textural profile of pulp was analyzed using a hand held penetrometer (TA.XT Plus, Stable Micro Systems Ltd., UK), equipped with a load cell of 50 kg and diameter compression plate probe of 75mm, at the equator of fruit where a section of rind (1.5 × 1.5 cm and ≈ 4 mm deep) had been removed. The speed of the probe was first standardized and was kept 2.0 mm/s during compression. Texture analysis was done at room temperature of 25ºC. Three readings were taken for each guava fruit. The textural properties include hardness, cohesiveness, and adhesiveness.

The surface color of the fruit was measured by Hunterlab Colorimeter and expressed in terms of (L, a and b) values.

Statistical analysis

The experiment design used will be completely randomized design with three replications. The data obtained will be subjected to analysis of variance (ANOVA) and averages would be compared by Duncan's multiple range test at 5% probability.

RESULTS AND DISCUSSION

Weight loss

Chitosan coating application reduced the weight loss of guava fruits during storage compared to the control. There was an increased benefit to control of weight loss by increasing concentrations of chitosan from 1% to 2%. The addition of 500 µM ascorbic acid along with chitosan coating further reduced the per cent weight loss and proved beneficial. For example, the lowest weight loss was found in 2.0% chitosan coating treated with 500 µM ascorbic acid followed by 2.0 and 1.0% solely applied chitosan coating and then uncoated fruits after 12 days of storage (Fig 1). Mainly transpiration and respiration processes cause the loss of water responsible for loss of weight in fresh fruit and vegetable [25]. Chitosan coating can be utilized as a protective barrier to lower respiration and transpiration rates through fruit surfaces and generates a layer of semi-transparent smoothness on the pericarp surface [26]. The guava fruit's weight loss was reduced during evaluation in our study, demonstrating that coating it with chitosan was definitely beneficial in creating a physical barrier to moisture loss. In addition to guava fruit, chitosan coatings have shown promise in preventing weight loss from other foods, such as mangoes, sponge gourds, fresh-cut red pitayas, Washington navel oranges, and fresh-cut red pitayas [27-28].

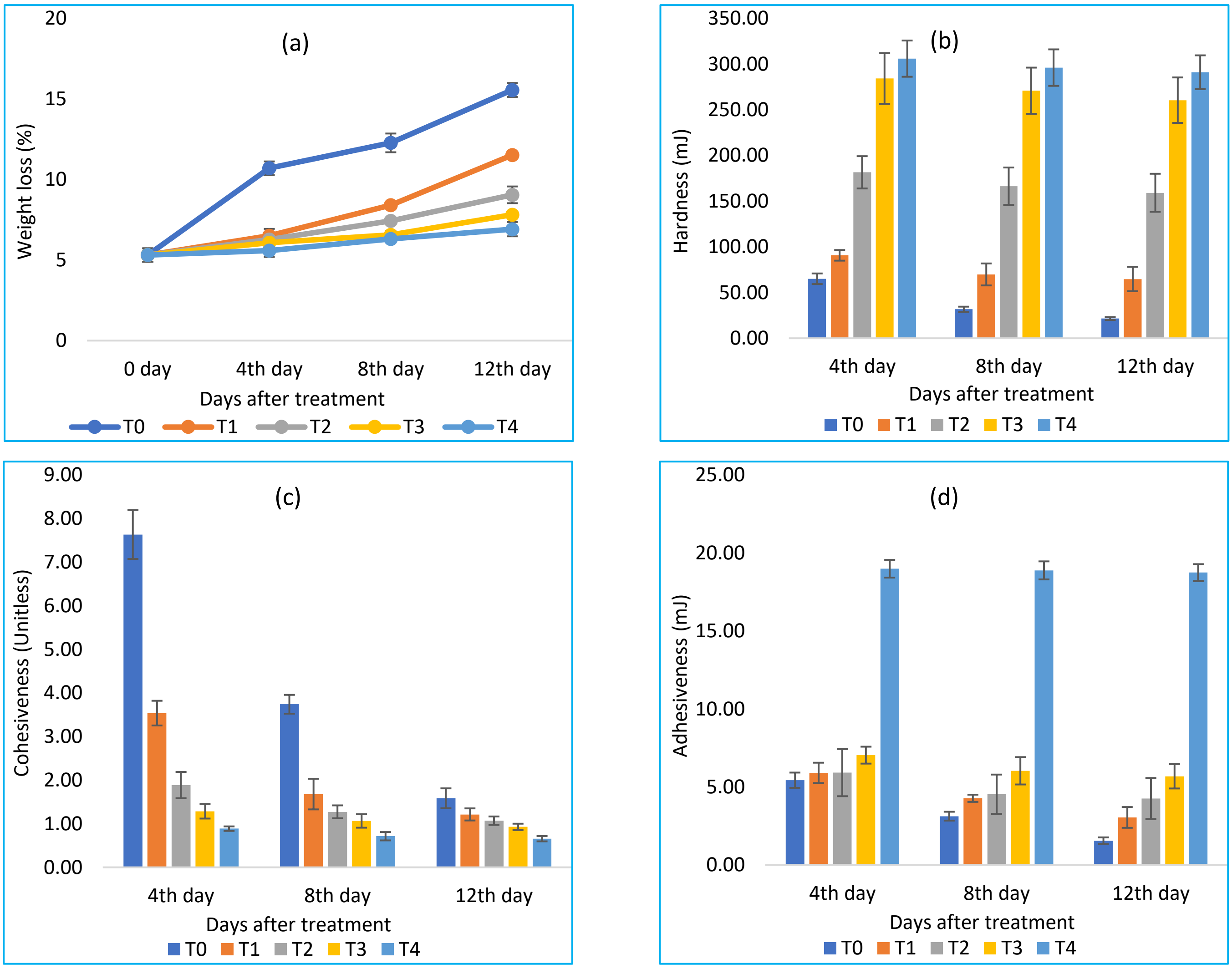
Textural profile

Fruit textural property is sometimes the first of many significant qualities assessed by the consumer and is therefore crucial to the acceptance of the overall product. Guava experiences a rapid loss of textural property during senescence, which significantly shortens its postharvest life and makes it more vulnerable to fungus contamination.

Data in (Fig 1) depicts the differences in flesh textural properties between control and coated fruit samples after 12 days of ambient storage. In case of hardness the initial values for control and coated samples were comparable. Uncoated guavas started to lose their hardness on the fourth day of storage. The hardness of coated guavas also decreased gradually, but on and after the fourth day of storage hardness values for coated samples were progressively higher than the control samples, and then for the same period, significant differences were found between treatments using 2.0% chitosan alone or in combination with ascorbic acid. With regard to coated samples, 2.0% chitosan coating with ascorbic acid (500 µM) was more effective in preventing decline of fruit hardness than the other treatments at ambient condition. Similarly in case of cohesiveness (Fig 1c) of uncoated guavas were seen higher than coated guavas and its value rapidly decreasing after fourth day of treatment, significant differences were shown between 1% chitosan solution alone and a combination of 2% chitosan coating and its combination with ascorbic acid. The adhesiveness values (Fig 1d) showed pattern opposite to cohesiveness, where the coated samples revealed higher adhesiveness value than that of uncoated samples. The different treatments for adhesiveness showed significant differences among themselves with 2% chitosan solution in combination with 500 µM ascorbic acid showing the highest adhesiveness values.

Table 1 Effect of chitosan concentrations alone and in combination with ascorbic acid on surface color in guava fruit stored at ambient storage condition

Treatments	Storage days		
L value	4^{th} Day	8^{th} Day	12^{th} Day
CONTROL	68.35 ± 0.26^{a}	64.47 ± 0.28^{a}	60.31 ± 0.24^{b}
CHI 1%	64.41 ± 0.24^{b}	62.72 ± 0.40^{b}	62.19 ± 0.30^{a}
CHI2%	56.49 ± 0.32^{c}	58.79 ± 0.34^{c}	58.57 ± 0.26^{c}
CHI1% + 500µM AsA	53.43 ± 0.32^{d}	56.35 ± 0.14^{d}	56.01 ± 0.19^{d}
CHI2% + 500µM AsA	51.26 ± 0.18^{e}	54.27 ± 0.37^{e}	53.25 ± 0.23^{e}
a value	4^{th} Day	8^{th} Day	12^{th} Day
CONTROL	4.43 ± 0.23^{a}	15.26 ± 0.18^{a}	18.20 ± 0.33^{a}
CHI 1%	-2.79 ± 0.14^{b}	10.37 ± 0.27^{b}	12.56 ± 0.33^{b}
CHI2%	-9.55 ± 0.30^{c}	-4.63 ± 0.25^{c}	-3.45 ± 0.21^{c}
CHI1% + 500µM AsA	-11.46 ± 0.21^{d}	-7.49 ± 0.21^{d}	-5.59 ± 0.19^{d}
CHI2% + 500µM AsA	-14.58 ± 0.24^{e}	-11.42 ± 0.21^{e}	-9.62 ± 0.20^{e}
b value	4^{th} Day	8^{th} Day	12^{th} Day
CONTROL	47.24 ± 0.38^{a}	49.35 ± 0.27^{a}	49.48 ± 0.44^{a}
CHI 1%	44.65 ± 0.19^{b}	45.41 ± 0.35^{b}	45.87 ± 0.47^{b}
CHI2%	38.53 ± 0.14^{c}	39.94 ± 0.18^{c}	40.24 ± 0.17^{c}
CHI1% + 500µM AsA	37.57 ± 0.17^{d}	39.22 ± 0.11^{c}	39.67 ± 0.12^{c}
CHI2% + 500µM AsA	37.11 ± 0.17^{d}	37.98 ± 0.28^{d}	38.39 ± 0.11^{d}



T_0 = Control, T_1 = 1% chitosan, T_2 = 2% chitosan, T_3 = 1% chitosan with 500µM ascorbic acid, T_4 = 2% chitosan with 500µM ascorbic acid

Fig 1 Effect of chitosan coating alone and with ascorbic acid on weight loss
(a) and various textural properties including hardness (b) cohesiveness (c) and adhesiveness (d) of guava fruits. Each value is the mean for three replicates, and vertical bars indicate the standard errors

Color

L, a, and b represent the surface color, and the values are listed in (Table 1). Brightness has steadily grown during storage from the day of harvest to the end of storage life, according to the L-value. Fruits that had been treated with both chitosan (1% and 2%) and with ascorbic acid (500 µM) had significantly higher values than fruits that had just been treated with chitosan. Positive a-values suggest red color, while negative a-values indicate greenness. The loss of fruit greenness is indicated by the negative value's progressive reduction over the course of storage. Regardless of the treatment, the negative a-value dropped from the date of harvest until the end of their storage life. However, after 4 days of storage, the untreated fruits lost their green color. Fruits treated with 1 percent chitosan lost their green color in 8 days, whereas fruits treated with 2 percent chitosan maintained their green color even after 8 days of storage. Fruits treated with 500 µM ascorbic acid and 2 percent chitosan showed minimal chlorophyll breakdown up to 12 days after treatment. The rise in yellowness from the day of harvest till the end of their storage life is indicated by a positive b-value. Both untreated and treated fruits saw an increase in b-value as of the day of harvest, although chitosan 2 percent treated fruits with 500 µM ascorbic acid had a lower b-value than other treatments.

The breakdown of chlorophyll and production of carotenoid pigments cause the colour shift. In comparison to control and the rate of greenness loss and the development of yellowness was slower in fruits treated with chitosan (both 1% and 2%). This could be as a result of the decreased respiration rate and the declined metabolic activity in fruits treated with chitosan. However, fruits treated with 2% chitosan did not show yellow colour at all, which may be related to the significant CO_2 deposition in fruit tissue that slowed the synthesis of the carotenoid pigment. These fruits also had green mosaic patches that were caused by CO_2 damage. In papaya fruits treated with 2% chitosan, similar outcomes were found [29].

CONCLUSION

Based on the weight loss, textural profile and colour characteristics, it can be said that guava fruits treated with ascorbic acid (500 µM) and chitosan coating, particularly 2.0% (w/v) immediately after harvest, retained the fruit quality attributes the best up to 12 days of ambient storage. Given that guava fruits are highly perishable, the current work offers a viable means of improving their preservation, boosting their marketability and increasing public consumption at little extra cost.

LITERATURE CITED

1. Menzel CM, Paxton BF. 1985. The pattern of growth, flowering and fruiting of guava varieties in sub-tropical Queensland. *Australian Jr. Exp. Agriculture* 26: 123-127.
2. Chadha KL, Pandey RM. 1986. *Psidium guajava*, in Abraham H Halevy (Ed.), CRC Handbook of Flowering, CRC Press Inc., Boca Raton, Florida.
3. McCook-Russell KP, Nair MG, Facey PC, Bowen-Forbes CS. 2012. Nutritional and nutraceutical comparison of Jamaican *Psidium cattleianum* (strawberry guava) and *Psidium guajava* (common guava) fruits. *Food Chemistry* 134: 1069-1073.
4. Murmu SB, Mishra HN. 2018. Post-harvest shelf-life of banana and guava: Mechanisms of common degradation problems and emerging counteracting strategies. *Innov. Food Sci. Emerg. Technology* 49: 20-30.
5. Singh SP, Pal RK. 2008. Response of climacteric-type guava (*Psidium guajava* L.) to postharvest treatment with 1-MCP. *Postharvest Biol. Technology* 47: 307-314.
6. González-Aguilar GA, Tiznado-Hernández ME, Zavaleta-Gatica R, Martínez-Téllez MA. 2004. Methyl jasmonate treatments reduce chilling injury and activate the defense response of guava fruits. *Biochem. Biophys. Res. Commun.* 313: 694-701.
7. Singh SP. 2011. Guava (*Psidium guajava* L.). In Postharvest Biology and Technology of Tropical and Subtropical Fruits: Cocona to Mango; Woodhead Publishing: Sawston, UK. pp 213-246.
8. Alba-Jiménez JE, Benito-Bautista P, Nava GM, Rivera-Pastrana DM, Vázquez-Barrios ME, Mercado-Silva EM. 2018. Chilling injury is associated with changes in microsomal membrane lipids in guava fruit (*Psidium guajava* L.) and the use of controlled atmospheres reduce these effects. *Sci. Hortic.* 240: 94-101.
9. Botelho RV, Souza N, Peres N. 2000. Effect of the postharvest treatment with calcium chloride by the temperature differential method on the control of *Colletotrichum gloeosporioides* in guavas "Branca de Kumagaii. *Summa Phytopathol* 26: 268-271.
10. Mantilla N, Castell-Perez ME, Gomes C, Moreira RG. 2013. Multilayered antimicrobial edible coating and its effect on quality and shelf-life of fresh-cut pineapple (Ananas comosus). *LWT-Food Science and Technology* 51(1): 37-43.
11. Lago-Vanzela ES, do Nascimento P, Fontes EAF, Mauro MA, Kimura M. 2013. Edible coatings from native and modified starches retain carotenoids in pumpkin during drying. *LWT-Food Science and Technology* 50(2): 420-425.
12. Lima AM, Cerqueira MA, Souza BWS. 2010. New edible coatings composed of galactomannans and collagen blends to improve the postharvest quality of fruits-influence on fruits gas transfer rate. *Journal of Food Engineering* 97(1): 101-109.
13. dos Santos NST, Athayde Aguiar AJA, de Oliveira CEV. 2012. Efficacy of the application of a coating composed of chitosan and *Origanum vulgare* L. essential oil to control *Rhizopus stolonifer* and *Aspergillus niger* in grapes (*Vitis labrusca* L.). *Food Microbiology* 32(2): 345-353.
14. Dutta PK, Tripathi S, Mehrotra GK, Dutta J. 2009. Perspectives for chitosan based antimicrobial films in food applications. *Food Chemistry* 114(4): 1173-1182.
15. Aider M. 2010. Chitosan application for active bio-based films production and potential in the food industry: review. *LWT-Food Science and Technology* 43(6): 837-842.
16. Xing Y, Xu Q, Che Z, Li X, Li W. 2011. Effects of chitosan-oil coating on blue mold disease and quality attributes of jujube fruits. *Food and Function* 2(8): 466-474.
17. Abbasi NA, Iqbal Z, Maqbool M, Hafiz IA. 2009. Postharvest quality of mango (*Mangifera indica* L.) fruit as affected by chitosan coating. *Pakistan Journal of Botany* 41(1): 343-357.
18. Tahiri I, Desbiens M, Lacroix C, Kheadr E, Fliss I. 2009. Growth of *Carnobacterium divergens* M35 and production of Divergicin M35 in snow crab by-product, a natural-grade medium. *LWT - Food Science and Technology* 42(2): 624-632.
19. Xing Y, Li X, Xu Q, Yun J, Lu Y. 2010. Antifungal activities of cinnamon oil against *Rhizopus nigricans*, *Aspergillus flavus* and *Penicillium expansum* in vitro and in vivo fruit test. *Int. Jr. Food Sci. Technology* 45(9): 1837-1842.

20. Xing Y, Li X, Xu Q, Yun J, Lu Y, Tang Y. 2011. Effects of chitosan coating enriched with cinnamon oil on qualitative properties of sweet pepper (*Capsicum annuum* L.). *Food Chemistry* 124(4): 1443-1450.
21. De Reuck K, Sivakumar D, Korsten L. 2009. Effect of integrated application of chitosan coating and modified atmosphere packaging on overall quality retention in litchi cultivars. *Jr. Sci. Food Agric.* 89: 915-920.
22. Chien PJ, Sheu F, Yang FH. 2007. Effects of edible chitosan coating on quality and shelf-life of sliced mango fruit. *Jr. Food Engineering* 78: 225-229.
23. El-Ghaouth A, Smilanick JL, Wilson CL. 2000. Enhancement of the performance of *Candida saitoana* by the addition of glycolchitosan for the control of postharvest decay of apple and citrus fruit. *Postharvest Biol. Technology* 19: 103-110.
24. Jiang, YM, Li YB. 2001. Effects of chitosan coating on postharvest life and quality of longan fruit. *Food Chemistry* 73: 139-143.
25. Zhu X, Wang QM, Cao JK, Jiang WB. 2008. Effects of chitosan coating on postharvest quality of mango (*Mangifera indica* L. cv. Tainong) fruits. *Jr. Food Process. Preserv*. 32: 770-784.
26. Dong H, Cheng L, Tan J, Zheng K, Jiang Y. 2004. Effect of chitosan coating on quality and shelf-life of peeled litchi fruit. *Jr. Food Engineering* 64: 355-358.
27. Han C, Zuo J, Wang Q. 2014. Effects of chitosan coating on postharvest quality and shelf life of sponge gourd (*Luffa cylindrica*) during storage. *Sci. Hortic.* 166: 1-8.
28. Xing Y, Xu Q, Li X, Chen C, Ma L, Li S, Lin H. 2016. Chitosan-based coating with antimicrobial agents: preparation, property, mechanism, and application effectiveness on fruits and vegetables. *Int. Jr. Polym. Sci*. 2016: 1-24.
29. Krishna KR, Rao DS. 2014. Effect of chitosan coating on the physiochemical characteristics of guava (*Psidium guajava* L.) fruits during storage at room temperature. *Indian Jr. Sci. Technology* 7(5): 554-558.