EFFECT OF CHITOSAN COATING ON THE POST HARVEST QUALITY OF BANANA DURING STORAGE

ABSTRACT

Edible coating is beneficial to the shelf life of postharvest fruit and vegetable. Chitosan-based coating was concerned in recent years owing to its non-toxic, biodegradable, and biocompatible. The main benefits of edible active coatings are to maintain the quality and extend shelf-life of fresh fruits and prevent microbial spoilage. Chitosan has been proven one of the best edible and biologically safe preservative coatings for different types of foods because of its film-forming properties, antimicrobial actions and lack of toxicity, biodegradability and biochemical properties. Chitosan coating offers a defensive barrier against bacterial contamination and loss of moisture from the surface of food products, thus extending their shelf life.

The objective of the study was to evaluate the effect of chitosan Coatings were applied by double immersion of fruits in the film-forming solutions for 5 min, depending on treatments: (i) chitosan at 1.5% (w/v) in lactic acid 1% (v/v); (ii) chitosan at 1.5% (w/v) in lactic acid 1% (v/v) and Tween 80 at 0.1% (w/v); and (iii) chitosan at 1.5%(w/v) in acetic acid 1% (v/v). (iv) uncoated. Fruits were allowed to dry for 1h air dry and were subsequently stored during 10 days. The effectiveness of the treatments in extending fruit shelf-life was evaluated by determining ripening stages, weight loss, firmness, ph, total sugars, reducing sugars, non- reducing sugars.

The addition of Lactic acid at 1% (w/v based on chitosan) and Tween 80 at 0.1% (v/v) in chitosan solution improved its coating properties delaying the ripening stage, weight loss, firmness, pH, total sugars, reducing sugars non-reducing sugars of banana.

Keywords: banana**,** chitosan, food, fruits, lactic acid, shelf life, vegetable.

INTRODUCTION

The physicochemical characteristics of Chitin and Chitosan influence their functional properties such as chemical reactivity, solubility and biological activities (F.A. Al Sagheer et al 2009) like biodegradability (H. Sato et al 1998), (P. Sorlier et al 2001), which differs depending on the crustacean species and preparation methods (H.K. No et al 2003). Chitosan, is a natural, non-toxic, biodegradable, high molecular weight polycationic polymer. It has been described as "nature's most versatile biomaterial" (Sandford, 1989). Chitosan is composed primarily of glucosamine, or 2- amino-2-deoxy-D-glucose linked together by β (1-4) glycosidic bonds (Sandford, 1989).

Chitosan is not native to animal sources and is normally obtained by the deacetylation of chitin (extracted from exoskeleton of prawns) using sodium hydroxide. Most chitosan is manufactured from shellfish because a large amount of shellfish exoskeleton is available as a by-product of food processing. Plant sources of chitin include algae, commonly known as marine diatoms, protozoa and the cell wall of several fungal species (Feofilova et al., 1996).

Edible coatings are traditionally used to improve food conservation and appearance due to their environmentally friendly nature. They are obtained from both animal and vegetable or plant agricultural products. The type and concentration of edible components have important effects on the quality characteristics of coated fruits such as weight loss, pH, firmness, colour, reducing sugars, total sugars and Non reducing sugars.

Post-harvest treatment of Allahabad Safeda guava fruits with 1% chitosan delayed the ripening process and pro¬longed storage life up to 7 days at ambient conditions (28-32 oC and 32 - 41% RH) (K. Rama Krishna and D. V. Sudhakar Rao, 2014). Chitosan coating could prolong fresh-cut Fa-lun mangoes during storage at 6°C for 7 days. Chitosan could reduce weight loss, maintain total soluble solids and retard the growth of microorganisms in fresh-cut Fa-lun mangoes (Sinee Nongtaodum and Anuvat Jangchud, 2009). The application of chitosan coating (with optimum concentration 20 g/kg) could be beneficial and considered for commercial application in extending the shelf-life and maintaining quality and to some extent controlling decay of mushroom. In using chitosan for decay control we consider that it may be suitable in the treatment of mushroom stored for shorter periods (e.g. 3 days) or for short-distance transport and distribution. However, for longer storage and marketing, chitosan coating to control. (Hesham A. A. Eissa, 2008).

Application of edible chitosan coatings can increase the shelf-life time of matured melons. The effect was monitored by several physical and chemical techniques. It could be explained in the sense of decreasing of respiration rate and stabilization of the cell wall. Further strengthening of the structure could be achieved by addition of calcium ions that interact with cell pectin to create water insoluble ca-pectate network, (Zsivanovits., Get al.,.2012). The major factors responsible for extending the shelf life of fruits and vegetables include: careful harvesting so as not to injure the product, harvesting at optimal horticultural maturity for intended use, and good sanitation (Moleyar and Narasimham, 1994; Lee et al., 1996).

In the present work chitosan coating of the banana were performed by using three different solutions ie., Lactic acid, Acetic and Tween 80.The banana were kept under observation for 10 days by testing physical and chemical parameters every day and graphs were plotted to analyze the delay of the fruit ripening. The results show that chitosan coating with Lactic Acid and Tween 80 is better to use for fruit storage and to delay the ripening stages.

MATERIALS AND METHODS

Preparation of chitosan

The process was carried out by adding 50% sodium hydroxide to the obtained chitin sample on a hot plate and boiling it for 2 hrs at 100°C. The sample was then allowed to cool at room temperature for 30 minutes. Then they were washed continuously with 50% sodium hydroxide. The sample obtained is filtered and oven-dried for 6 hrs at 110°C to obtain chitosan (Muzzarelli RA and Rochetti R, 1985).

Bananas

Long life banana fruits of nearly 80 number were purchased from a local market. Fruits were selected, based on uniformity of size, ripening stage, absence of physical damage and fungal infection.

Edible coating formulations

A chitosan aqueous solution (1.5%, w/v) was prepared dissolving chitosan powder in a solution of lactic acid (1%, v/v) and acetic acid (1% v/v) at 40 °C, since chitosan is only soluble in an acidic medium. Then, Tween 80 at 0.1% (v/v) was added for improving wettability for 24 h. After wards, chitosan solution was added into pretreated Lactic acid solutions The resulting mixture was stirred vigorously with heating using a magnetic stirrer during 60 min until chitosan was dissolved. After the chitosan was dissolved, the solutions were filtered to remove foam and any undissolved impurity.

Coating applications

40 Bananas were randomly distributed into four groups. Three groups were assigned to one of three treatments whilst the fourth group provided the untreated control. Coatings were applied by double immersion of fruits in the film-forming solutions for 5 min, depending on treatments: (i) chitosan at 1.5% (w/v) in lactic acid 1% (v/v); (ii) chitosan at 1.5% (w/v) in lactic acid 1% (v/v) and Tween 80 at 0.1% (w/v); and (iii) chitosan at 1.5% (w/v) in acetic acid Fruits were allowed to dry by natural air for 1 h at 25 ºC and were subsequently stored for future use.

Physical parameters-Quality attributes

Classification according to ripening stages

The bananas were classified according to their ripening stage using a visual scale proposed by Kramer, A., 1965. These changes during ripening period (loss of greenness and increase in yellowness) may occur as breakdown of the chlorophyll in the peel tissue. Maximum polyphenol oxidase activity was observed at maturity stage four days which was gradually decreased as ripening progressed. The bananas were expressed as the predominant ripening stage in each treatment. The bananas were observation of ripening stage different treatment for every day.

Weight loss

The selected 80 bananas, corresponding to each treatment, were weighed at the beginning, just after coating and air-drying, and thereafter each sampling days during the storage. Weight loss was expressed as the percentage loss of the initial total weight and of every day weight.

Firmness /texture analysis

The firmness of a banana is linked to the state of maturity and ripeness and may be influenced by the variety as well as the region of production and the growing conditions. The Penetrometer instrument used consists of a cone, set in position so that the rake of the dial touches the upper end of the stick. The dial gauge is set on “0” postion by a small knob. Now arm with dial and cone set is lowering till the tip of cone touch the surface of banana the botton of arm is pressed for 5 seconds and the cone can down in to the banana. Four replicates in individual banana were done for each treatment. Each banana was measured in the central point and both sides’ points. Firmness was measured as the maximum penetration distance reached during penetration time.

Chemical parameters

pH: After firmness analysis, banana were cut into small pieces and homogenized in a grinder, and 10 g of ground banana was suspended in 100 mL of distilled water and then filtered. The pH samples were assessed using a pH meter (SYSTRONICS).

Titratable Acidity (TA): After firmness analysis, banana were cut into small pieces and homogenized in a grinder, and 10 g of ground Banana was suspended in 100 mL of distilled water and then filtered. The titrable acidity of the samples was titrated using 0.1 N NaOH. Titrable acidity was expressed as grams of citric acid per 100 g of banana weight.

Extraction and determination of total sugar and reducing and non reducing sugar from banana pulp

Extraction of sugar from banana pulp was done by using Loomis and Shull (1937) method. Four banana pulps were cut into small pieces and immediately plunged into boiling ethyl alcohol and were allowed to boil for 5 to 10 minutes (10 to 20 ml of alcohol was used per gm of pulp). The extract was filtered through the two layers of cheese cloth and the ground tissue was re-extracted for 3 minutes in hot 80% alcohol, using 2 to 3 ml of alcohol per gm of tissue. The second extraction was ensured complete removal of alcohol suitable substances. The extract was cooled and passed through the two layers of cheese cloth. Both extracts were filtered through Whatman No.41 filter paper.

The volume of the extract was evaporated to about 25% of the volume over steam bath and cooled. This reduced volume of extract was transferred to a 100 ml volumetric flask and it was made up to the mark with distilled water. Total sugar content of banana pulp was determined by phenol sulphuric acid method. Reducing sugar content of banana pulp was determined by dinitrosalicylic acid method (Miller, 1972) and non reducing sugar was calculated by subtracting reducing sugar from the total sugar.

RESULTS AND DISCUSSION

Classification according to ripening stages:

The following figures show the changes in ripening stages of uncoated (Control) and coated banana.

(A)Uncoated Banana (Control) **(B) Coated banana with Solution (i)(ii) (iii)**

Figure 1(A): Effect of chitosan coating on ripening stages of (control) Banana during storage (Represent on Day1).

(A) UnCoated Banana (control) (B) Coated banana with solution (i)(ii)(iii)

Figure 1(B): Effect of chitosan coating on ripening stages of banana during storage (Represent after Day 10)

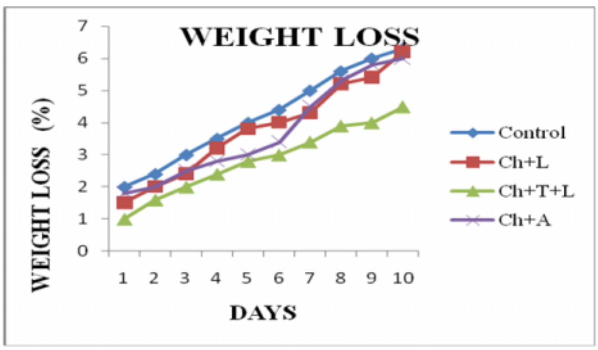
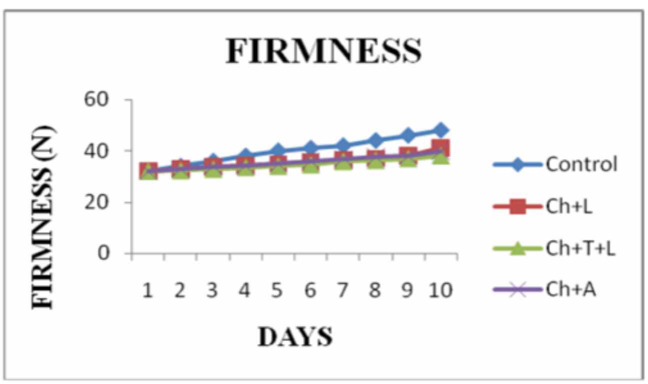


Fig: 2. Effect of chitosan coating on weight loss of banana during storage.
(Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A =



Chitosan+Acetic Acid)
Fig 3: Effect of chitosan coating on firmness of banana during storage.

(Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

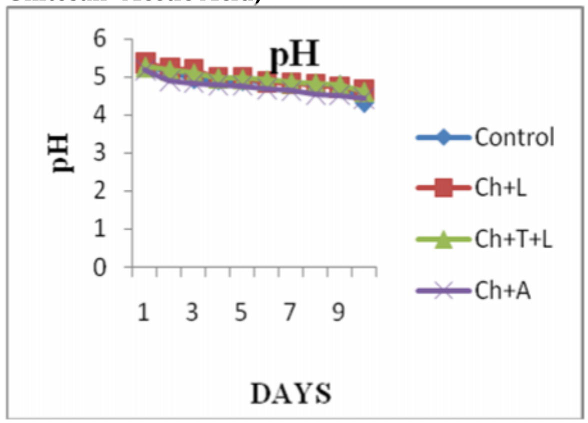


Fig 4: Effect of chitosan coating on pH of banana during storage.
(Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

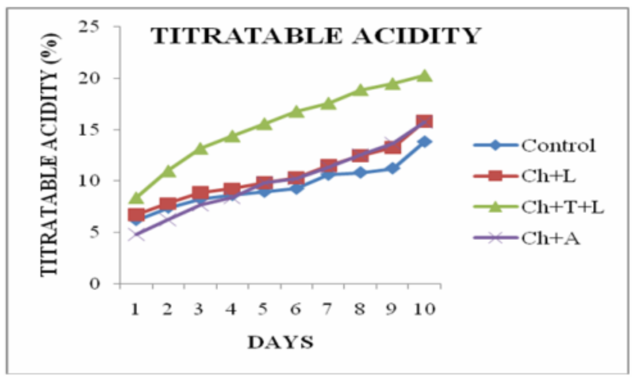


Fig 5: Effect of chitosan coating on Titratable Acidity of banana during storage. (Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

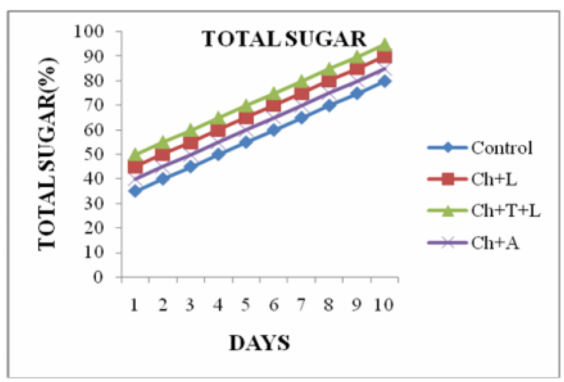


Fig 6 : Effect of chitosan coating on Total Sugars of banana during storage. (Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

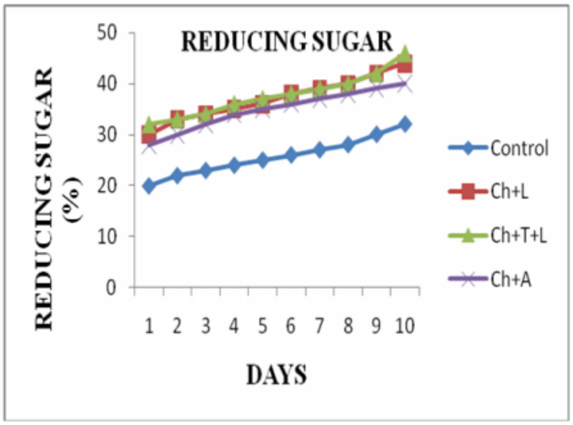


Fig: 7. Effect of chitosan coating on Reducing Sugar of banana during storage.
(Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

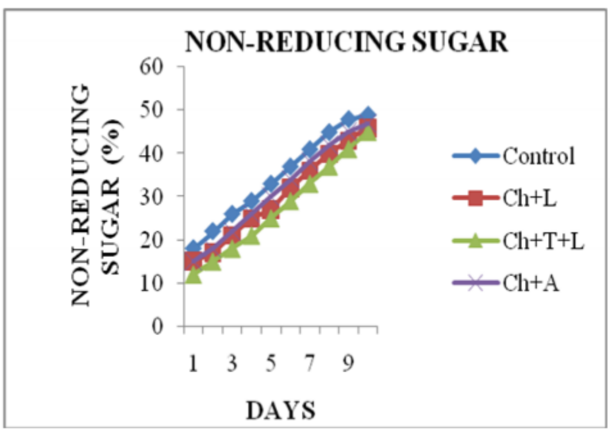


Fig: 8. Effect of chitosan coating on Non-Reducing Sugar of banana during storage. (Ch+L = Chitosan +Lactic Acid, Ch+T+L = Chitosan+Tween 80+Lactic Acid, Ch+A = Chitosan+Acetic Acid)

The highest weight loss was observed in control fruit (6.3%).The lowest weight loss was observed in coated fruits with the Chitosan, Tween 80 and Lactic acid coated fruit (4.5%). There is no significant difference in coated fruits of Chitosan and Lactic acid (6.2%), Chitosan and Acetic acid (6%) coatings. Chitosan was found to be more effective at delaying weight loss.

The highest firmness was observed in control fruit (48%).The lowest weight loss was observed in coated fruits the Chitosan, Tween 80 and Lactic acid coated fruit (38%). There is no significant difference in coated fruits Chitosan and Lactic acid (41.2%), Chitosan and Acetic acid (40%) coated fruits. Chitosan was found to be more effective at delaying firmness.

The lowest pH was observed in uncoated fruit (4.84).There is no significant difference in coated fruits with Chitosan, Lactic acid and tween 80 (4.92) Chitosan and Lactic acid (4.87), Chitosan and Acetic acid (4.89). Chitosan was found to be more effective at delaying pH concentration.

The calculation for determining the sugar/acid ratio of banana contain malic acid (0.0067).The appropriate multiplication factor must be applied to each calculation.

The highest titratable acidity was observed in coated fruit of Chitosan, Tween 80 and lactic acid (20.3%). There is no significant difference in coated fruits Chitosan and Lactic acid (15.83%), Chitosan and Acetic acid (15.75%). Chitosan was found to be more effective at delaying firmness. The lowest titratable acidity was observed in uncoated fruit (13.80%). At the beginning of the ripening process the sugar/acid ratio is low, because of low sugar content and high fruit acid content. When the ripening process stated the sugar/acid ratio is high because of high sugar content and low fruit acid content. This makes during the ripening process the fruits storage of future purpose.

The chitosan coated fruits of total sugar content were found to be significant during storage. The total sugar content was gradually increased and reached the pick point at day of storage in both coated and uncoated fruits.

The highest total sugar content was observed in coated fruit of Chitosan and Tween 80 and lactic acid (95%). There is no significant difference in coated fruits Chitosan and Lactic acid (90%), Chitosan and Acetic acid (85%). Chitosan was found to be more effective at delaying of total sugar contents. The lowest total sugar content was observed in uncoated fruit (80%).

The significant of chitosan coated banana were observed in reducing sugar content gradually increased between four fruits of uncoated and coated at during storage. The increase in reducing sugar with the progress of ripening as well as storage time was due to the degradation of starches to glucose and fructose by the activities of amylase and maltase.

The highest reducing sugar content was observed in coated fruit of Chitosan and Tween 80 and lactic acid (46%). There is no significant difference in coated fruits with Chitosan and Lactic acid (43%), Chitosan and Acetic acid (40%). Chitosan was found to be more effective at delaying of reducing sugar contents. The lowest reducing sugar content was observed in uncoated fruit (control) (32%).

The significant of chitosan coated banana were observed in non-reducing sugar content gradually increased between four fruits of uncoated and coated at during of storage.The maximum non-reducing sugar contents were found in uncoated fruit (49%). The lowest non-reducing sugar content was observed in Chitosan and Tween 80 and lactic acid (45%). There is no significant difference in coated fruits with Chitosan and Lactic acid (46%), Chitosan and Acetic acid (47%).

CONCLUSION

The application of chitosan with different physicochemical parameters was performed. The lowest Weight loss and Firmness is observed less in coated banana. The control shows early ripening stage, pH decreased in uncoated banana. Total sugars levels gradually increased in both coated and uncoated bananas. Reducing sugars levels increased only in coated bananas, whereas Non-reducing sugars levels increased in uncoated banana. Our results demonstrate that this is a valuable product for the fruit preservation and viable for commercial applications.

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