American Journal of Agricultural Science
2019; 6(1): 1-10
http://www.aascit.org/journal/ajas
ISSN: 2381-1013 (Print); ISSN: 2381-1021 (Online)

AASCIT American Association for Science and Technology

Assessment of Chitosan as Preservative on Shelf Life and Major Nutrient Contents on Fruits and Vegetables

Must Alima Rahman[1, 2, *], Mohammed Ariful Islam[1], Mohammad Tipu Sultan[3], Abu Hena Mostofa Kamal[2], Ruhul Amin Khan[2], Mohammad Razzak[2], Mohammad Tazul Islam Chowdhury[1], Mohammad Sirajul Islam Khan[1], Mohammad Zahirul Islam Mollah[2]

[1]Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2]Institute of Radiation and Polymer Technology, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh
[3]Department of Soil, Water and Environment Discipline, Khulna University, Khulna, Bangladesh

Email address

alimarahman11@gmail.com (M. A. Rahman)

[*]Corresponding author

Citation

Must Alima Rahman, Mohammed Ariful Islam, Mohammad Tipu Sultan, Abu Hena Mostofa Kamal, Ruhul Amin Khan, Mohammad Razzak, Mohammad Tazul Islam Chowdhury, Mohammad Sirajul Islam Khan, Mohammad Zahirul Islam Mollah. Assessment of Chitosan as Preservative on Shelf Life and Major Nutrient Contents on Fruits and Vegetables. *American Journal of Agricultural Science.* Vol. 6, No. 1, 2019, pp. 1-10.

Received: October 9, 2018; **Accepted**: November 4, 2018; **Published**: March 6, 2019

Abstract: Postharvest loss of perishable fruits and vegetable is of great concern for Bangladesh. As agricultural crops are rapidly perishable, they are also damaged due to high humidity and temperature. To address this problem, chitosan was prepared from prawn shell collected from local market and applied on tropical fruits and vegetables namely banana, tomato and papaya for extending shelf life. Samples were collected from 3 markets near Dhaka city. Chitosan was applied on treatment groups by deep coating method. The experiment was laid out with three replications under two doses of chitosan (500ppm and 1000ppm). Significant difference were found higher in tomato and papaya than banana for color index and weight loss parameter, while EC, pH, percent Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) levels were remains similar. In case of Total Viable Count (TVC) and Total Fungal Count (TFC), the significant difference was higher in control than 500ppm and 1000ppmchitosan for banana, tomato and papaya. Percentages of nitrogen (N) and potassium (K) content were remaining similar or high, while phosphorus (P) content was remaining similar. Present study shows that 500ppm dose of chitosan is more effective compared to that of 1000ppm dose of chitosan in banana. It can be concluded that coating with chitosan can be employed to extend the shelf life and to improve quality of fruits and vegetables by delaying ripening, reducing weight loss and reducing microbial growth in fruits and vegetables.

Keywords: Chitosan, Preservatives, Deep Coating Method, Shelf Life, Nutrient Contents

1. Introduction

Bangladesh is predominantly an agrarian country. Due to its very fertile land and favorable weather, varieties of crops grow abundantly in this country. Agriculture sector contributes about 17 percent to the country`s Gross Domestic Product (GDP) and employs more than 45 percent of total labour force [1]. However every year, a huge portion of produced crops are damaged due to lack of proper postharvest preservation. During the past decade, there was an increasing interest to develop and use bio-based active films which are characterized by antimicrobial and antifungal activities in order to improve food preservation and to reduce the use of chemical preservatives such as plastic. Abundant naturally occurring polymers – as starch, collagen, gelatin, alginate, cellulose and chitin represent attractive candidates as natural preservatives [2]. Biologically active bio-molecules such as chitosan and its derivatives have a

significant potential in the food industry because of probable microbial contaminations associated with food products and the increasing concerns in relation with the negative environmental impact of conventional packaging materials [3]. Currently, chitin and chitosan are produced commercially by chemical extraction process from crab, shrimp, and prawn wastes [4-5]. There are few industrial-scale plants of chitin and chitosan worldwide located in the USA, Canada, Scandinavia, and Asia [6]. Chitosan displays interesting characteristics including biodegradability, biocompatibility, chemical inertness, high mechanical strength, good film-forming properties, and low cost [7-9]. Due to its low toxicity, biocompatibility and bioactivity, chitosan has become a very attractive material in such diverse applications as biomaterials in medical devices and as a pharmaceutical ingredient [10-11]. Chitosan can function as a moisturizer for the skin, and because of its lower costs, it might compete with hyaluronic acid in this application [12-14]. The aim of the present research work is to assess the effect of chitosan (an organic preservative collected from Shrimp) on shelf life and major nutrient contents of some selected fruits and vegetables.

2. Materials and Methods

2.1. Preparation of Chitosan

The collected prawn shells samples were transported to the laboratory and air dried. After drying in air, the prawn shells were converted into chitosan through deprotenization, demineralization and deacetylation processes.

(a). The collected waste prawn shell was washed with hot water (70°C) and then dried in an oven at 105°C for 72 hours. Dried prawn shellwas ground and then deproteinized with 1 N NaOHsolutionat boiling temperature (100°C) for 4 hours (prawn shell: NaOH = 1:16, w/v) and demineralinzed with 1 N HClsolution at boiling temperature (100°C) for 4 h (chitin: HCl = 1:13, w/v). The mixture was then washed with distilled water, filtered to neutralize and dried at 105°C in an oven for 24 hours. Prepared chitin is an intermediate product of chitosan [15].

(b). Chitosan was obtained by deacetylation of chitin using 1N NaOH (chitin: NaOH = 1:20, w/w, Solid state ratio) at 100°C for 4hours. After this process, solid was separated from the alkali and was extensively washed with distilled water to removetraces of NaOH (neutralization was confirmed using Litmus paper). The resultant solid was dried in a vacuumoven at 50°C for 24 hours. Chitosan was extracted in this wayfrom prawn shell waste. At last solid chitosan was converted into solution by 2% acetic acid [15].

2.2. Application of Chitosan

At first some selected fruits and vegetables were divided into 2 and 3 groups. Among them 1 group for control and other groups for treatment. Chitosan was applied on treatment groups by deep coating method.

3. Name of the Parameters

3.1. Color Index

Skin color development was assessed visually and a color index was calculated on scale from 1 (green) to 5 (full color) [16]. To do so, skin color of individual fruit was scored on a ripening scale of: 0 = green, 1 = breaker, 2 = <25% color change, 3 = 25-30% color change, 4 = >50% color change but <75% color change, 5 = full color.

The color index (CI) was calculated using the following formula:

$$\text{CI}\ (\%) = \frac{\sum(\text{color scale} \times \text{No. of corresponding fruits or vegetables})}{(\text{The highest scale} \times \text{No. of the total fruits or vegetables})} \times 100$$

Note: Color Index was recorded at days 0, 10, 20 and 30.

3.2. Weight Loss

The weight loss was measured, fruits or vegetables were taken out from each samples and weighed per 3 days [17]. The weight loss was calculated by the following formula:

$$\text{Weight loss}\ (\%) = \frac{\text{m0} - \text{m1}}{\text{m0}} \times 100$$

Where, m_o = the initial weight

m_1 = the weight measured during storage

3.3. Electrical Conductivity

At first, take 20g sample and add 50mL distilled water. Stir the mixture for half an hour to ensure complete dispersion of the sample. Left the conical flask in rest to decant the sample and the electrode of the EC meter is deep into the overlying water. Take care that the electrode does not touch the underlying sample. Record the reading [18].

3.4. pH

At first, take 20g sample and add 50mL distilled water. Stir the mixture for half an hour to ensure complete dispersion of the sample. Left the conical flask in rest to decant the sample and the electrode of the p^H meter is deep into the overlying water. Take care that the electrode does not touch the underlying sample. After stabilization, take the reading [19].

3.5. Total Suspended Solid

Oven dry a WN-1 filter paper at 110°C temperature for

about 2-3 hours and record the weight after cooling. Take 20g sample and add 50mL distilled water. Mixed very well and filter with WN-1 filter paper. After filtration, again oven dry the filter paper at 110°C temperature for about 2-3 hours and record the weight after cooling [20].

Calculation:

$$TSS\ (\%\ w/w) = [(W_s - W_e) \div E] \times 100$$

Where, W_s = Oven dry weight of the filter paper with suspended materials

W_e = Oven dry weight of the empty filter paper

E = Weight of the sample taken for filtration

3.6. Total Dissolved Solid

Oven dry a empty conical flask at 110°C temperature for about 2-3 hours and record the weight after cooling. Take 20g sample and add 50mL distilled water. Mixed very well and filter with WN-1 filter paper. After filtration, again oven dry the conical flask at 110°C temperature for about 2-3 hours and record the weight after cooling [20].

Calculation:

$$TDS\ (\%\ w/v) = [(W_d - W_e) \div E] \times 100$$

Where, W_d = Oven dry weight of the conical flask with dissolved materials

W_e = Oven dry weight of the empty conical flask

E = Volume of the water taken for filtration

3.7. For Microbial Growth Analysis

It is often necessary to determine how many live bacteria and fungus are actually in a sample, especially when measuring growth rates or determining disinfectant effectiveness. This involves the serial dilution of bacteria and fungus samples and plating them on suitable growth media [21]. We can also filter our samples through a membrane which we place on a pad soaked with growth media. The plates are incubated until we see visible colonies, usually 18-24 hours. The colonies we see growing on the plate are considered to have started from one viable bacterial and fungal unit. Because bacteria and fungus are usually not found as individuals, the colony we see may have started from a single cell or a group of cells. The results are reported as colony forming units (CFU's) [22-23]. There are several methods commonly used for plate counting bacteria and fungus but we worked in pour plate method. For the pour method the bacterial and fungal sample is suspended in molten agar that is just barely warm enough to keep the agar from setting up. It is then poured into an empty Petri dish or poured in a thin layer on another agar surface. The advantages of these methods are that the colonies stay small and compact [24-26]. We can count plates with a lot higher concentration because the colonies will not be touching one another. The main disadvantage is the difficulty in keeping the agar hot enough to keep it from setting up until we pour it and cool enough to not heat shock or kill bacteria and fungus.

3.8. Analysis of Different Chemical Constituents in Fruits and Vegetables Samples

After application of Chitosan, dried in an oven at 60-70°C and then samples were used in analysis of different chemical constituents in fruits and vegetables samples.

3.8.1. Grinding

The samples after oven dried were ground in a Wiley Hammer Mill, passed through 40 mesh screens, mixed well and stored in plastic vials.

3.8.2. Digestion

Exactly 1g oven-dried samples of fruits and vegetables were taken in digestion tube. About 10 mL of concentrated percloric acid in a digestion tube and left to stand for 20 minutes and then transferred to a digestion block and continued heating at 100°C. The temperature was increased to 365°C gradually to prevent frothing (50°C steps) and left to digest until yellowish color of the solution turned to whitish color. Then the digestion tubes were removed from the heating source and allowed to cool to room temperature. About 40 mL of de-ionised water was carefully added to the digestion tubes and the contents filtered through Whatman no. 40 filter paper into a 100 mL volumetric flask and the volume was made up to the mark with de-ionized water. The samples were stored at room temperature in clearly marked containers.

3.9. Chemical Analysis

Chemical analysis (N, P and K) was done by the following methods-

3.9.1. Total Nitrogen

Total Nitrogen of the soil was determined by Micro-Kjeldahl's method following H_2SO_4 acid digestion [27].

3.9.2. Available Phosphorus (P)

Available Phosphorus was determined by Molybdophosphoric blue color method in sulfuric acid system. It is measured by Spectrophotometer at 882 nm wavelength [27].

3.9.3. Available Potassium (K)

Available Potassium (K) was extracted from the samples by 1N NH_4OAc (pH-7) solution followed by measurement of extractable K by Flame emission spectrophotometer (Model: Jenway, PEP-7) at 769 nm wave length using Potassium filter [19].

3.10. Statistical Analysis

Means of three replicates of each control and treatment were calculated. Statistical analysis were performed by Microsoft Excel and SPSS window version 17.0 (SPSS Inc., Chicago, USA) to determine the statistical significance of the different parameters. Duncan's multiple range test (DMRT) at 5% level of probability will be used to test the difference between means of individual treatments [28].

4. Results and Discussion

4.1. Color Index

Significantly *(p≤0.05)* high percentage of weight loss (50%, 22.22%, 50%) were found in the treatment-1 of banana, tomato and control of papaya respectively. The lowest percentage of weight loss (45.83%, 0%, 16.66%) were observed with the sample of control and treatment-1 in banana, tomato and papaya respectively.

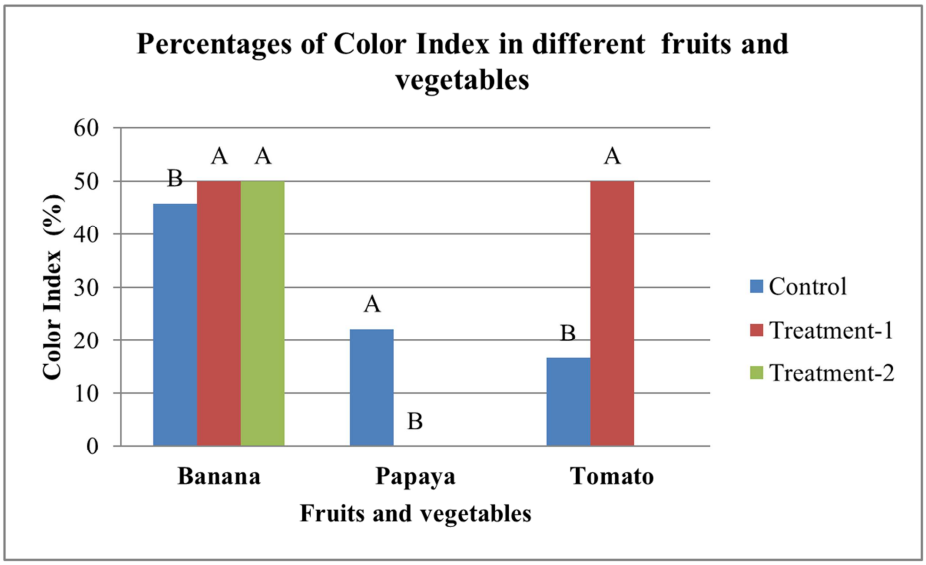


Figure 1. *Percentages of color index in different fruits and vegetables with three replications (color index were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, it can be said that there is a significant difference (p≤0.05) among the varieties in case of color index. The significant difference is higher in tomato and papaya than banana. In case of banana and tomato, if percentages of color index is high, it is beneficial. In case of papaya, if percentages of color index is low, it is beneficial. As, banana and tomato are sold to the customer shown by its color; so, color index of banana and tomato play significant role. But in case of papaya is not sold into the customer shown by its color.

4.2. Weight Loss

Significantly (p≤0.05) high percentage of weight loss (16.5667%, 12.9033%, 12.7867%) were found in the control of banana, papaya and tomato respectively. The lowest percentage of weight loss (15.81%, 7.3967%, 9.49%) were observed with the sample of treatment-1 in banana, papaya and tomato respectively.

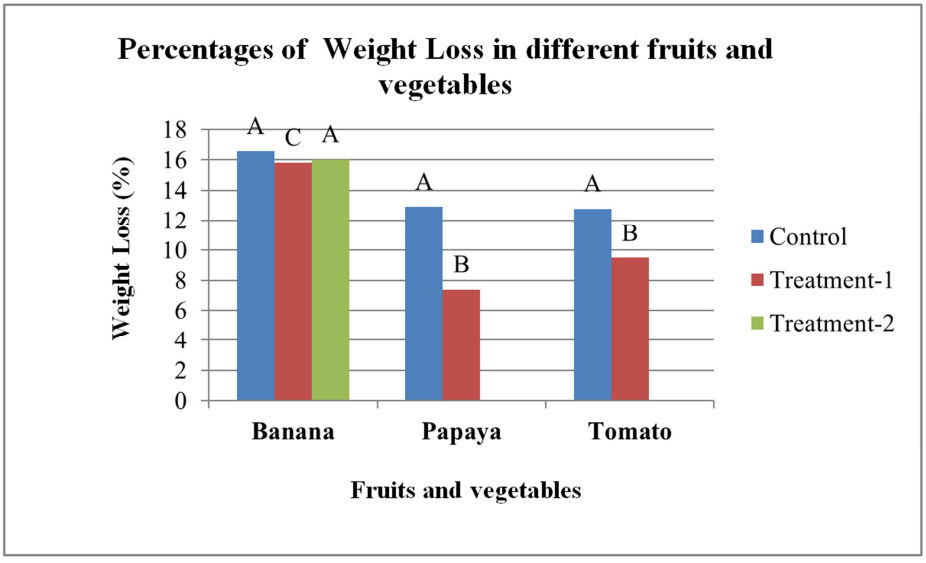


Figure 2. *Percentages of weight loss in different fruits and vegetables with three replications (weight loss were recorded at days 0, 3 and 6 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, it can be said that there is a significant difference ($p \leq 0.05$) among the varieties in case of weight loss. The significant difference is higher in tomato and papaya than banana. In case of weight loss, if percentages of weight loss is low then it is beneficial. As, banana is not sold in kilogram but in hally; so, weight loss of banana doesn't play significant role. But in case of papaya and tomato are sold in kilogram and the weight loss is less in treatments than control.

4.3. Electrical Conductivity (EC)

Insignificantly (at 5% level) high level of Electrical conductivity (0.00022, 0.00088, 0.00024dS/m) were found in the control of banana, papaya and tomato respectively. The lowest amount of electrical conductivity level (0.00021, 0.00087, 0.00023dS/m) were observed with the sample of treatment-2 and treatment-1 in banana, papaya and tomato respectively.

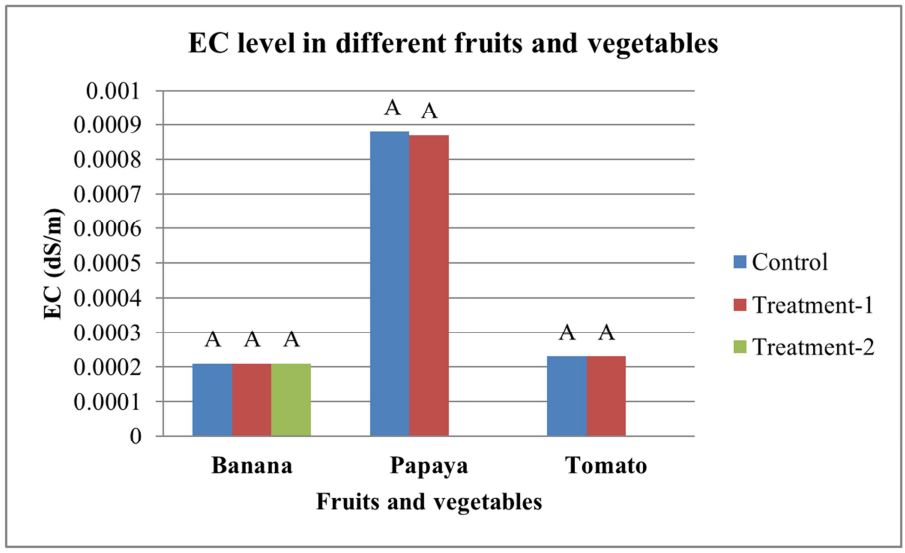


Figure 3. *EC level in different fruits and vegetables with three replications (EC level were recorded at days 0, 3 and 6 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

EC value shows that each and every control, treatment-1 and treatment-2 in different fruits and vegetables are non saline. In case of EC level, if EC levelis remaining similar, it is beneficial.

4.4. pH

pH level were insignificantly (at 5% level) more or lesshigh (4.877, 5.5533, 4.593) at the treatment-2, control and treatment-1 of banana, papaya and tomato respectively. The lowest amount of pH level (4.6667, 5.35, 4.377) were associated with the sample of treatment-1, treatment-1 and control of banana, papaya and tomatorespectively.

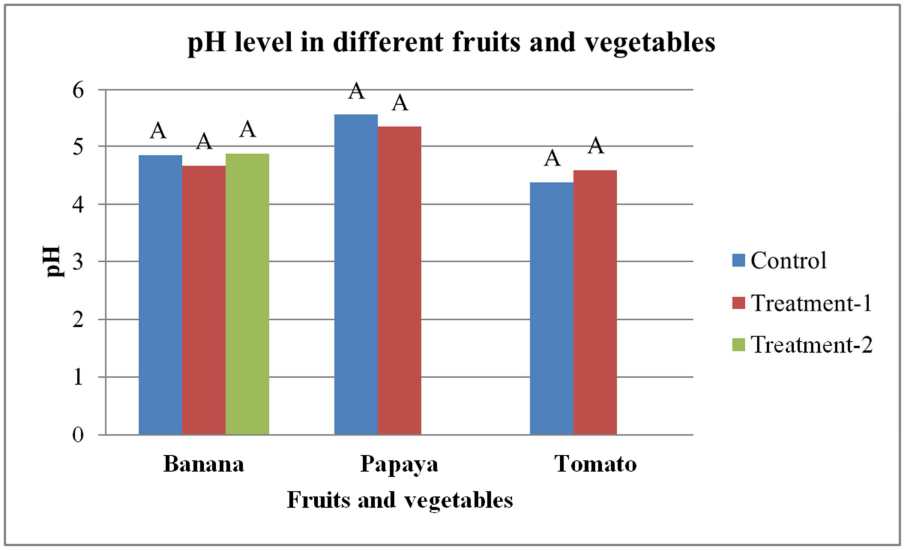
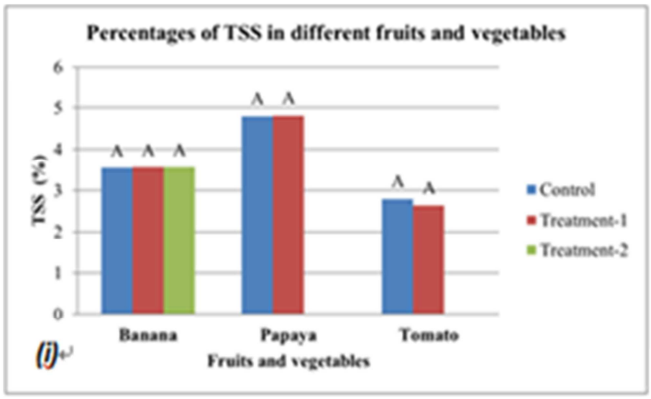


Figure 4. *pH level in different fruits and vegetables with three replications (pH level were recorded at days 0, 3 and 6 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, pH level of the different fruits and vegetables was acidic to moderately acidic in all the study fruits and vegetables. In case of pH level, if pH level is remaining similar, it is beneficial.

4.5. Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)

Total Suspended Solids (TSS) were insignificantly *(at 5% level)* more or less high (3.564, 4.8123, 2.7963) at the treatment-2, treatment-1 and control of banana, papaya and tomato respectively. The lowest amount of TSS (3.543, 4.7987, 2.6387) were associated with the sample of control, control and treatment-1 of banana, papaya and tomato respectively. And for Total Dissolved Solids (TDS) were insignificantly *(at 5% level)* more or less high (1.0553, 1.1953, 1.01267) at the control, treatment-1 and control of banana, papaya and tomato respectively. The lowest amount of TDS (1.03867, 1.2453, 1.011) were associated with the sample of treatment-2, treatment-1 and treatment-1 of banana, papaya and tomato respectively.



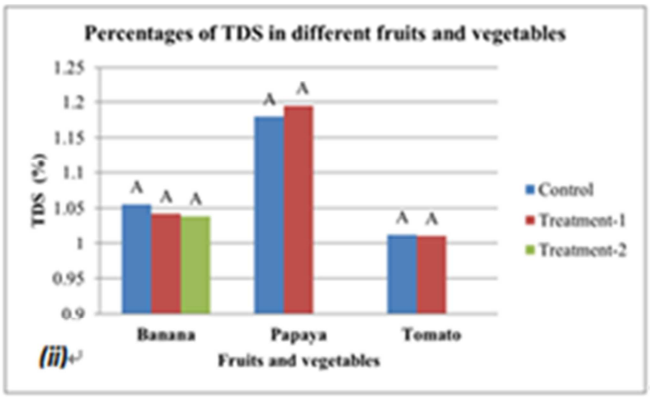


Figure 5. *(i.). Percentages of Total Suspended Solids (TSS) and 5(ii). Percentages of Total Dissolved Solids (TDS) in different fruits and vegetables with three replications (Percentages of TSS were recorded at days 0, 3 and 6 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, it can be said that there is an insignificant difference (at 5% level) among the varieties for Total Suspended Solids (TSS). In case of TSS, if percentages of TSS is remaining similar, it is beneficial.

From the result, it can be said that there is an insignificant difference (at 5% level) among the varieties for Total Dissolved Solids (TDS). In case of TDS, if percentages of TDS is remaining similar, it is beneficial.

4.6. Total Viable Count (TVC) or Total Bacterial Count (TBC)

Significantly *($p \leq 0.05$)* high level of Total Viable Count (TVC) or Total Bacterial Count (TBC) (970, 820, 180 per g) were found in the control of banana, papaya and tomato respectively. The lowest amount of TVC or TBC level (1, 3, 3 per g) were observed with the sample of treatment-1 in banana, papaya and tomato respectively.

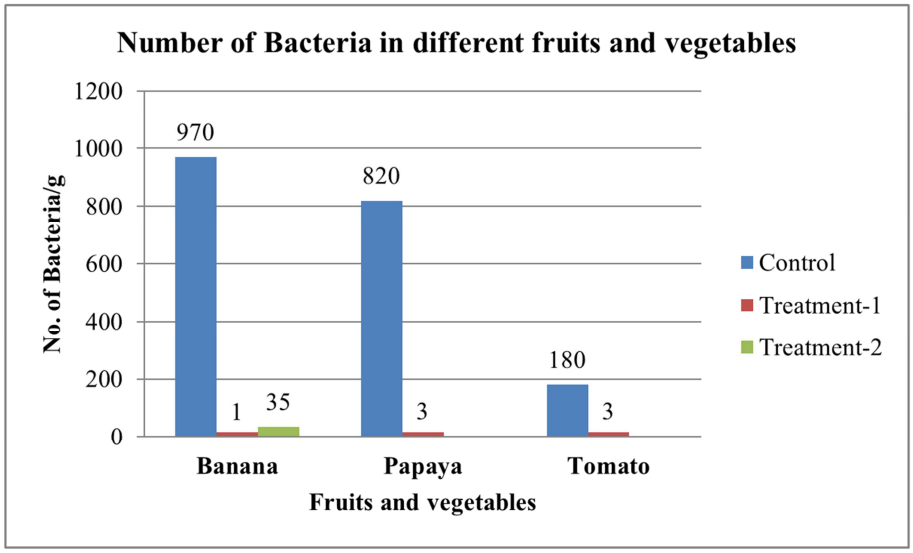


Figure 6. *Distribution of number of Bacteria in different fruits and vegetables with three replications (Data were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, it can be said that there is a significant difference ($p \leq 0.05$) among the varieties in case of Total Viable Count (TVC) or Total Bacterial Count (TBC). The significant differences were higher in control of banana, tomato and papaya than treatment-1 and treatment-2 of banana, tomato and papaya. As, microbial growth is higher, the fruits and vegetables are rotten more fast and the market value will be lessered. In case of TVC or TBC, if number of TVC or TBCis low, it is beneficial.

4.7. Total Fungal Count (TFC) or Yeast & Mold Count (YMC)

Significantly ($p \leq 0.05$) high level of Total Fungal Count (TFC) or Yeast & Mold Count (YMC) (6133, 416, 85 per g) were found in the control of banana, papaya and tomato respectively. The lowest amount of TFC or YMC level (1, 1, 4 per g) were observed with the sample of treatment-1 in papaya, tomato and banana respectively.

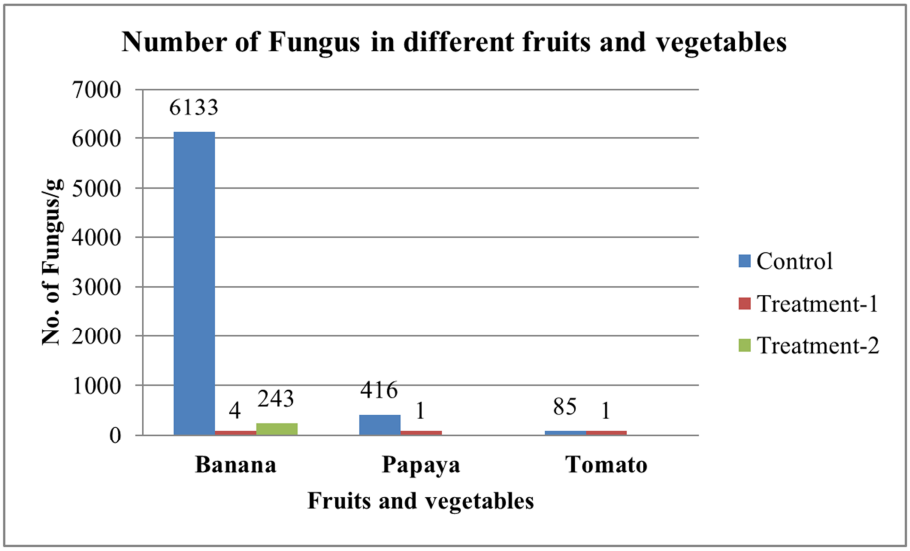


Figure 7. *Distribution of number of Fungus in different fruits and vegetables with three replications (Data were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

From the result, it can be said that there were a significant difference ($p \leq 0.05$) among the varieties in case of TFC or YMC. The significant difference is higher in control of banana, tomato and papaya than treatment-1 and treatment-2 of banana, tomato and papaya. As, microbial growth is higher, the fruits and vegetables are rotten more fast and the market value will be lessered. In case of TFC or YMC, if number of TFC or YMC is low, it is beneficial.

4.8. Total Nitrogen (N) Percentage (%)

Nitrogen contentswere significantly *($p \leq 0.05$)* high (0.9439%, 1.215%, 3.38%) in the treatment-1 in banana, papaya and tomatorespectively. The lowest amount of nitrogen content (0.7593%, 1.02367%, 1.9233%) were associated with the sample of control of banana, papaya and tomato respectively.

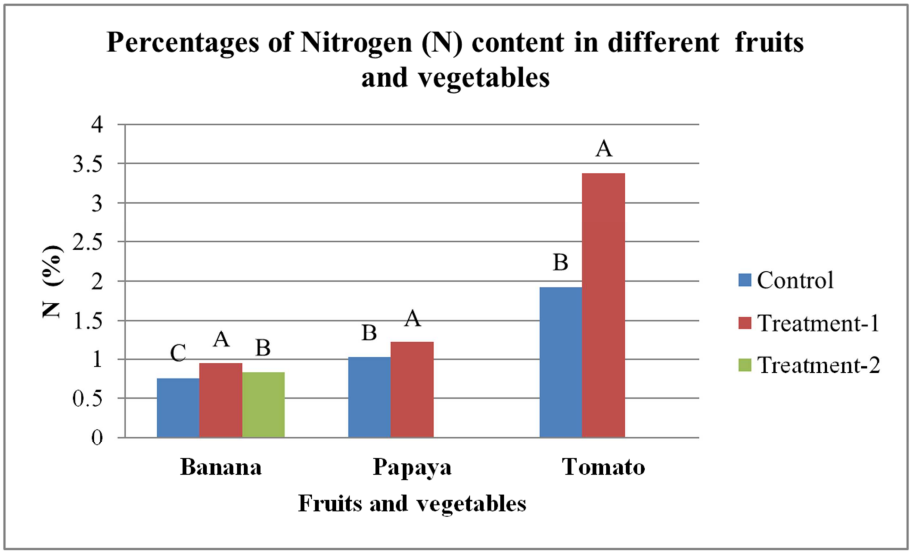


Figure 8. *Distribution of Nitrogen content in different fruits and vegetables with three replications (Data were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

[29] stated that optimum limit of percentage of total nitrogen (N) is four categories such as low (< 1.180%), medium (1.180-2.360%), high (2.361-4.450%) and very high. According to their standard, Nitrogen level is low in banana, medium in papaya and medium to high in tomato of the experimental fruits and vegetables which might be attributed to limiting effects of all factors [30]. In case of nitrogen content, if percentages of nitrogen content is remaining similar or high, it is beneficial.

4.9. Phosphorus (P) Content (ppm)

Phosphorus (P) contents were insignificantly (at 5% level) high (6.7266, 20.163, 42.81 ppm) in the treatment-2 and treatment-1 in banana, papaya and tomato respectively. The lowest amount of phosphorus (P) content (5.9576, 18.572, 41.35 ppm) were associated with the sample of control of banana, papaya and tomato respectively.

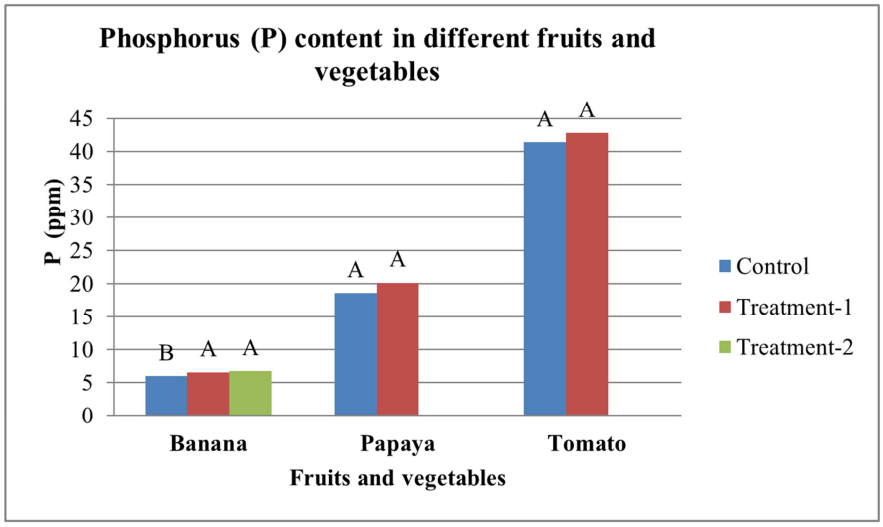


Figure 9. *Distribution of Phosphorus (P) content in different fruits and vegetables with three replications (Data were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

Four categories for optimum limit of total Phosphorus percentage are such as low (< 12 ppm), medium (12.1-24.00 ppm), high (24.0-30.00 ppm) and very high (> 30. 0 ppm). Thus, Content of total phosphorus is very low in the sample of all banana. In case of phosphorus (P) content, if P content is remaining similar, it is beneficial.

4.10. Available Potassium (K) Content (ppm)

Available Potassium (K) contents were significantly ($p \leq 0.05$) high (7.4667, 7.5, 18.1 ppm) in the treatment-1 in banana, papaya and tomato respectively. The lowest amount of Available potassium (K) content (6.2, 6.3333, 14.2 ppm) were associated with the sample of treatment-2 and control of banana, papaya and tomato respectively.

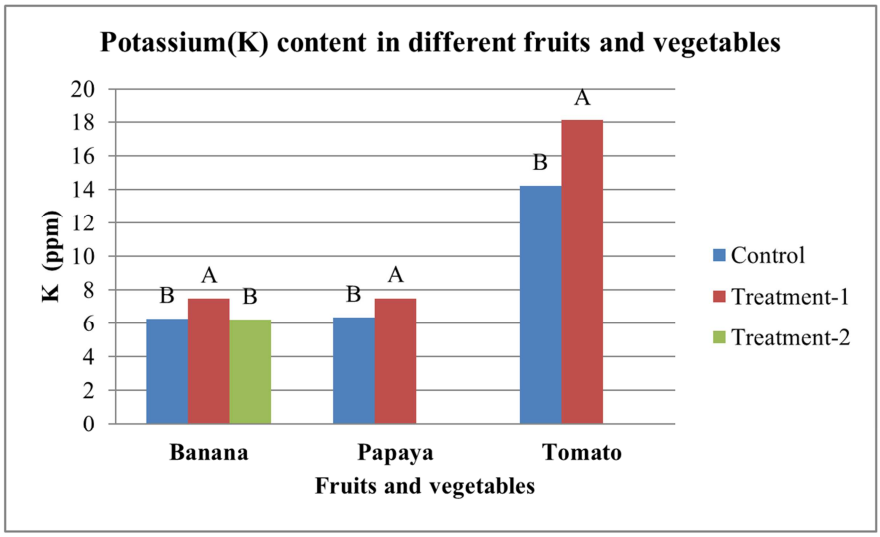


Figure 10. *Distribution of Potassium (K) content in different fruits and vegetables with three replications (Data were recorded at days 0, 5 and 10 and presented in average). Here, Treatment-1= 500ppm and Treatment-2= 1000ppm chitosan.*

Fruits and vegetables of Bangladesh having Potassium level of (5 to 50 ppm) represents optimum condition. Thus treatment-1 in different fruits and vegetables as it has a potassium concentration. In case of potassium (K) content, if K content is remaining similar or high, it is beneficial.

Table 1. *The preservative effect of chitosan on some selected and available fruits and vegetables in Bangladesh.*

Controls & Treatments	Color Index	Weight Loss	Electrical Conductivity	pH	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)
BC	45.83b	16.5667a	0.00021a	4.8533a	3.543a	1.0553a
BT_1	50a	15.81c	0.00021a	4.6667a	3.5557a	1.042a
BT_2	50a	16.03a	0.00021a	4.877a	3.564a	1.03867a
PC	22.22a	12.9033a	0.00088a	5.5533a	4.7987a	1.17967a
PT_1	0b	7.3967b	0.00087a	5.35a	4.8123a	1.1953a
TC	16.66b	12.7867a	0.00023a	4.377a	2.7963a	1.01267a
TT_1	50a	9.49b	0.00023a	4.593a	2.6387a	1.011a
Significant level	s	s	ns	ns	ns	ns

s=Significant at 5% level, ns= Non-significant at 5% level
BC= Banana Control, BT_1= Banana Treatment 1, BT_2= Banana Treatment 2, PC= Papaya Control, PT_1= Papaya Treatment 1, TC= Tomato Control and TT_1= Tomato Treatment 1; T_1= 500 ppm Chitosan and T_2= 1000 ppm Chitosan

Table 2. *The preservative effect of chitosan on the major nutrient contents on some selected and available fruits and vegetables in Bangladesh.*

Controls & Treatments	Nitrogen (%)	Phosphorus (ppm)	Potassium (ppm)
BC	0.7593c	5.9576a	6.2667b
BT_1	0.9439a	6.5852a	7.4667a
BT_2	0.8277b	6.7266a	6.2b
PC	1.02367b	18.572a	6.3333b
PT_1	1.215a	20.163a	7.5a
TC	1.9233b	41.35a	14.2b
TT_1	3.38a	42.81a	18.1a
Significant level	s	ns	s

s=Significant at 5% level, ns= Non-significant at 5% level
BC= Banana Control, BT_1= Banana Treatment 1, BT_2= Banana Treatment 2, PC= Papaya Control, PT_1= Papaya Treatment 1, TC= Tomato Control and TT_1= Tomato Treatment 1; T_1= 500 ppm Chitosan and T_2= 1000 ppm Chitosan

Table 3. *The preservative effect of chitosan on the microbial effects on some selected and available fruits and vegetables in Bangladesh.*

Controls & Treatments	Number of Bacteria/g	Number of Fungal/g
BC	970	6133a
BT_1	1c	4c
BT_2	35b	243b
PC	820a	416a
PT_1	3b	1b
TC	180a	85a
TT_1	3b	1b
Significant level	s	s

s=Significant at 5% level
BC= Banana Control, BT_1= Banana Treatment 1, BT_2= Banana Treatment 2, PC= Papaya Control, PT_1= Papaya Treatment 1, TC= Tomato Control and TT_1= Tomato Treatment 1; T_1= 500 ppm Chitosan and T_2= 1000 ppm Chitosan

5. Summary and Conclusion

Bio-based polymers are closer to the reality of replacing conventional polymers than ever before. Commonly found in many applications from commodity to hi-tech applications due to advancement in biotechnologies and public awareness. This study points out that 500ppm chitosan is sufficient for storage of tomatoes, papayas and bananas at low temperature and high humidity. Shows that coating with chitosan can be employed to extend the shelf life and to improve quality of fruits and vegetables by delaying ripening, reducing weight loss and reducing microbial growth in fruits and vegetables. The application of chitosan was observed more tolerant in the treatment fruits and vegetables compared to the control fruits and vegetables. 500ppm dose of chitosan is more effective compared to that of 1000ppm dose of chitosan in banana. From the result, in case of banana, after 5 days the application of chitosan was observed more tolerant in the treatment fruits compared to the control fruits. After 15 days initially microbial growth was observed in the papaya fruits in control compared to the treatment fruits. In case of tomato initially it was unspoiled about 8 days. After that it got rotten compared to the treatment fruits. It can be concluded that, the application of preservatives is more effective to the microbial attack area rather than the whole fruits. Conclude that the effect of a chitosan coating appears to be comparable to the control which is without coating in improving postharvest preservation of fruits and vegetables. Due to its lower cost,

chitosan is probably the most attractive and effective biopolymer for achieving conservation of different fruits and vegetables.

6. Recommendation

i. Farmers could be adopt the use of chitosan to improve food quality as well as preservative.
ii. More studies should be needed to find out the suitable doses of chitosan preservatives.
iii. Future studies are recommended to assess the effect of coatings on the internal atmosphere of fruit; internal gas must be analyzed for CO_2 and O_2 levels.
iv. Food industry should be revealed to apply these new technologies.

References

[1] BBS (Bangladesh Bureau of Statistics), 2016. Yearbook of Agricultural Statistics – 2015, 27th Series, Statistics and Informatics Division (SID), Ministry of Planning Government of the People's Republic of Bangladesh, 3 pp.

[2] Croisier, F. and Jerome, C. 2013. Chitosan-based biomaterials for tissue engineering, 49 (4): 780-792.

[3] Gomes, L. P., Paschoalin, V. M. F. and Del Aguila, E. M. 2017. Chitosan Nanoparticles: Production, Physicochemical Characteristics and Nutraceutical Applications, 9 (1): 387.

[4] Roberts, G. A. F. 1997. Chitosan production routes and their role in determining the structure and properties of the product. In Advances in Chitin Science, National Taiwan Ocean University, Taiwan, vol. 2: 22–31.

[5] Win, N. N., Stevens, W. F. 2001. Shrimp chitin as substrate for fungal chitin deacetylase. Appl Microbiol Biotechnol, 57: 334–341.

[6] Ravi Kumar, M. N. V. 2000. A review of chitin and chitosan applications. Reactive Functional Polym, 46: 1–27.

[7] Marguerite, R. 2006. Chitin and chitosan: properties and applications. Progress in PolymSci, 31: 603–632.

[8] Virginia, E., Marie, G., Eric, P. and Luc, A. 2011. Structure and properties of glycerol plasticized chitosan obtained by mechanical kneading. Carbohydrate Polym, 83: 947–952.

[9] Liu, M., Zhang, Y., Wu, C., Xiong, S. and Zhou, C. 2012. Chitosan/halloysite nanotubes bionanocomposites: structure, mechanical properties and biocompatibility. Int J Biological Macromol, 51: 566–575.

[10] Bae, K. P. and Moo-Moo, K. 2010. Applications of chitin and its derivatives in biological medicine. Int J Mol Sci, 11: 5152–5164.

[11] Ramya, R., Venkatesan, Jayachanndran Kim, S. and Sudha, P. N. 2012. Biomedical applications of chitosan: an overview. J Biomaterial Tissue Engg, 2: 100–111.

[12] Bansal, V., Pramod, K. S., Nitin, S., Omprakask, P. and Malviya, R. 2011. Applications of chitosan and chitosan derivatives for drug delivery. AdvaBiol Res, 5: 28–37.

[13] Valerie, D. and Vinod, D. V. 1998. Pharmaceutical applications of chitosan. Pharmaceutical SciTechnol Today, 1: 246–253.

[14] Hafdani, F. N. and Sadeghinia, N. 2011. A review on applications of chitosan as a natural antimicrobial. World Academy of SciEnggTechnol, 50: 252–256.

[15] Rashidul Alam., Mubarak A. Khan., Ruhul A. Khan., Sushanta Ghoshal. and M. I. H. Mondal. 2008. Study on the Physico-mechanical Properties of Photo-cured Chitosan Films with Oligomer and Acrylate Monomer. J Polym Environ, 16: 213–219.

[16] Yu, Wang., Baogang Wang. and Lite, Li. 2008. Keeping quality of tomato fruit by highelectrostatic field pretreatment duringstorage. J Sci Food Agric, 88: 464–470.

[17] Zhang Juan., Zhang Shaoying., Yu Youwei. And Ren Yinzhe. 2014. Cherry tomato preservation using chitosan combined with zinc/cerium ion, 3 (2): 111-118.

[18] USDA (United States Department of Agriculture). 2004. Soil survey laboratory manual. Soil survey investigation report no. 42, version 4.0, USDA-NRCS, Nebraska, USA.

[19] Jackson, M. L. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi, pp. 495-498.

[20] Misra, R. D. and Ahmed, M. 1987. Manual of Irrigation Agronomy. Oxford and IBH publishing company and private limited, New Delhi, India, pp. 248-271.

[21] International Commission on Microbial Specifications for Food. 1978. Microorganisms in foods. Their significance and methods of enumeration, 2nd ed. University of Toronto Press, Toronto.

[22] Anderson, E. H. and C. A. Stuart. 1935. A quantitative differential method for counting mixed cultures of bacteria. J. Bacteriol, 30: 207–209.

[23] Reed, R. W. and G. B. Reed. 1948. Drop plate method of counting viable bacteria. Can. J. Res. E: 316–326.

[24] Dick, S. L. 1967. The enumeration of bacteria in urinary tract infections. Can. J. Med. Techn, 29: 15–22.

[25] Guthrie, R. K. and D. J. Reeder. 1969. Membrane filter-fluorescent antibody method for detection and enumeration of bacteria in water. Appl. Microbiol, 17: 399–401.

[26] Winn, W. R., M. L. White, W. T. Carter, W. T. Miller, and S. M. Finegold. 1966. Rapid diagnosis of bacteremia with quantitative differential membrane filtration culture. J. Am. Med. Assoc, 197: 539–548.

[27] Jackson, M. L. 1962. Soil Chemical Analysis. Prentice hall, In: Englewood cliffs, New Jersey, USA.

[28] Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. 2nd ed. International Rice Research Institute, Los Banos, Philippines, p. 627.

[29] Chowdhury, M. A., Khairun, Y., Salequzzaman, M. and Rahman, M. M. 2011. Effect of combined shrimp and rice farming on water and soil quality in Bangladesh. Aquaculture International, 19 (6): 1193-1206.

[30] Sumner, M. 2000. Handbook of soil science. CRC Press, Boca Raton, pp. 2148.