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RESEARCH ARTICLE

Effect of edible coating on shelf life of fresh pomegranate arils

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ABSTRACT

Pomegranate (Punica granatum L.), grown in tropical and subtropical regions of the world has a long storage life. However, arils when separated from fruits loose quality attributes easily. The present study entitled "Effect of edible coating on fresh pomegranate arils" was conducted at post-harvest technology laboratory of the Department of Horticulture and Post-Harvest Technology, Institute of Agriculture, Palli Siksha Bhavana, Sriniketan, Visva-Bharati University. The experiment was laid out in Completely Randomized Design (CRD), which comprised three replications of six treatments i.e. T1 (0.5 % Chitosan), T2 (0.5 % Chitosan and 1% Ascorbic Acid), T3 (0.75 % Chitosan), T4 (0.75 % Chitosan and 1 % Ascorbic Acid), T5 (1 % Chitosan), T6 (1 % Chitosan and 1 % Ascorbic Acid) and T7 (Control) Chemical parameters viz. total soluble solids (TSS), total sugars, reducing sugar, non-reducing sugars, titratable acidity, anthocyanin content, spoilage loss as well as organoleptic characters of treated arils were evaluated during the investigation. Based on the results obtained from the study, it can be inferred that edible coating of pomegranate arils with 1 % Chitosan proved to be beneficial in maintaining the quality of arils during storage period. Application of 1% Chitosan as edible coating on arils was found promising in maintenance of quality parameters such as total soluble solids, titratable acidity, total sugars, anthocyanin content etc. Therefore, it is concluded that coating of 1 % Chitosan can successfully be used to extend shelf life of pomegranate arils upto 21 days of storage.

Keywords: Edible coating, arils, chitosan, chemical parameters, shelf life

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INTRODUCTION

Pomegranate (*Punica granatum* L.), is one of the choicest table fruits grown in the world. It is native to the area from Iran to the Himalayas in Northern India and has been cultivated and naturalized over the whole Mediterranean region since ancient times (Holland et al. 2009). The genus has two species i.e. Punica protopunica and Punica granatum. Punica protopunica is found wild in the Socotra island and Punica granatum is cultivated in tropical and subtropical parts. Pomegranate provides a calorific value of 68 kcal per 100 grams. The fruits are a good source of carbohydrates, fat, protein, vitamins and minerals. (Dhinesh & Ramasamy, 2016). The fruit is liked for its cool and refreshing juice besides its use as a table fruit. It also possesses a number of medicinal properties. The juice is considered to be useful for patients suffering from leprosy. The bark and rind of the fruit are commonly used against dysentery and diarrhoea. The demand for pomegranate arils (ready-to-eat arils) is increasing in domestic as well as international markets, because of changing life style and food consumption pattern.

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However, maintaining the nutritional quality of pomegranate arils is a major challenge, because arils easily deteriorate in texture, color, together with an increase in microbial and fungal spoilage. Several techniques such as high hydrostatic pressure, ultrasound, gamma radiation, synthetic chemicals such as fungicides/preservatives, controlled atmosphere storage, modified atmosphere storage and vegetable oils are used for preserving whole fruits and fruit products by reducing their quality changes and quantity losses during storage. Recent advances in post-harvest treatments include the use of organic edible coatings to increase the shelf life of fresh cut fruits and vegetables. An edible coating is defined as a thin layer of edible material applied to the surface of food products to extend its shelf life, by reducing moisture and solute migration, gas exchange, respiration, and oxidative rates, as well as by reducing or even suppressing physiological disorders (Quirós-Sauceda et al. 2014; Kester and Fennema, 1986). The main advantage of using edible films and coatings is that several active ingredients can be incorporated into the produce, thus enhancing safety or even nutrition and sensory attributes. Chitosan is a high molecular weight cationic polysaccharide, obtained by the deacetylation of chitin. It is the second most abundant naturally occurring biopolymer after cellulose (Andrady and Xu, 1997). Chitosan is widely used in post-harvest studies in recent years because of its excellent film forming and anti-fungal, bio-safe and bio-chemical properties (Lin et al. 2008). The maintenance of nutritional quality as well as reduction in spoilage and microbial losses of pomegranate arils is a major challenge, since minimally processed arils loose quality attributes easily resulting in spoilage. Therefore to avoid this, they need to be treated with proper coatings and stored at ideal temperature. Thus present investigation is planned to study the effect of edible coating on shelf life of fresh pomegranate arils.

MATERIALS AND METHODS

The present investigation entitled, “Effect of edible coating on shelf life of fresh pomegranate arils” was conducted in the Post-Harvest Technology laboratory of the Department of Horticulture and Post-Harvest Technology, Institute of Agriculture, Palli Siksha Bhavana, Sriniketan, Visva-Bharati University. The study area mostly falls under red lateritic zone of West Bengal, which is situated centrally between 23˚ 42' North latitude and 87˚40' 30'' East longitude, with average altitude of 40 m above mean sea level. The experiment was laid out in Completely Randomized Design (CRD), which comprised three replications of six treatments i.e. T1 (0.5 % Chitosan), T2 (0.5 % Chitosan and 1% Ascorbic Acid), T3 (0.75 % Chitosan), T4 (0.75 % Chitosan and 1 % Ascorbic Acid), T5 (1 % Chitosan), T6 (1 % Chitosan and 1 % Ascorbic Acid) and T7 (Control). To prepare chitosan solution, known quantity of chitosan powder was weighted using citizen balance and solution was prepared dissolving chitosan powder in aqueous solution of 0.5 % acetic acid. The resulting mixture was stirred continuously at room temperature (25 ± 1oC) until chitosan was dissolved. Coatings were applied by immersion of arils in the chitosan solution for 5 min, depending on treatments whereas the control samples were washed with distilled water. The arils were then strained out and kept on the blotting paper to remove the excess moisture at room temperature. Then arils were packed in polythene bags and kept in refrigerated storage at 7oC. Chemical parameters viz. TSS (%) total sugars (%), reducing sugar (%), non-reducing sugars (%), titratable acidity (%), anthocyanin content (%), spoilage loss as well as organoleptic characters of treated arils were evaluated during the investigation at 7th, 14th, 21st and 28th day of storage. Data obtained on various characters were analyzed statistically according to the analysis of variance techniques for CRD (Fisher 1950).

RESULTS AND DISCUSSION

TSS (°Brix)

The mean data pertaining influence of different treatments of edible coating on the changes in TSS of pomegranate arils was recorded from 7th to 28th day of storage and is presented in Table 1. The highest (15.63) TSS (oBrix) on the 7th day of observation was found in T6 (1 % Chitosan and 1 % Ascorbic Acid) while, on other days of observations i.e. 14th, 21st and 28th day (14.83, 14.27 and 7.93) the highest TSS was recorded in T5 (1 % Chitosan). Lowest TSS on the respective days 7th, 14th, 21st, and 28th day (14.43, 13.80, 14.27 and 6.10) were noted in T3 (0.75 % Chitosan), T2 (0.5 % Chitosan and 1% Ascorbic Acid), T6 (1 % Chitosan and 1 % Ascorbic Acid) and T4 (0.75 % Chitosan and 1 % Ascorbic Acid). TSS in the coated arils generally decreased and it was found that chitosan treatments played a positive role in maintaining TSS of arils during storage period. Arils treated with 1 % Chitosan and 1 % Ascorbic acid recorded high TSS compared to other treatments on 7th day of storage whereas treating arils with 1 % Chitosan recorded significantly higher TSS during whole storage period except on 7th day. Initially the decrease in TSS during the storage was slow i.e. upto 21st day but after that it became fast after 21st day and on 28th day marked decrease was found in TSS of the arils. This may due to rapid utilization of reducing sugar and other organic metabolites. A suppressed respiration rate slows down the synthesis and the use of metabolites, resulting in lower soluble solids due to the slower hydrolysis of carbohydrates to sugars (Das et al. 2013). Ali et al. (2011) also expressed similar views who observed that chitosan coating effectively delayed changes in soluble solids in papaya. The findings were same as of Salama et al. (2012) who reported that decrease in TSS of pomegranate juice was observed as storage period proceeded. Ayhan and Esturk (2009) reported that TSS remained unchanged for the first 9 days of cold storage, but afterwards reduction of TSS was observed in minimally processed pomegranate arils which is also in line with the finding.

Table 1 - Effect of edible coating on changes in TSS of pomegranate arils

Treatments	Treatment details	Storage period			
		7^{th} Day	14^{th} Day	21^{st} Day	28^{th} Day
T_1	0.5 % Chitosan	15.43	14.47	13.22	7.33
T_2	0.5 % Chitosan + 1 % Ascorbic acid	14.57	13.80	13.20	7.17
T_3	0.75 % Chitosan	14.43	13.97	13.27	7.33
T_4	0.75 % Chitosan + 1 % Ascorbic acid	15.37	14.17	13.53	6.10
T_5	1 % Chitosan	15.13	14.83	14.27	7.93
T_6	1 % Chitosan + 1 % Ascorbic acid	15.63	14.40	13.06	7.47
T_7	Control	15.47	14.70	13.83	6.40
CD		**0.30**	**0.21**	**0.24**	**0.18**
SEm (±)		**0.10**	**0.07**	**0.08**	**0.06**

Table 2 - Effect of edible coating on total sugar of pomegranate arils

Treatments	Treatment details	Storage period			
		7^{th} Day	14^{th} Day	21^{st} Day	28^{th} Day
T_1	0.5 % Chitosan	7.13	6.90	4.35	2.77
T_2	0.5 % Chitosan + 1 % Ascorbic acid	6.65	6.45	4.55	2.05
T_3	0.75 % Chitosan	7.43	7.14	5.55	2.56
T_4	0.75 % Chitosan + 1 % Ascorbic acid	6.45	6.24	5.88	2.35
T_5	1 % Chitosan	7.97	7.43	6.05	3.13
T_6	1 % Chitosan + 1 % Ascorbic acid	7.13	6.45	5.71	1.77
T_7	Control	6.88	6.24	3.92	2.08
CD		**0.03**	**0.03**	**0.02**	**0.08**
SEm (±)		**0.01**	**0.01**	**0.01**	**0.03**

Total Sugars (%)

Perusal of the data on total sugars (%) is reported statistically significant and is demonstrated in Table 2. It was observed that treatment T5 (1 % Chitosan) maintained higher amounts of total sugars (%) during the whole storage period i.e. 7.97, 7.43, 6.05 and 3.13 on 7th, 14th, 21st, and 28th day respectively. The minimum total sugar (%) (6.45) was recorded in T4 (0.75 % Chitosan and 1 % Ascorbic Acid) on 7th day. However, treatments T4 (0.75 % Chitosan and 1 % Ascorbic Acid) and T7 (Control) were found with lowest total sugars (%) (6.24) on 14th day whereas on 21st and 28th day minimum total sugars (%) (3.92 and 1.77) were found in T7 (Control) and T6 (1 % Chitosan and 1 % Ascorbic Acid) respectively. The decrease in total sugars from initial to final storage period may be possible due to coating of chitosan; the conversion of starch into sugars as well as biosynthesis of sucrose slowed down as a result of modified gaseous exchange and reduced respiration rates and reflected as lower total sugars content.

Table 3 - Effect of edible coating on reducing sugar of pomegranate arils

Treatments	Treatment details	Storage period			
		7^{th} Day	14^{th} Day	21^{st} Day	28^{th} Day
T_1	**0.5 % Chitosan**	6.65	6.45	4.17	2.52
T_2	**0.5 % Chitosan + 1 % Ascorbic acid**	6.24	6.06	4.25	1.65
T_3	**0.75 % Chitosan**	5.73	6.45	5.13	2.25
T_4	**0.75 % Chitosan + 1 % Ascorbic acid**	6.88	5.87	5.42	1.79
T_5	**1 % Chitosan**	6.88	6.46	5.54	2.93
T_6	**1 % Chitosan + 1 % Ascorbic acid**	6.25	5.74	5.26	1.43
T_7	**Control**	6.05	5.55	3.52	1.86
CD		**0.02**	**0.03**	**0.02**	**0.04**
SEm (±)		**0.01**	**0.01**	**0.01**	**0.01**

Table 4 - Effect of edible coating on non-reducing sugar of pomegranate arils

Treatments	Treatment details	Storage period			
		7^{th} Day	14^{th} Day	21^{st} Day	28^{th} Day
T_1	**0.5 % Chitosan**	0.48	0.44	0.18	0.25
T_2	**0.5 % Chitosan + 1 % Ascorbic acid**	0.41	0.40	0.26	0.40
T_3	**0.75 % Chitosan**	0.97	0.69	0.42	0.31
T_4	**0.75 % Chitosan + 1 % Ascorbic acid**	0.72	0.38	0.46	0.57
T_5	**1 % Chitosan**	1.09	0.97	0.51	0.23
T_6	**1 % Chitosan + 1 % Ascorbic acid**	0.88	0.72	0.45	0.33
T_7	**Control**	0.83	0.68	0.40	0.22
CD		**0.04**	**0.04**	**0.04**	**0.09**
SEm (±)		**0.01**	**0.01**	**0.01**	**0.03**

Reducing Sugars (%)

The statistical observation of data explaining the changes in reducing sugars of treated arils by different treatment has been observed significant which is showed in Table 3. Reducing sugar (%) which is a sweetness factor was recorded highest (6.88, 6.46, 5.54 and 2.93) in T5 (1 % Chitosan) than all other treatments during storage on all observation days. Moreover, the lowest reducing sugars (%) were recorded as 6.05, 5.55 and 3.52 in treatments T7 (Control) on 7th, 14th, and 21st day whereas it was found lowest in T6 (1 % Chitosan and 1 % Ascorbic Acid) on the 28th day.

Non-reducing sugars (%)

It is evident from Table 4 that there were significant differences in non-reducing sugars of treated pomegranate arils due to different treatments. Non reducing Sugars (%) were found to high in T5 (1 % Chitosan) during storage period except at 28th day on which it was recorded higher in T2 (0.5 % Chitosan and 1% Ascorbic Acid).The minimum value varied as the storage period proceeded and treatment T2 (0.5 % Chitosan and 1% Ascorbic Acid) recorded minimum value on 7th day, treatment T4 (0.75 % Chitosan and 1 % Ascorbic Acid) recorded minimum value on 14th day whereas on 21st and 28th day it was noted in T1 (0.5 % Chitosan), and T2 (1 % Chitosan and 1% Ascorbic Acid). As proven that coating reduces respiration rates by modification in exchange of O2 and CO2 in fruits. The lower level of non-reducing sugar (sucrose) coated arils might be due to its specific capacity to altered respiration process resulted in slow hydrolysis of starch as well as inadequate biosynthesis of sucrose during ripening.

Table 5 - Effect of edible coating on titratable acidity of pomegranate arils

Treatments	Treatment details	Storage period			
		7th Day	14th Day	21st Day	28th Day
T_1	0.5 % Chitosan	0.02	0.03	0.03	0.03
T_2	0.5 % Chitosan + 1 % Ascorbic acid	0.02	0.03	0.03	0.03
T_3	0.75 % Chitosan	0.02	0.03	0.03	0.03
T_4	0.75 % Chitosan + 1 % Ascorbic acid	0.02	0.03	0.03	0.03
T_5	1 % Chitosan	0.02	0.02	0.02	0.03
T_6	1 % Chitosan + 1 % Ascorbic acid	0.02	0.02	0.02	0.03
T_7	Control	0.02	0.02	0.02	0.03
CD		NS	NS	NS	NS
SEm (±)		NS	NS	NS	NS

Titratable Acidity (%)

In the present research the data collected regarding the changes in titratable acidity (%) of treated arils of pomegranate has been found non-significant and is presented in Table 5. Least changes were noticed in titratable acidity (%) of treated arils. Treatments T5 (1 % Chitosan), T6 (1 % Chitosan and 1 % Ascorbic Acid) and T7 (Control) were found with less acidity (%) upto 21st day as compared to other treatments. Moreover, acidity (%) of T1 (0.5 % Chitosan), T2 (0.5 % Chitosan and 1% Ascorbic Acid), T3 (0.75 % Chitosan) and T4 (0.75 % Chitosan and 1 % Ascorbic Acid) remained unchanged after 14th day and on 28th day these were found in line with remaining treatments. As revealed from the data slight variations in the titratable acidity were recorded in the treated arils during the storage. The finding is in line with Ibrahim et al. (2014) who stated that chitosan coating can develop an oxygen barrier on fruit surface that leads to reduced metabolic rates and consequently, less acidity variation in chitosan-treated fruits.

Table 6 - Effect of edible coating on anthocyanin content of pomegranate arils

Treatments	Treatment details	Storage period			
		7th Day	14th Day	21st Day	28th Day
T_1	0.5 % Chitosan	12.01	10.32	8.32	4.52
T_2	0.5 % Chitosan + 1 % Ascorbic acid	12.13	10.27	8.10	4.34
T_3	0.75 % Chitosan	11.85	10.02	6.68	4.44
T_4	0.75 % Chitosan + 1 % Ascorbic acid	12.24	10.46	6.96	4.99
T_5	1 % Chitosan	12.92	11.38	9.29	5.21
T_6	1 % Chitosan + 1 % Ascorbic acid	11.67	10.11	9.29	4.60
T_7	Control	11.33	9.62	7.11	4.01
CD		**0.21**	**0.13**	**0.22**	**0.11**
SEm (±)		**0.06**	**0.05**	**0.07**	**0.04**

Table 7 - Effect of edible coating on spoilage of pomegranate arils

Treatments	Treatment details	Storage period			
		7th Day	14th Day	21st Day	28th Day
T_1	0.5 % Chitosan	-	0.12	3.64	6.00
T_2	0.5 % Chitosan + 1 % Ascorbic acid	-	1.50	4.62	5.36
T_3	0.75 % Chitosan	-	0.29	1.33	4.64
T_4	0.75 % Chitosan + 1 % Ascorbic acid	-	0.52	2.68	6.00
T_5	1 % Chitosan	-	0.47	3.42	4.67
T_6	1 % Chitosan + 1 % Ascorbic acid	-	0.33	2.24	4.69
T_7	Control	-	0.05	1.36	6.63
CD		**-**	**0.09**	**1.12**	**1.62**
SEm (±)		**-**	**0.03**	**0.33**	**0.53**

Anthocyanin content (mg/100 g)

The perusal of the observations on changes in anthocyanin content (mg/ 100) of the treated arils is found statistically significant and is demonstrated in Table 6. Anthocyanin content (mg/100g) was found high (12.92, 11.38, 9.29 and 5.21) in treatment T5 (1 % Chitosan) during storage period on all observation days however, variations were recorded in lowest anthocyanin content (mg/100g) and it was recorded minimum (11.33 and 9.62) in T7 (Control) on 7th and 14th day while at 21st day lowest (6.68) anthocyanin content (mg/100g) was recorded in T3 (0.75 % Chitosan) and on 28th day T7 (Control) was found with less anthocyanin content (mg/100g) (4.01) compared to other treatments. The reduction in anthocyanin content from initial to final storage period recorded in the current study was similar to findings as reported earlier by Ayhanand and Estruck (2009), Salama et al. (2012) and Caleb et al. (2013) in pomegranate. The arils treated with one per cent chitosan were found better in anthocyanin keeping properties compared to other treatments. It may be due to the barrier effect the chitosan coating which imposes on the surface of the produce resulting in the modification in its endogenous CO_2 and O_2 levels, which could result in a reduced O_2 supply required for the enzymatic oxidation reaction of anthocyanin as reported by Zhang and Quantick (1998) in strawberries and raspberries. Chitosan coatings has also been demonstrated to have beneficial effects in maintaining anthocyanin content in several fruits such as longan fruit (Jiang and Li, 2002) and peeled litchi fruit (Dong et al. 2004).

Spoilage Loss

The mean data pertaining to spoilage loss of treated arils is presented in Table 7. No spoilage loss was recorded on the 7th day of storage while on 14th day and 21st day samples were found with some spoiled arils which was recorded more in T2 (0.5 % Chitosan and 1% Ascorbic Acid) and less (0.05) in T7 (Control) on 14th day and (1.33) in T3 (0.75 % Chitosan) on 21st day. As the storage period passed maximum spoilage (6.63) occurred in T7 (Control) however, minimum spoilage (4.64) was recorded in T3 (0.75 % Chitosan)

CONCLUSION

Based on the results obtained from the study, it can be inferred that edible coating of pomegranate arils with 1 % Chitosan proved to be beneficial in maintaining the quality of arils during storage period. Application of 1% Chitosan as edible coating on arils was found promising in maintenance of quality parameters such as total soluble solids, titratable acidity, total sugars, anthocyanin content etc. Therefore, it is concluded that coating of 1 % Chitosan can successfully be used to extend shelf life of pomegranate arils upto 21 days of storage.

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