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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 477-480

www.thepharmajournal.com
Received: 02-08-2022
Accepted: 06-09-2022

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Effect of different surface coating materials on chemical characteristics of guava (*Psidium guajava* L.) cv. Allahabad safeda fruits

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Abstract
The lab experiment conducted in complete randomized design under three replications of seventeen treatment on variety Allahabad safeda of Guava. The experiment was conducted during 2019 - 2020 at the Instructional cum Research Department of Fruit Science, RVSKVV- K.N.K. College of Horticulture, Mandsaur 458001 (M.P.). Guava freshly harvested fruits were coated with different coatings Guar gum (0.5%, 1.0%, 1.5% and 2.0%), Shellac (0.5%, 1.0%, 1.5% and 2.0%), *Aloe vera* gel (25%, 50%, 75% and 100%) and CMC, Carboxyl Methyl Cellulose (0.5%, 1.0%, 1.5% and 2.0%). Periodically effects of different surface coating materials were observed for Chemical parameters of fruits like- total soluble solids (°Brix), titratable acidity (%), ascorbic acid (mg/100 g), total sugars (%), tannins (mg/100 g) and organoleptic evaluation like- fruit flavour. Guar gum was found to be more beneficial as compared to other edible coatings throughout storage period. The application of edible coating (Guar gum) has proved to be best post-harvest application storage of guava cv. Allahabad Safeda from the point of different chemical characteristics *viz*. total soluble solids (°Brix), titratable acidity (%), ascorbic acid, total sugars, tannins and organoleptic evaluation like- flavour during storage up to 12th day of storage.

Keywords: Guar gum, *Aloe vera* coating, Carboxyl methylcellulose, total soluble solids, total sugars, tannins, flavour

1. Introduction
Guava (*Psidium guajava* L.) is one of the predominant fruit crop in tropical and subtropical tracts of the world and claims superiority over different fruits by virtue of its commercial and nutritional values. It is also known as "The Apple of Tropics". Botanically, it belongs to the family Myrtaceae which comprises at least 150 genera and more than 5,650 species. It occupies fourth position in terms of area 2.65 lakh ha and production 40.54 lakh MT after mango, banana and citrus. The guava fruit is an excellent source of ascorbic acid but with poor calorific value (66 cal/100 g), protein content (1%), dry matter (17%) and moisture (83%). The fruit is also rich in minerals like phosphorus (2337 mg/100 g), calcium (14-30 mg/100 g), iron (0.6-1.4 mg/100 g) as well as vitamins like niacin, pantothenic acid, thiamine, riboflavin and vitamin A. Edible coatings have high potential to carry active ingredients such as anti-browning agents, colorants, flavours, nutrients, spices and antimicrobial compounds that can extend product shelf-life and reduces the risk of pathogen growth on fruit surfaces (Pranoto *et al*., 2015) [12]. There has been increasing interest for the use of *Aloe vera* gel as an edible coating material for fruits and vegetables driven by its antifungal activity (Jasso Rodriguez de *et al*., 2005) [7]. The positive effect of this edible coatings is based on their hygroscopic properties, which enables formation of O_2 and CO_2 by creating modified atmosphere (MA) and acting as moisture barrier between the fruit and the environment and thus reduced weight loss, browning, softening and growth of yeast and molds (Morillon *et al*., 2002) [11]. Shellac resin is secreted by the insect *Laccifer lacca* found in India. Shellac is composed of aleuritic and shelloic acids is compatible with waxes and gives coated products a high gloss appearance (Hagenmaier and Shaw, 1991) [6]. Guar gum is a galactomannan rich flour, water soluble polysaccharide obtained from the leguminous Indian cluster bean (*Cyamopsis tetragonoloba* L.). It is one of the most important thickener and versatile material for many food applications due to its different physico-chemical properties as well as its high availability, low cost and biodegradability. This galactomannan has similar properties as carrageenan, alginate, xanthan gumand gum Arabic as an edible coating but guar gum has the advantage of being cheaper than all the others (Rodge *et al*., 2012) [15].

Carboxy Methyl Cellulose (CMC) is a derivative of cellulose and prepared by reaction of cellulose with sodium hydroxide and chloroacetic acids. Characteristics of CMC are generally odorless, tasteless, flexible, transparent, and non-toxic. It is widely used in food and pharmaceutical industries (Sunardi *et al*., 2017) [18]. The post-harvest losses can be minimized by checking the rate of transpiration, respiration, microbial infection and protecting membranes from disorganization (Bisen and Pandey, 2008) [4].

2. Materials and Methods

The experiment was conducted during 2019-2020 at the Instructional cum Research Department of Fruit Science, KNK College of Horticulture, Mandsaur (M.P.). Guava fruits were selected for uniformity in size, shape and colour. Diseased, sunburn, bruised and injured fruits were discarded. The fruits were randomized and divided into seventeen treatment lots of 45 fruits for the following treatments in three replicates (each replicate contained 15 individual fruits). The experiment was laid out in completely randomized design (CRD) with three repetitions and consisting of seventeen treatments comprising of surface coatings. T_1: Guar gum 0.5%, T_2: Guar gum 1.0%, T_3: Guar gum 1.5%, T_4: Guar gum 2.0%, T_5: Shellac 0.5%, T_6: Shellac 1.0%, T_7: Shellac 1.5%, T_8: Shellac 2.0%, T_9: *Aloe vera* 100%, T_{10}: *Aloe vera* 75%, T_{11}: *Aloe vera* 50%, T_{12}: *Aloe vera* 25%, T_{13}: CMC 0.5%, T_{14}: CMC 1.0%, T_{15}: CMC 1.5%, T_{16}: CMC 2.0%, T_{17}: control stored at Room temperature. The coatings of guar gum, Shellac, *Aloe vera* gel and Carboxyl Methyl Cellulose of the required concentrations for each treatment were prepared. Forty five fruits were dipped in each solution for 10 minutes and then air dried. Preparation of guar gum solution and fruit application was done according to the method of Wijewardane *et al.* (2013) [19]. 0.5 g, 1.0 g, 1.5 g and 2.0 g guar gum powder were dissolved in 100 ml water for the preparation of 0.5%, 1.0%, 1.5% and 2.0% solutions, respectively. Similarly, 0.5%, 1.0%, 1.5% and 2.0% shellac coating solution was prepared by dissolving 0.5 g, 1.0 g, 1.5 g and 2.0 g of shellac powder in 100ml of 20% Iso propyl alcohol. *Aloe vera* gel preparation was undertaken as per method described by Ramachandra and Rao (2008) [13]. Accordingly, coatings of *Aloe vera* gel were made in 25%, 50%, 75% and 100% with water. Preparation of Carboxyl Methyl Cellulose solution and fruit application was done as per method described by Asghar *et al.*, (2014) [2]. Carboxyl Methyl Cellulose coating solution was prepared on the percentage of weight basis with distilled water. 0.5 g, 1.0 g, 1.5 g and 2.0 g Carboxyl methyl cellulose coating powder was mixed with 100ml of water for the preparation of 0.5%, 1.0%, 1.5% and 2.0% solutions, respectively. Coated fruits then allows for air drying at ambient conditions.

The total soluble solids of the fruits were determined with the help of hand refractometer, expressed as ^{0}Brix (A.O.A.C., 1980) [1]. Titratable acidity (%) was observed Ten grams of sample was taken, ground well and transferred to volumetric flask and volume was made up to 100 ml with distilled water. The contents were filtered and taken for titration. An aliquot of 10 ml was taken into conical flask to which 2-3 drops of phenolphthalein indicator was added and titrated against 0.1 N NaOH till a pink color was obtained which persists at least for 15 seconds, as an end point. Ascorbic acid and colorimetric estimation of tannins is based on the measurement described by Ranganna (1986) [14]. The design adopted was (CRD) completely randomized design using the established statistical analysis as per the procedure. Significance was tested by 'F' value at 5 percent level of significance.

3. Results and Discussion

3.1 Total Soluble Solids (°Brix)

TSS value of guava fruits was found to increase initially during storage up to 6th days and later on decreased gradually as the storage increased i.e, 9th and 12th day of storage period is presented in Table-1. The result indicates that maximum TSS content (10.62, 12.09, 11.59 and 11.44 °Brix) was found in treatment T_4 (Guar gum 2%) from 3rd, 6th, 9th and 12th day during the storage days interval respectively and the least value of TSS (10.05, 11.39, 10.86 and 10.58 °Brix) was observed in treatment T_{17} (control) from 3rd, 6th, 9th and 12th day of storage period, respectively. However, Treatment T_3 (Guar gum 1.5%), T_2 (Guar gum 1.0%), T_9 (*Aloe-vera* 100%) and T_{10} (*Aloe-vera* 75%) were found *at par* with T_4 (Guar gum 2%) on 3rd day of storage period. Guar gum coating has been to increase hinders the fruits skin gas permeability and reducing the respiration rate which was able to maintain a better taste supported by Wijewardane *et al.* (2013) [19] and Bhowmick *et al.* (2015) [3].

3.2 Titratable Acidity (%)

The result indicates that the highest titratable acidity (0.75, 0.69, 0.66 and 0.63%) was found in treatment T_4 (Guar gum 2%) from 3rd, 6th, 9th and 12th day during the storage days interval respectively followed by Treatment T_3 (Guar gum 1.5%) and T_9 (*Aloe-vera* 100%) presented in Table-1. However, the lowest titratable acidity (0.70, 0.64, 0.58 and 0.50%) was observed in treatment T_{17} (control) from 3rd, 6th, 9th and 12th day of storage period, respectively. Similar results were reported by Keditsu *et al.* (2003) [8] and Saha *et al.* (2016) [16].

3.3 Ascorbic acid (mg/100 g)

The data presented in Table-1 indicated that the ascorbic acid (mg/100 g) of guava fruit experienced a linear decline during storage period up to 12 days. However, the loss of Ascorbic acid (mg/100 g) during storage period was more rapid and faster in control highest ascorbic acid content (242.38, 230.91, 214.89 and 201.24 mg/100 g) was found in treatment T_4 (Guar gum 2%) from 3rd, 6th, 9th and 12th day during the storage days interval, respectively and the lowest ascorbic acid (227.78, 214.43, 198.42 and 178.09 mg/100 g) was observed in treatment T_{17} (control) from 3rd, 6th, 9th and 12th day of storage period, respectively. However, Treatment T_3 (Guar gum 1.5%) and T_9 (*Aloe-vera* 100%) were found *at par* with T_4 (Guar gum 2%). This finding is in agreement with Wijewardane *et al.* (2013) [19] and Singh *et al.* (2018) [17].

Table 1: Effect of different post-harvest treatments on Total soluble solids (°Brix), Titratable acidity (%) and Ascorbic acid (mg/100 g) of *guava* cv. Allahabad Safeda during storage

Treatments		Total soluble solids (°Brix)					Titratable acidity (%)					Ascorbic acid (mg/100 g)				
		0Day	3rdDay	6thDay	9thDay	12thDay	0Day	3rdDay	6thDay	9thDay	12thDay	0Day	3rdDay	6thDay	9thDay	12thDay
T_1	Guar gum 0.5%	9.58	10.44	11.53	11.22	11.05	0.78	0.72	0.66	0.64	0.60	254.93	233.62	223.72	207.23	195.42
T_2	Guar gum 1.0%	9.55	10.51	11.64	11.30	11.15	0.76	0.73	0.67	0.65	0.61	255.50	235.59	225.52	209.49	195.88
T_3	Guar gum 1.5%	9.72	10.60	11.72	11.39	11.30	0.75	0.73	0.68	0.65	0.62	257.17	240.83	227.89	212.52	198.72
T_4	Guar gum 2.0%	9.84	10.62	12.09	11.59	11.44	0.78	0.75	0.69	0.66	0.63	259.57	242.38	230.91	214.89	201.24
T_5	Shellac 0.5%	9.59	10.09	11.39	10.92	10.81	0.78	0.70	0.65	0.60	0.52	255.40	230.03	215.09	202.72	183.92
T_6	Shellac 1.0%	9.63	10.10	11.49	11.01	10.83	0.75	0.71	0.65	0.61	0.53	255.30	231.92	216.42	203.62	185.42
T_7	Shellac 1.5%	9.65	10.17	11.59	11.17	10.86	0.76	0.72	0.66	0.61	0.55	255.40	233.78	216.58	205.59	187.59
T_8	Shellac 2.0%	9.68	10.24	11.58	11.28	11.13	0.77	0.72	0.67	0.62	0.56	255.93	235.87	218.77	206.92	189.78
T_9	*Aloe vera* 100%	9.55	10.57	11.68	11.42	11.26	0.78	0.74	0.68	0.64	0.62	255.93	240.19	226.57	212.09	197.49
T_{10}	*Aloe vera* 75%	9.52	10.50	11.62	11.35	11.12	0.75	0.73	0.67	0.64	0.60	255.90	235.88	224.40	209.77	195.72
T_{11}	*Aloe vera* 50%	9.59	10.40	11.52	11.28	11.08	0.76	0.72	0.66	0.63	0.59	255.70	233.64	222.82	209.54	194.92
T_{12}	*Aloe vera* 25%	9.65	10.20	11.45	11.26	11.04	0.78	0.72	0.66	0.62	0.58	256.23	231.89	219.77	207.72	192.22
T_{13}	CMC 0.5%	9.62	10.16	11.41	11.07	10.85	0.76	0.71	0.66	0.61	0.06	256.13	230.44	215.78	204.08	188.72
T_{14}	CMC 1.0%	9.59	10.24	11.55	11.17	10.96	0.75	0.71	0.67	0.62	0.56	256.40	233.84	217.54	207.72	189.64
T_{15}	CMC 1.5%	9.55	10.37	11.59	11.23	11.06	0.77	0.72	0.67	0.63	0.57	255.83	235.78	218.42	208.82	192.55
T_{16}	CMC 2.0%	9.59	10.42	11.62	11.31	11.13	0.78	0.73	0.68	0.63	0.59	255.67	236.22	220.98	210.46	193.84
T_{17}	Control	9.41	10.05	11.39	10.86	10.58	0.75	0.70	0.64	0.58	0.50	251.47	227.78	214.43	198.42	178.09
S.E(m) ±		0.03	0.04	0.07	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.78	1.49	1.52	1.59	1.74
C.D. at 5%		0.09	0.14	0.20	0.16	0.14	0.03	0.04	0.03	0.03	0.04	2.28	4.31	4.40	4.60	5.06

3.4 Total sugars (%)

The Total sugars (%) of guava fruits result indicates that the highest total sugars (7.83, 8.74, 8.23 and 6.65%) was found in treatment T_4 (Guar gum 2%) from 3rd, 6th, 9th and 12th day during the storage days interval respectively followed by Treatment T_3 (Guar gum 1.5%) and T_9 (*Aloe-vera* 100%) presented in Table-2. However, the lowest total sugars (7.72, 7.85, 6.87 and 4.44%) was observed in treatment T_{17} (control) from 3rd, 6th, 9th and 12th day of storage period, respectively. Similar results were reported by Mohamed et al. (2013) [10] and Minh *et al.* (2019) [9].

3.5 Tannins (mg/100 g)

The data presented in Table-2 indicated that the tannins (mg/100 g) of guava fruits indicates that the highest tannin content (25.07, 22.83, 19.77 and 18.87mg/100 g) was found in treatment T_4 (Guar gum 2%) from 3rd, 6th, 9th and 12th day during the storage days interval respectively followed by Treatment T_3 (Guar gum 1.5%) and T_9 (*Aloe-vera* 100%). However, the lowest tannin content (17.70, 16.50, 15.90 and 13.67mg/100 g) was observed in treatment T_{17} (control) from 3rd, 6th, 9th and 12th day of storage period, respectively.

3.6 Fruit Flavour

The data presented in Table-2 indicated that the maximum organoleptic value for flavour of fruits (8.98 to 6.61 out of 9) was recorded under treatment T_4 (Guar gum 2%) from initial day to 12th day of storage period followed by Treatment T_3 (Guar gum 1.5%) and T_9 (*Aloe-vera* 100%) and the minimum organoleptic value for flavour of fruits (8.94 to 3.45 out of 9) was recorded under treatment T_{17} (control) from initial day to 12th day of storage period. The above results supported by Mohamed *et al.* (2013) [10] and Chacon *et al.* (2017) [5].

Table 2: Effect of different post-harvest treatments on Total sugars (%), Reducing sugars (%) and Non Reducing sugars (%) of guava cv. Allahabad Safeda during storage

Treatments		Total sugars (%)					Tannins (mg/100 g)					Fruit colour				
		0Day	3rdDay	6thDay	9thDay	12thDay	0Day	3rdDay	6thDay	9thDay	12thDay	0Day	3rdDay	6thDay	9thDay	12thDay
T_1	Guar gum 0.5%	6.12	7.50	8.16	7.85	5.83	26.87	23.23	20.43	16.83	16.03	8.95	8.14	7.18	6.37	5.77
T_2	Guar gum 1.0%	6.13	7.63	8.32	7.97	6.09	27.47	23.77	21.17	17.60	17.23	8.86	8.30	7.36	6.52	5.91
T_3	Guar gum 1.5%	6.11	7.74	8.50	8.10	6.23	28.13	24.07	21.87	18.83	18.13	8.97	8.61	7.67	6.68	6.10
T_4	Guar gum 2.0%	6.27	7.83	8.74	8.23	6.65	29.47	25.07	22.83	19.77	18.87	8.98	8.68	7.72	6.82	6.25
T_5	Shellac 0.5%	6.10	7.52	7.98	7.15	4.56	27.23	18.33	17.03	16.67	14.53	8.85	7.60	6.55	5.90	4.80
T_6	Shellac 1.0%	6.11	7.57	8.05	7.26	4.80	27.93	19.23	18.23	17.40	15.43	8.93	7.71	6.67	6.15	4.97
T_7	Shellac 1.5%	6.11	7.62	8.27	7.45	5.10	26.33	20.10	19.73	18.23	16.10	8.91	7.95	6.89	6.23	5.15
T_8	Shellac 2.0%	6.12	7.68	8.36	7.58	5.26	28.37	21.40	20.57	18.28	17.50	8.93	8.05	6.96	6.31	5.32
T_9	*Aloe vera* 100%	6.13	7.79	8.52	7.93	6.42	27.07	23.96	21.73	18.43	18.17	8.90	8.42	7.45	6.61	5.98
T_{10}	*Aloe vera* 75%	6.11	7.68	8.39	7.76	6.10	27.77	23.50	20.87	17.87	17.40	8.95	8.20	7.22	6.32	5.81
T_{11}	*Aloe vera* 50%	6.12	7.59	8.15	7.52	5.77	28.50	22.13	19.53	17.13	16.87	8.96	8.10	7.04	6.16	5.73
T_{12}	*Aloe vera* 25%	6.12	7.52	8.05	7.36	5.57	26.73	21.40	18.20	16.50	16.47	8.90	8.01	6.93	6.11	5.62
T_{13}	CMC 0.5%	6.10	7.52	8.10	7.22	4.67	27.10	19.23	17.83	17.23	15.07	8.91	7.69	6.62	6.05	4.92
T_{14}	CMC 1.0%	6.11	7.59	8.19	7.39	4.92	28.30	20.70	18.43	17.83	15.60	8.90	7.85	6.79	6.22	5.05
T_{15}	CMC 1.5%	6.13	7.67	8.29	7.48	5.13	26.67	21.43	19.83	18.13	16.10	8.94	7.95	6.88	6.45	5.23
T_{16}	CMC 2.0%	6.14	7.72	8.40	7.64	5.36	27.83	22.83	20.87	18.30	16.73	8.85	8.15	7.00	6.58	5.42
T_{17}	Control	6.04	7.23	7.85	6.87	4.44	26.13	17.70	16.50	15.90	13.67	8.93	7.15	6.00	5.35	4.10
S.E(m) ±		0.01	0.02	0.04	0.03	0.02	0.29	0.34	0.22	0.20	0.23	0.01	0.015	0.01	0.01	0.01
C.D. at 5%		0.05	0.08	0.11	0.09	0.06	0.85	0.99	0.64	0.60	0.68	0.03	0.04	0.04	0.03	0.04

4. Conclusion

It can be concluded that application of various edible coatings may be used for extending post-harvest shelf life of guava fruits during storage Among the edible coating materials, Guar gum was significantly proved to be best post-harvest application storage of guava cv. Allahabad Safeda from this treatment also maintained different chemical characteristics *viz*. total soluble solids (TSS), ascorbic acid, total sugars, tannins and organoleptic evaluation like- fruit flavour. During storage up to 12th day of storage. It may therefore, be recommended that the post-harvest application of guar gum (2%) improved the quality at ambient conditions resulting in prolonging the shelf-life of guava fruit cv. Allahabad Safeda.

6. Acknowledgement

We are thankful to the Department of Fruit Science, and postharvest management laboratory, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) - K.N.K. College of Horticulture, Mandsaur (M.P.) for providing lab facilities for the analysis. I sincerely thanks to my advisory members and other scientist for their valuable time for data analysis.

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