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Effect of edible coatings for enhancing shelf-life and quality in Ber (*Zizyphus mauritiana* Lamk.) fruits

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Abstract: An experiment was conducted to study the effect of post-harvest application of different edible coatings like Chitosan (0.5%, 1.0%, 2.0%), Guar gum (1%, 1.5%, 2%), Gum tragacanth (1.0%, 1.5%, 2.0%) on shelf life and quality of cv. BAU ber. Fruits of uniform size were harvested at physiological maturity and treated with various edible coatings. Observations were recorded at intervals of 4 days from storage on physiological loss in weight, fruit length, breadth, colour, TSS, total sugar, reducing sugar,acidity, and ascorbic acid. The results revealed that coating of fruits resulted in reduced loss in fruit weight and higher level of ascorbic acid content, TSS, acidity, total sugar, reducing sugar as compared to the fruits under control. The most effective coating was Guar gum (2%) that extended the shelf life of ber up to 16 days. Fruits under control had a shelf life of only10 days.

Key wards: Ber, Chitosan, Guar gum, Gum tragacanth, Shelf life

INTRODUCTION

Ber (*Ziziphus mauritiana* Lam) is an economically important tropical fruit tree belongs to the family Rhamnaceae. Fruit is highly perishable and has poor shelf life (hardly 2-4 days) at ambient condition (Meena *et al*. 2009).It is highly nutritious, rich in ascorbic acid, contains fairly good amount of vitamin A and B, minerals like calcium, phosphorus, iron and has high calorific value and ascorbic acid content (Jawanda *et al.* 1978).Cultivation of ber is popular in present days. With the introduction of ber cv. BAU Ber in the sub-Himalayan Terai region of West Bengal, the area and production of ber has been increased many folds. Due to the surplus of fruits in the local markets during peak season, a substantial quantity goes to waste, resulting in heavy postharvest losses.Edible coatings have long been known to protect perishable food products from deterioration (Debeaufort *et al.*1998).The purpose is to extend the shelf life of produce and to provide a barrier against hazards. It may retard moisture migration and the loss of volatile compounds, reduce the respiration rate and delay changes in textural properties (Del-Valle *et al*. 2005). Edible coatings are used to create a modified atmosphere and to reduce weight loss during transport and storage (Baldwin, 1994). In fact, the barrier characteristics to gas exchange for films and coatings are the subjects of much recent interest (Tripathi, 2004). The objective of this study was to examine the effects of the treatment with chitosan, guar gum, gum tragacanth solution on the shelf life of the ber fruit at ambient temperature.

MATERIALS AND METHODS

Source of fruits and coating materials: To conduct the experiment, fully mature but green ber fruits were collected from farmer's field and immediately brought to the laboratory of the Department of Pomology and Post-harvest Technology, Faculty of Horticulture, at Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, during the year 2013, for storage after necessary treatments. Uniform sized, defect-free fruits were selected. The fruits after washing in running tap water dried in the shade for few minutes. A set of 90 fruits with 30 fruits per replication were taken each of the following treatments.

Chitosan (purchased from HIMEDIA, Mumbai, India) solutions was done according to the method of Jiang and Li (2001). To prepare 500 ml of 0.5%, 1.0% and 2% (w/v) chitosan solution, accurate weight of 2.5 g, 5.0 g and 10g of chitosan were dispersed in 50 ml of glacial acetic acid, respectively. The pH of the solution was adjusted to pH 6.0 with 1 M NaOH and the solutions were made up to 500 ml. Guar gum (purchased from HIMEDIA, Mumbai, India) coating solution was

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prepared on the percentage of weight basis with distilled water. 1gm, 1.5gm and 2gm guar gum powder was mixed with 100ml of water for the preparation of 1%, 1.5% and 2% solutions, respectively. Solutions were heated in oven, cooled in air followed by Wijewardane *et al*. 2013. Gum tragacanth powder (purchased from HIMEDIA,(Mumbai, India) was used in ratio of 10 to 100 ml (w/w) and was mixed in water (pH was 1.70), stirred vigorously with a magnetic stirrer on a hotplate for 40 min and were kept in the refrigerator for 24 hrs (Mohebbi *et al*. 2012) for using as coating of ber fruit. Fruit samples were analysed for physico-chemical properties at an interval of 3 days after treatments. The percentage of weight loss was calculated based on initial weight and weight at subsequent intervals. The length and breadth (millimeter scale) of ber fruits were measured as an index for shrinkage for each parameter was performed using Proc Glm of Statistical Analysis System (SAS) software (version9.3). Mean separation for different treatment under different parameter were performed using Least Significant Difference(LSD) test ($P \leq 0.05$). Normality of residuals under the assumption of ANOVA was tested using Kolmogrov-Smirnov procedure using Proc-Univariate procedure of SAS, (version 9.3). Data transformation was done following the method of Gomez and Gomez (1983) and it was measured by digital verniercallipers at zero time of storage (beginning) and 3 days interval during the storage period. The fruit colour was recorded with the help of Royal Horticulture Society mini colour chart. Total soluble solids (TSS), total sugar and reducing sugar were estimated by the method described by Mazumdar and Majumder, 2003. The acidity and ascorbic acid were estimated by the method described by Rangana (1977).

Treatments: 1.Chitosan (0.5%), 2.Chitosan (1%), 3.Chitosan (2%), 4.Guar gum (1%), 5.Guar gum (1.5%), 6.Guar gum(2%), 7.Gum tragacanth(1%), 8.Gum tragacanth(1.5%), 9.Gum tragacanth(2%), 10.Control(Untreated).

RESULTS AND DISCUSSION

Physiological loss in weight: On 4 days after treatment of ber fruits, the Physiological loss in weight was found lowest (7.37%) in fruits treated with guar gum 2% where as it was maximum (25.71%) in the fruits treated with chitosan 2%. However, on 16 days after treatment, the Physiological loss in weight was found lowest (8.01%) in fruits treated with guar gum 2% where as it was maximum (26.41%) in the fruits treated with guar gum 1.5%. The reduction in weight loss was probably due to the effects of these coatings as a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al*. 1999).

Fruit length and breadth: On 4 days after treatment, the fruit length was found highest (19.3mm) in fruits treated with guar gum 2% where as it was minimum (13.5mm) in the fruits treated with guar gum 1%. However, on 16 days after treatment, the fruit length was found highest (9.41mm) in fruits treated with guar gum 2% where as it was minimum (5.15mm) in the fruits treated with guar gum 1.5%.On 4 days after treatment of BAU ber fruits, the fruit breadth was found highest (15.41mm) in fruits treated with guar gum 2% where as it was minimum(10.46mm) in the fruits under control. However, on 16 days after treatment, the fruit breadth was found highest (7.56mm) in fruits treated with guar gum 2% where as it was minimum (4.31mm) in the fruits under control. It might be due to the anti-senescent action of coatings which had an inhibitory effect on ethylene biosynthesis and retard the activity of enzymes responsible for ripening, cell degradation was prevented which in turn facilitated reduced moisture loss and lesser respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage (Sudha *et al.* 2007).

TSS (Total soluble solid): Observation during storage of fruits revealed that the TSS content was decreased up to the storage period progressed. On 4 days after treatment, the TSS content was found highest (12.27^0brix) in fruits treated with guar gum 2% where as it was lowest (7.27^0 brix) in the fruits under control. However, on 16 days after treatment, TSS content was found maximum (6.67^0brix) in fruits treated with guar gum - 2% where as it was minimum (3.6^0brix) in the fruits under control. The increase in TSS and sugar content may be due to the hydrolysis of insoluble polysaccharides into simple sugars. When conversion is lower than the utilization, a decrease of TSS can be seen (Gupta,1987). Rate of increase in TSS under coating treatment may be due to delaying of ripening.

Total sugar: Observation during storage of fruits revealed that the total sugar content was decreased up to the storage period progressed. On 4 days after treatment, the total sugar content was found highest (10.23%) in fruits treated with guar gum 2%, chitosan 2%, and gum tragacanth 1.5% where as it was lowest (6.2%) in the fruits under control. However, on 16 days after treatment, total sugar content was found maximum (5.17%) in fruits treated with guar gum 2% where as it was minimum (3.2%) in the fruits under control. The change of sugar content is occurred due to utilization of sugar as a respiratory substrate (Nandane and Jain 2011).

Reducing sugar: It is revealed that the reducing sugar content of ber fruits was decreased up to the storage period progressed. On 4 days after treatment of bauber fruit, the reducing sugar content was found highest (4.66%) in fruits treated with guar gum 2% where as it was lowest (3.3%) in the fruits under control. However, on 16 days after treatment, total sugar content was found maximum (1.74%) in fruits treated with guar gum 2%

Table. 1. Effect of some post-harvest treatments on Physiological loss in weight (%).

Treatments	Days after storage				
	4	**8**	**12**	**16**	**Cumulative**
Chitosan(0.5%)	8.25b	7.77a	7.69c	6.47c	22.88e
Chitosan(1%)	11.57ab	8.99a	9.17c	17.97abc	39.82d
Chitosan(2%)	25.71a	9.41a	11.06bc	23.83ab	55.43a
Guar gum(1%)	10.83ab	12.36a	12.76abc	15.25abc	42.39cd
Guar gum(1.5%)	20.4ab	12.66a	15.81abc	26.41a	57.08a
Guar gum(2%)	7.37b	8.22a	7.92c	8.01bc	25.92e
Gum tragacanth(1%)	13.63ab	13.44a	18.66ab	19.48abc	51.78ab
Gum tragacanth(1.5%)	18.56ab	9.51a	9.54bc	24.21ab	49.61abc
Gum tragacanth(2%)	19.31ab	9.2a	13.96abc	9.3bc	43.3bcd
Control(Untreated)	11.41ab	13.43a	20.89a	20.68a	52.29a
SEM(±)	79.53	30.89	29.02	95.44	26.42
LSD(P≤0.05)	15.18	9.46	9.17	16.63	8.75

**Means with the same letter are not significantly different

Table. 2.Effect of some post-harvest treatments on length (mm.) of fruits

Treatments	Days after storage			
	4	**8**	**12**	**16**
Chitosan(0.5%)	17.94 ab	15.13ab	12.05a	7.21abc
Chitosan(1%)	18.5ab	15.84a	11.88a	5.38bc
Chitosan(2%)	17.44ab	15.18ab	12.77a	7.03abc
Guar gum(1%)	13.5b	11.78bc	10.5ab	6.84abc
Guar gum(1.5%)	15.42ab	11.77bc	7.64bc	5.15c
Guar gum(2%)	19.3ab	16.07a	13.03a	9.41a
Gum tragacanth(1%)	17.58ab	15.38ab	11.26a	9.13ab
Gum tragacanth(1.5%)	13.78b	10.68c	6.94c	6.32abc
Gum tragacanth(2%)	17.8a	15.54a	11.75a	7.84abc
Control(Untreated)	18.75a	14.54ab	11.57a	7.78ab
SEM(±)	8.93	4.73	4.05	4.91
LSD(P≤0.05)	5.13	3.73	3.45	3.80

**Mean with the same letter are not significantaly diffrent

Table. 3. Effect of some post-harvest treatments on fruit breadth(mm.)

Treatments	Days after treatments			
	4	**8**	**12**	**16**
Chitosan(0.5%)	13.51abc	11.99ab	6.25a	5.19 a
Chitosan(1%)	12.79abc	11.07ab	9.63a	5.25b
Chitosan(2%)	11.94abc	9.21ab	6.58ab	4.75ab
Guar gum(1%)	12.01abc	9.86ab	7.46ab	5.63ab
Guar gum(1.5%)	11.26bc	9.13ab	6.97ab	4.99ab
Guar gum(2%)	15.41c	12.68a	9.71b	7.56ab
Gum tragacanth(1%)	12.39abc	9.09ab	7.7ab	5.78ab
Gum tragacanth(1.5%)	14.91ab	11.63ab	9.49a	6.04ab
Gum tragacanth(2%)	12.1abc	9.87ab	7.7ab	4.91ab
Control(Untreated)	10.46a	8.19a	8.65ab	4.31ab
SEM(±)	5.74	5.26	3.62	2.84
LSD(P≤0.05)	4.08	3.91	3.24	2.87

**Means with the same letter are not significantly different

where as it was minimum (1%) in the fruits under control.The change of reducing sugar content is occurred due to utilization of sugar as a respiratory substrate (Nandane and Jain 2011).

Ascorbic acid: Observation during storage of ber fruits revealed that the ascorbic acid content (Table 7) was decreased in all the treatments as the storage period advanced. On 4 days after treatment, the ascorbic acid content was found maximum (90.98 mg) with guar gum 2%, where as it was minimum (89 mg) in the fruits under control. However, on 16 days after treatment, the ascorbic acid content was found highest (78.73 mg) in fruits treated with guar gum 2% where as it was lowest (77.03mg) under control. Bhowmick *et al.* (2015) reported that guar gum not only extends the shelf life but also preserves the ascorbic acid content which is associated with antioxidant capacity during storage and also suggests that guar gum is promising as an edible coating

Titrable acidity: It was revealed from this experiment that the titrable acid content (Table 8) was decreased in

Table . 4. Effect of some post-harvest treatments on TSS % .

Treatments	Days after storage			
	4	**8**	**12**	**16**
Chitosan(0.5%)	8.2f	5.8e	5.03ef	4.43de
Chitosan(1%)	10.13c	9.1b	7.8b	6.47ab
Chitosan(2%)	11.43b	9.27b	5.13a	4.3a
Guar gum(1%)	8.97e	8.23c	7.37c	6.57a
Guar gum(1.5%)	9.43d	8.33c	6.2d	5.53bc
Guar gum(2%)	12.27a	10.23b	8.07ef	6.67de
Gum tragacanth(1%)	10.3c	8.1c	5.17ef	3.97de
Gum tragacanth(1.5%)	11.2b	9.23a	5f	4.53de
Gum tragacanth(2%)	10.03c	7.23d	5.27e	4.6cd
Control(Untreated)	7.27g	5.77e	4.27g	3.6e
SEM(±)	0.04	0.02	0.02	0.32
LSD(P≤0.05)	0.33	0.24	0.26	0.96

**Means with the same letter are not significantly different

Table. 5. Effect of some post-harvest treatments on total sugar % .

Treatments	Days after storage			
	4	**8**	**12**	**16**
Chitosan(0.5%)	7.23d	4.43e	4.03de	3.55c
Chitosan(1%)	9.1b	8b	6.47b	5.13a
Chitosan(2%)	10.23a	8.07b	4.27a	3.94b
Guar gum(1%)	8.07c	7.37c	6.2b	3.32a
Guar gum(1.5%)	8.07c	7.37b	6.2c	3.32b
Guar gum(2%)	10.23a	9.27b	7.37de	5.17cd
Gum tragacanth(1%)	8.23c	7.27c	3.97de	3.43d
Gum tragacanth(1.5%)	10.23a	8.07a	4.53cd	3.28cd
Gum tragacanth(2%)	9.23b	8.07b	3.6e	3.09cd
Control(Untreated)	6.2e	6.37d	4.6cd	3.2cd
SEM(±)	0.02	0.03	0.18	0.05
LSD(P≤0.05)	0.27	0.30	0.72	0.04

**Means with the same letter are not significantly different

Table. 6. Effect of some post-harvest treatments on reducing sugar % of fruits.

Treatments	Days after treatment			
	4	**8**	**12**	**16**
Chitosan(0.5%)	3.47ef	2.61c	2.33c	1.55a
Chitosan(1%)	4.42a	3.88ab	2.85b	1.62a
Chitosan(2%)	3.97bcd	3.76b	2.31a	1.7a
Guar gum(1%)	3.41f	3.72b	2.76b	1a
Guar gum(1.5%)	3.37f	3.64b	2.13cd	1.04b
Guar gum(2%)	4.66ab	4.17ab	3.23c	1.74b
Gum tragacanth(1%)	3.56f	3.74b	2.04d	1.01b
Gum tragacanth(1.5%)	4.17abc	3.86a	2.08d	1.02b
Gum tragacanth(2%)	3.91cde	3.62b	2.02d	1.1b
Control(Untreated)	3.3 def	2.89c	2.13cd	1.02b
SEM(±)	0.08	0.04	0.02	0.02
LSD(P≤0.05)	0.49	0.32	0.23	0.23

**Means with the same letter are not significantly different

all the treatments as the storage period advanced. On 4 days after treatment, the titrable acid content was found maximum (0.53%) in fruits treated with guar gum 2% where as it was minimum (0.23%) in the fruits under control. However, on 16 days after treatment, the acid content was found highest (0.19%) in fruits treated with guar 2% where as it was lowest (0.11) in the fruits treated with guar gum 1%.It is also considered that coatings reduce the rate of respiration and may therefore delay the utilization of organic acids (Yamanand Bayoindirli, 2002).

Fruit colour : From Table 9, it is revealed that on 4 days after treatment, the fruit colour was grey brown group in chitosan treated fruits and yellow green group in remaining treated fruits. However, on 16 days after treatment, the fruits colour was yellow green (light) in colour in guar gum treated fruits except the fruits treated with chitosan, gum tragacanth and fruits under

Table. 7. Effect of some post-harvest treatments on ascorbic acid (mg/100g of fruit pulp) .

Treatments	Days after storage			
	4	8	12	16
Chitosan(0.5%)	90.2bcd	85.5abc	82.1cd	78.1a
Chitosan(1%)	89.99d	85.1cd	81e	77.95a
Chitosan(2%)	89.12e	85.5abc	82.4abc	77.4a
Guar gum(1%)	90.11cd	85.7ab	81.8d	78.2a
Guar gum(1.5%)	89.1e	84.9cd	82.59ab	78.39a
Guar gum(2%)	90.98a	86.1a	82.76a	78.73a
Gum tragacanth(1%)	90.5b	85.8ab	82.19cd	77.99a
Gum tragacanth(1.5%)	89e	84.7d	82.34bc	78.1a
Gum tragacanth(2%)	90.45bc	85.03bcd	81.89d	78.22a
Control(Untreated)	90.19bcd	85bcd	82cd	77.03a
SEM(±)	0.04	0.18	0.06	1.08
LSD(P≤0.05)	0.35	0.72	0.41	1.77

**Means with the same letter are not significantly different

Table. 8. Effect of some post-harvest treatments on acidity % .

Treatments	Days after storage			
	4	8	12	16
Chitosan(0.5%)	0.47ab	0.22a	0.16bc	0.15abc
Chitosan(1%)	0.37bc	0.21b	0.14c	0.12bcd
Chitosan(2%)	0.23a	0.32a	0.19a	0.15a
Guar gum(1%)	0.4b	0.21b	0.13c	0.11d
Guar gum(1.5%)	0.28bc	0.21b	0.16bc	0.12bcd
Guar gum(2%)	0.53d	0.35b	0.28bc	0.19abc
Gum tragacanth(1%)	0.23d	0.19b	0.19bc	0.16ab
Gum tragacanth(1.5%)	0.42b	0.22b	0.19bc	0.14bcd
Gum tragacanth(2%)	0.23d	0.26ab	0.21b	0.16abc
Control(Untreated)	0.23d	0.26ab	0.16bc	0.12cd
SEM(±)	0.003	0.003	0.001	0.0005
LSD(P≤0.05)	0.09	0.09	0.06	0.04

**Means with the same letter are not significantly different

Table. 9. Effect of some post-harvest treatments on colour.

Treatments	Days after storage			
	4	8	12	16
Chitosan(0.5%)	GBGN199D	GBG199B	GBGN199C	GBG199B
Chitosan(1%)	GBGN199D	GBGN199B	GBGN199C	GBG199B
Chitosan(2%)	GBGN199D	GBGN199B	GBGN199C	GBG199B
Guar gum(1%)	YGG144B	YGG144D	YGG145A	YGG144B
Guar gum(1.5%)	YGGN144C	YGG144D	YGG145A	YGG144B
Guar gum(2%)	YGG144B	YGG144D	YGG144B	YGG144B
Gum tragacanth(1%)	YGG144B	YGG144D	YGG144B	BG200D
Gum tragacanth(1.5%)	YGGN144C	YGG144D	YGG145A	BG200D
Gum tragacanth(2%)	YGGN144C	YGG144D	YGG144B	BG200D
Control(Untreated)	YGG144B	YGG144D	YGG144B	BG200D

GBG- GREY BROWN GROUP, YGG- YELLOW GREEN GROUP, BG- BROWN GROUP

4th day **16th day** **4th day** **16th day**

Guar gum2% treatment **Control fruit**

control which was grey brown group and brown group in colour respectively.

Conclusion

Ber is a climacteric fruit ripens rapidly after harvest. Edible coating of fruits is a purpose to maintain the nutritional quality and to increase the shelf life. The statistical analysis showed that there was significant variation in all coatings and 2% guar gum coated ber variety was found significantly superior than other treatments. The results show that the percentage reduction in ascorbic acid, reducing sugars and titratable acidity are less in application of guar gum; higher levels of nutrients are maintained in fruits during storage. The study provides minimizing post-harvest losses by using appropriate edible coating. The extent to which variability in fruit quality at harvest influences shelf life and future research as well as organoleptic tests should be done to determine the acceptance of the stored fruits by consumers.

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