Int.J.Curr.Microbiol.App.Sci (2021) *10*(04): 39-45

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 04 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1004.004

Effect of Post-Harvest Treatment on Physico-Chemical Quality of Ber (*Ziziphus mauritiana* L.) cv. Apple

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Keywords

Physico-chemical, TSS, Acidity, Ber

Article Info

Accepted:
12 March 2021
Available Online:
10 April 2021

A B S T R A C T

An experiment entitled "Effect of post-harvest treatment on shelf life and quality of ber (*Ziziphus mauritiana* L.) cv. apple" was conducted at Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be university) during 2019-20. The experiment was carried out to study about different combination of chemical effect and storage condition on shelf life and quality of ber. The ber fruits were treated with different concentrations of chemicals such as $CaCl_2$ @ 0.5%, $CaCl_2$ @ 1%, $Ca(NO_3)_2$ @ 0.5%, $Ca(NO_3)_2$ @ 1%, and water spray as a control with two storage conditions ambient and cold storage condition. The result of the present investigation revealed that the ber fruit treated with $Ca(NO_3)_2$ @ 1% in cold storage condition (T9) recorded highest total soluble solids (TSS) (14.76 °Brix), total sugar (15.31%), reducing sugar (7.96%), non – reducing sugar (8.38%)with minimum titratable acidity (0.140%).

Introduction

The Ber (*Ziziphus mauritiana* L.) is also known as Chinese date, Chinese apple, Indian plum, Indian jujube and dunks is one of the ancient and common fruit of India and China belongs to Rhamanaceae family. Ber is known as poor man's fruit due to its wide cultivation. The total area under ber cultivation in India is about 50,000ha with annual production of 5,45,000 MT (Anonymous, 2017-18). While in Rajasthan ber is grown in about 710 ha with annual production of 6730 MT (Anonymous, 2016-17). The ber is one of the most nutritious fruit, its pulp contains about 13-19 (°Brix) T.S.S. and 0.20 to 0.60 % acidity at fully ripe stage. It is one of the richest sources of vitamin C next to anole and guava. It is also rich in protein (0.8g / 100g) and minerals such as phosphorous (0.148 %) and iron (0.54 %) (Sharma *et al.,* 2002). Ber fruits are perishable in nature and cannot be stored for a longer period under ambient storage conditions (Salunkhe and Kadam, 1995). The retention of post harvest quality of the fruits for longer period is one of the most important part of the post harvest handling and storage of perishable fruits. Out of which a few techniques have been used to preserve the post-harvest quality of fruits. Unlike auxins, gibberellins did not counteract the stimulatory effect of previously applied ethylene on mango Calcium (Ca) delays the process of ripening, more particularly softening and hence, increases the shelf-life by altering intercellular and extracellular processes. Calcium ion forms cross links between pairs of negatively charged homogalacturonans, thus improves rigidity of cell walls and obstructs enzymes such as PG from reaching their active sites, thereby retarding tissue softening and ultimately delaying ripening. This makes it imperative to study the biochemistry and molecular biology of fruit ripening and to investigate the role of GA_3 and $CaCl_2$ in ripening related changes in ber fruits. The fruit growers can be highly benefited if its post-harvest life is suitably extended without much deterioration in quality of fruit. The purpose to extend the marketing periods from mid April to end April Keeping the above requirement in view, the experiment was conduct on "Effect of post-harvest treatment on physicochemical quality of ber (*Ziziphus mauritiana* L.) cv. Apple" fruits during ambient and cold storage conditions was planned with the following objectives: To study about combination between different chemicals and storage on shelf-life of ber.

Materials and Methods

An investigation was carried out in ambient and cold storage condition at the Post-harvest technology laboratory, Department of Horticulture, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar aim to study combination between different chemicals and storage on shelf-life of ber. The experiment was laid out in combination between different chemicals and storage on shelf-life of ber with 10 treatments with 3 replications. The treatment combinations are 0.5 %@$CaCl_2$ (S_1C_1), 1%@$CaCl_2$ (S_1C_2),, 0.5 %@$Ca(NO_3)_2$ (S_1C_3), 1%@$Ca(NO_3)_2$ (S_1C_4) and water as a control (S_1C_5) in ambient and 0.5 %@$CaCl_2$ (S_2C_1), 1%@$CaCl_2$ (S_2C_2), 0.5 %@$Ca(NO_3)_2$ (S_2C_3), 1%@$Ca(NO_3)_2$ (S_2C_4) and water as a control (S_2C_5) cold storage condition. Data was taken in the interval of 3,5,10 and 15 days. The observation was taken regarding Total soluble solids (°Brix), Reducing sugar (%), Total sugars (%), Non-Reducing sugars (%), Titrable Acidity (%), Physiological loss in weight (%).

Results and Discussion

The interaction effect of storage Condition and chemical treatment on TSS content of ber was also found significant during 3 rd, 5th, 10th and 15th days of storage. From the table no 1 it was observed that the highest TSS was noted in the treatment combination S_2C_4 having cold storage condition and $Ca(NO_3)_2$ chemical treatment the lowest was S_1C_5 (control) and the reading were 14.76°Brix and 10.94°Brix respectively. The total soluble solid increased with duration of storage, reached its peak value after 10 days under ambient and cold storage conditions and then started to decrease during the storage conditions. This increase in total soluble solids was probably due to hydrolysis of polysaccharides and dehydration of fruits. Therefore, total soluble solids showed gradual decrease with the advancement of storage period which may be due to increase in senescence process and high respiration rate. Similar rise and fall in total soluble solids was also noticed in guava Jayachandran *et al.*, (2004) and Akhtar *et al.,* (2010) in loquat, (Singh *et al.*, 2010) in peach fruits, Sakhale *et* *al.,* (2009) in mango, Agrwal and Jaiswal (2012) in guava and Reshi *et al.,* (2013) in litchi, Mounika *et al.,* (2017) in apple.

It was observed from table no 2 that the interaction effect of storage condition and chemical treatment on total sugar content of ber was found significant during 3rd, 5th, 10th and 15th days of storage. The highest total sugar was noted in the treatment combination S_2C_4 having cold storage condition and $Ca(NO_3)_2$ chemical treatment and the lowest was S_1C_5 (control) and the reading were 15.31% and 6.91% respectively. Total sugars increased initially with the highest on the 10^{th} day of storage and then declined this trend in all the treated fruits of ber under ambient storage condition. Similarly, in cold storage condition total sugar increased initially with the highest on the 10^{th} day of storage and decline in this trend was seen in all the treated fruits of ber cv. Apple. The initial rise may be due to water loss from fruits through evapo-transpiration and inhibition of activities of enzymes responsible for degradation of sugars, while the subsequent decline may be due to utilization of sugars in respiration. Fruits treated with calcium considering the effect of ripening retardants.

The possible reasons and findings associated with increase in total sugar up to peak and slight decline with increase during storage period of total sugar which were with $CaCl_2$ (1 %) cause accumulation of sugar as a consequence of starch hydrolysis further at the over ripe stage the leaching of sugar was carried out because of hydrolysis process.

Similar results were also recorded by Singh and Mandal (2000) in litchi, Navde *et al.,* (2005) in pear, Sharma and Singh, (2005) in fruits, Torres *et al.,* (2009) in atemoya and Girase (2011), Patel *et al.,* (2011) in custard apple, Kumar *et al.,* (2011), Tripathi and Shukla (2011), Gangwar *et al.,* (2012) in aonla. During the observation of table no 2, 3rd, 5th, 10th and 15th days of storage, the interaction effect of storage condition and chemical treatment on reducing sugar content of ber was also significantly found. The highest reducing sugar was observed in the treatment combination of S_2C_4 having cold storage condition and $Ca(NO_3)_2$ chemical treatment the lowest was S_1C_5 (control) and the reading were 7.96% and 3.70% respectively.

Reducing sugar content was continuously increased during the storage period under ambient and cold storage conditions up to 10 days, peak than decline slightly in ber fruits. This may be a consequence of release of sugar during starch hydrolysis. Ber is a non-climacteric fruit, rich in starch reserves and during post - harvest storage starch is hydrolyzed and liberating reducing sugars with enhancement of storage Jayachandran *et al.,* (2005) in guava, Navdeep *et al.,* (2005) in pear. It is might be due to $Ca(NO_3)_2$, $CaCl_2$ effect in Sharma and Singh (2005) in custard apple, ber fruits by Singh and Mandal (2000) in litchi, Singh *et al.,* (2010), Patel *et al.,* (2011) in custard apple, Kumar *et al.,* (2011), Tripathi and Shukla (2011), Gangwar *et al.,* (2012) in aonla and T. Mounika *et al.,* (2017) in apple.

During 3^{rd}, 5^{th}, 10^{th} and 15^{th} days of storage, the interaction effect of storage condition and chemical treatment on non-reducing sugar content of ber was also found significant from table no 2. It was noted that the highest non-reducing sugar in the treatment combination S_2C_4 having cold storage condition and $Ca(NO_3)_2$ chemical treatment was achieved, the lowest was S_1C_5 (control) and the reading were 8.38% and 3.21% respectively. Non - reducing sugars showed an increase up to 10^{th}day of storage and decreased on 15^{th} day of storage under ambient storage conditions and cold storage condition.

Table.1 Effect of post-harvest treatment on TSS and Acidity of ber (*Ziziphus mauritiana* L.) cv. Apple

Treatment combination	TSS(ºbrix)				Acidity(%)			
	3	5	10	15	3	5	10	15
S_1C_1	4.55	14.46	14.57	13.19	0.173	0.123	0.017	0
S_1C_2	4.53	14.55	14.71	13.34	0.190	0.137	0.070	0
S_1C_3	6.64	14.69	14.64	14.39	0.231	0.153	0.083	0
S_1C_4	6.69	14.75	14.76	14.37	0.223	0.170	0.117	0
S_1C_5	4.30	12.52	12.58	10.94	0.147	0.093	0	0
S_2 C_1	4.60	14.65	14.89	14.57	0.240	0.220	0.157	0.087
S_2 C_2	4.57	14.72	15.06	14.58	0.270	0.247	0.150	0.103
S_2C_3	7.48	15.28	15.57	14.63	0.293	0.283	0.167	0.127
S_2C_4	7.82	15.72	15.72	14.76	0.327	0.310	0.187	0.140
S_2C_5	4.58	13.42	12.18	11.91	0.203	0.183	0.133	0.073
SEm(±)	0.04	0.09	0.09	0.10	0.004	0.003	0.003	0.002
CD (5 %)	0.12	0.27	0.27	0.30	0.011	0.008	0.008	0.006

S_1C_1- ambient storage condition & 0.5 %@$CaCl_2$
S_1C_2- ambient storage condition & 1%@$CaCl_2$
S_1C_3- ambient storage condition & 0.5 %@$Ca(NO_3)_2$
S_1C_4- ambient storage condition & 1%@$Ca(NO_3)_2$
S_1C_5- ambient storage condition & water as a control
S_2C_1- cold storage condition & 0.5 %@$CaCl_2$
S_2C_2- cold storage condition & 1%@$CaCl_2$
S_2C_3- cold storage condition & 0.5 %@$Ca(NO_3)_2$
S_2C_4- cold storage condition & 1%@$Ca(NO_3)_2$
S_2C_5- cold storage condition & water as a control

Table.2 Effect of post-harvest treatment on Total, Reducing and Non-reducing sugar of ber (*Ziziphus mauritiana* L.) cv. Apple

Treatment combination	Total sugar(%)				Reducing sugar(%)				Non-reducing sugar(%)			
	3	5	10	15	3	5	10	15	3	5	10	15
S_1C_1	10.76	11.81	12.04	10.37	6.21	6.72	6.83	5.71	4.55	5.09	5.21	4.86
S_1C_2	10.84	11.89	12.49	10.39	6.31	6.75	6.92	5.82	4.53	5.13	5.58	4.57
S_1C_3	13.55	14.67	15.03	13.13	6.91	7.12	7.53	6.38	6.64	7.54	7.56	6.75
S_1C_4	13.30	14.54	15.15	13.03	6.60	6.94	7.65	6.18	6.69	7.60	7.49	6.84
S_1C_5	9.31	9.48	8.79	6.91	5.01	5.15	4.41	3.70	4.30	4.17	3.92	3.21
S_2 C_1	12.72	12.57	13.44	11.49	6.12	6.19	6.41	6.78	4.60	4.71	4.71	4.70
S_2 C_2	12.69	13.03	13.37	12.24	6.12	6.26	6.45	7.11	4.57	4.77	4.92	5.13
S_2C_3	14.61	16.31	17.39	15.11	7.13	8.06	8.93	7.91	7.48	8.56	8.92	7.13
S_2C_4	16.09	17.33	17.55	15.31	8.27	8.91	9.00	7.96	7.82	9.17	9.65	8.38
S_2C_5	9.80	9.74	9.11	8.87	5.25	5.38	5.18	5.22	4.58	4.83	4.38	3.31
SEm(±)	0.11	0.15	0.19	0.14	0.02	0.05	0.15	0.10	0.12	0.10	0.10	0.19
CD (5 %)	0.35	0.44	0.58	0.40	0.07	0.13	0.45	0.31	0.35	0.31	0.29	0.55

S_1C_1- ambient storage condition & 0.5 %@$CaCl_2$
S_1C_2- ambient storage condition & 1%@$CaCl_2$
S_1C_3- ambient storage condition & 0.5 %@$Ca(NO_3)_2$
S_1C_4- ambient storage condition & 1%@$Ca(NO_3)_2$
S_1C_5- ambient storage condition & water as a control
S_2C_1- cold storage condition & 0.5 %@$CaCl_2$
S_2C_2- cold storage condition & 1%@$CaCl_2$
S_2C_3- cold storage condition & 0.5 %@$Ca(NO_3)_2$
S_2C_4- cold storage condition & 1%@$Ca(NO_3)_2$
S_2C_5- cold storage condition & water as a control

Initial increase in non - reducing sugars might be due to evapo-transpirational losses and later decrease in non-reducing sugars might be due to conversion of these sugars into acids and also due to utilization of these sugars in respiration. The maximum non reducing sugar was retained in fruits treated with $Ca(NO_3)_2$ @ 1%under ambient and cold storage conditions. The present results are in close conformity with the finding of Hiwale and Singh (2003) and Agrwal and Jaiswal (2012) and Bisen *et al.,* (2014) in guava, T. Mounika *et al.,* (2017) and Vikash Ku. Sonkar *et at.* (2019) attributed to increase in the activity of the enzyme invertase which is responsible for conversion of acids into sugars.

It was observed from table no 1 that the interaction effect of storage condition and chemical treatment on titratable acidity content of ber was found significant during 3rd, 5th, 10th and 15th days of storage. The highest titratable acidity was noted in the treatment combination S_2C_4 having cold storage condition and $Ca(NO_3)_2$ chemical treatment and the lowest was S_1C_5 (control) and the reading were 0.140% and 0% respectively. Titratable acidity showed a constant decreased with the post-harvest treatments of ber fruits by $CaCl_2$ and $Ca(NO_3)_2$ during the storage period under ambient and cold storage conditions. At all the storage intervals, $Ca(NO_3)_2$ 1%retained highest percentage of titratable acidity under ambient and cold storage conditions and lowest was found in control. The decline in acidity may be attributed to utilize the acids in the process of respiration during ripening in presence of reduced supply of sugar as a substrate of respiration due to lower rate of starch degradation during ripening and which might be due to conversion of acids into salts and sugars by the enzymes particularly invertase. It could probably be due to delay in physiological ageing and alteration in metabolism. Gradual and progressive decrease in acidity was observed under all the treatments during storage and this progressive decline might be due to utilization of acid in metabolism. The reduction in acidity of ber fruits was quite slow at cool temperature. The results are in concurrence with those reported in ber by Hiwale and Singh (2003) in ber, Mahajan *et al.,* (2005) in kinnow, Jawandha *et al.,* (2008) in ber, Singh *et al.,* (2007) in ber, Patel *et al.,* (2011) in casturd apple, Gangwar *et al.,* (2012) in aonla, Shokrollahfam *et al.,* (2012) in ber fruits, T. Mounika *et al.,* (2017) in apple.

Based on present investigation on the "Effect of post-harvest treatment on physicochemical quality of ber (*Ziziphus mauritiana* L.) cv. apple". It can be concluded that 1% $Ca(NO_3)_2$ was helpful for enhancement of shelf life of ber with cold storage condition, and it requires to be further studied for another couple of years for making recommendation to small scale industries and farmer communities for minimizing spoilage during post-harvest management of ber.

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How to cite this article:

Mary Shiny Ekka, Manas Kumar Patel, Premananda Mohapatra, Madhukara Rout and Nikita Mohanty. 2021. Effect of Post-Harvest Treatment on Physico-Chemical Quality of Ber (*Ziziphus mauritiana* L.) cv. Apple. *Int.J.Curr.Microbiol.App.Sci.* 10(04): 39-45.
doi: https://doi.org/10.20546/ijcmas.2021.1004.004