emergent
Life Sciences Research

Research Article

Effect of composite edible coatings and modified atmospheric packaging on physical quality characteristics of ber (*Ziziphus mauritiana* Lamk.) cv. Umran

Km Kusum, Omveer Singh, A. K. Singh, Ratna Rai, N. C. Shahi, Gurdeep Bains

Received: 29 November 2023
Accepted: 31 January 2024
Online: 05 February 2024

Authors:
K. Kusum ✉, O. V. Singh, A. K. Singh, R. Rai, N. C. Shahi, G. Bains
Department of Horticulture
G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

✉ Kusum56652@gmail.com

Emer Life Sci Res (2024) 10(1): 41-47

E-ISSN: 2395-6658
P-ISSN: 2395-664X

DOI: https://doi.org/10.31783/elsr.2024.1014147

Abstract

Ber (*Ziziphus mauritiana* Lamk.) is an indigenous and economically important tropical fruit which is also known as Indian jujube, and belongs to the family Rhamnaceae. The major constraint for the market glut is the shelf life of ber fruit which is only 4 to 5 days. Due to the short shelf life of ber fruit, there is a need for proper preservation methods to enhance the shelf life. Methods to increase its shelf life by applying different surface coating treatments were developed to regulate the market for fresh fruit. Evaluation of a composite edible coating made of *Aloe vera* gel was scheduled along with modified atmospheric packaging to enhance the shelf life and maintain the quality of the ber cv. Umran. The physical characteristics of fruits were analyzed and recorded at four days intervals when kept at ambient conditions of 22-25 °C. The study revealed that during 16 days *Aloe vera* gel coatings proved beneficial in preserving the quality of ber fruit stored in modified polyethylene bags. The lowest Physiological loss in weight (PLW) %, percent decay, and shrinkage while the highest holding in weight and diameter of fruits were found in *Aloe vera* gel (75%) coatings integrated with 1% ascorbic acid and 1% citric acid as an antioxidant. According to the findings, it is concluded that *Aloe vera* gel based edible coatings incorporated with 1% ascorbic acid, duly packed in polyethylene bags and kept at ambient conditions were proved to best combinations and could be used to maintain the quality of ber fruits until 16 days.

Keywords decay, edible coatings, physical quality, physiological loss in weight, shrinkage

Introduction

In arid and semi-arid regions, ber (*Zizyphus mauritiana* Lamk.) is one of the most significant minor fruit crops. It is a member of the Rhamnaceae family and the order Rhamnales. Subsequently is widely acknowledged that the ber has a rich pulp that is abundant in nutritive compounds. It is believed to include a wide range of minerals and phytochemicals, which involve amino acids, carbohydrates, ascorbic acid, flavonoids, phenolic acids, vitamins A and C, phosphorus, calcium, and iron. It is a climacteric fruit that possesses a short shelf life and is prone to softening, browning, and decay due to ethylene resulting in ripening and senescence. The ber fruits have an extremely brief shelf life (just 2-4 days) in the environment due to their highly perishable nature [1]. Presently, 52,000 hectares of land are planted for ber cultivation in India, and that nation produces an astounding 639,000 metric tons of ber per year [2].

A range of techniques which includes packaging, cold storage, chemical preservation, and modified atmosphere storage, are employed to minimize the harmful effects. As compared to edible coating, all of which are significantly more expensive [3]. It is widely known the fact that edible coatings may prevent perishable food products from spoilage. The main types of packaging made from edible materials are edible films and coatings. Because edible coatings reduce gas exchange, water loss, flavor and aroma loss, and solute migration toward the cuticle, they improve shelf life by performing as a barrier against external elements. It is widely accepted that edible coatings decrease the rate of respiration, prevent moisture migration, conserve volatile compounds, and postpone textural property changes. In addition to adding a layer of protection for fresh goods, edible coatings have the same effect on internal gas composition as modified atmosphere storage [4].

Modified Atmosphere Packaging (MAP) is an innovative packaging technology that has gained significant attention. This technique involves the use of specialized films with varying permeability to carbon dioxide (CO_2) and oxygen (O_2) to create a modified atmosphere around the product within the package. By employing MAP, the respiration rate of the product is reduced, which helps slow down biochemical changes associated with ripening, and softening, and prevents chilling injury symptoms [5]. The use of plastic films in modified atmospheric packaging has become a widely adopted practice in fruit storage due to its cost-effectiveness.

Aloe vera gel includes antifungal qualities that make it suitable for use as an edible coating for fruits and vegetables [6]. *Aloe vera*, well known for its many therapeutic uses, is often referred to as a "medicinal plant". *Aloe barbadensis* and *Aloe arborescens* are the two most prevalent species. *Aloe vera* gel has been discovered to be a special coating agent with potent antibacterial properties. It was found that *Aloe vera* gel inhibited the growth of bacteria, both gram positive and gram negative [7-8]. When it came to certain food-borne pathogenic microorganisms like species. *Bacillus cereus*, *Salmonella typhimurium*, *Escherichia coli*, and *Klebsialla pneumonia*, *Aloe vera* gel revealed powerful antibacterial activity [9].

Methodology

Ber fruits (*Zizyphus mauritiana* Lamk.) cv. Umran was harvested when they reached the stage of commercial ripening at the Horticulture Research Centre in Pattharchatta, Pantnagar. The experimental design consisted of six treatments with each of 3 replications and the parameter data underwent analysis using a two-factor completely randomized design, where factor 1 is treatments and factor is storage intervals (0, 4, 8, 12, and 16 days) at room temperature.

Treatment details and formulations

Each replication involved studying a set of fifteen fruits. 45 mature fruits were chosen for three replications. The fruits were then treated with a mix of the following edible coating treatments: T_0 = Control, T_1 = *Aloe vera* gel @75 % + citric acid @ 1% + LDPE bag (Non-perforated), T_2 = *Aloe vera* gel @75 % + citric acid @ 1% + LDPE bag (Perforated), T_3 = *Aloe vera* gel @ 75 % + citric acid @ 1% + LDPE bag (Non - perforated) + $KMnO_4$ @ 2%, T_4 = *Aloe vera* gel @ 75 % + ascorbic acid @ 1% + LDPE bag (Non - perforated), T_5 = *Aloe vera* gel @75 % + ascorbic acid @ 1% + LDPE bag (Perforated), T_6 = *Aloe vera* gel @75 % + ascorbic acid @ 1% + LDPE bag (Non - perforated) + $KMnO_4$ @2%.

Packaging materials

300 gauze / 76.2 micron thickness of LDPE (Low Density Polyethylene) bags with 5mm dimension were used in the experiment. The top 4cm portion of the package was used for sealing the pack with an electronic sealing machine. Ten circular holes with 0.5mm diameter were made on both sides

of polyethylene bags.

Preparation of coating solutions for treatment

To create composite coatings, distilled water was placed within a beaker, and the precise amount of every chemical required for just one liter of the solvent was calculated. Subsequently, coatings were formulated for immersing the fruits. These edible coatings were derived from *Aloe vera* gel as the base, enriched with functional coating components such as ascorbic acid and citric acid, as an antioxidant, each at the desired concentration for each treatment. After being immersed in each solution for a minute, fifteen fruits were allowed to air dry.

Aloe vera gel coating preparation

Making *Aloe vera* gel, the gel matrix found beneath the green outer leaf rind of freshly harvested *Aloe vera* leaves was collected. The gel was extracted from the leaves and homogenized in a blender, and impurities and fibers were separated using a Whatman filter No. 1. After 45 minutes of pasteurization at 70 °C, the *Aloe vera* gel was quickly cooled at room temperature to stabilize it. Different concentrations of ascorbic acid (1%) and citric acid (1%) were added based on treatment combinations. The gel was applied to fresh fruits by dipping them in a prepared coating solution.

Physical quality attributes

An electronic balance was used to determine the weight of the fruits. Fruit weight was recorded at different storage intervals and physiological loss in weight was computed by the difference between the initial and final weight. By the use of digital vernier calipers track shrinkage during the storage period and also measure the fruit length and width. The decay percentage for both coated and uncoated fruits was determined by initially dividing the total number of fruits by the number of decayed fruits, and then multiplying the result by 100 at regular intervals.

Statistical analysis

The physical parameter data underwent analysis using a two-factor completely randomized design, following the methodology outlined by Snedecor and Cochran [10]. The results showed significant differences among the treatments, with storage intervals being significant at a level of $P<0.05$. The findings were visually represented using graphs.

Results and Discussion

Fruit weight (g)

T_4 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE (Non-perforated)] showed the maximum retention in fruit weight (15.67g), which is statistically at par to 15.32g in T_5 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE bag (Perforated)], while the control (T_0) untreated fruits displayed the lowest fruit weight (8.09g) (Figure 1). The weight loss of ber fruits was successfully slowed down by applying a composite coating made of *Aloe vera* gel during the entire storage interval as compared to control (uncoated fruits). Where T_4 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE (Non-perforated)] showed the maximum retention in fruit weight (15.67g), which is statistically at par to 15.32g in T_5 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE bag (Perforated)], while the control (T_0) untreated fruits displayed the lowest fruit weight (8.09g) (Figure 1) after the 16th day of storage. This preservation of higher fruit weight can be attributed to reduced moisture loss, which in turn contributed to maintaining turgidity and overall better fruit weight retention in comparison to the control fruits. Similarly, ber fruits coated with ascorbic acid were also observed to retain higher weight levels during storage [11-12]. Yaman and and Bayoindirli [13] reported similar findings regarding the positive impact of ascorbic acid coatings on retention in fruit weight.

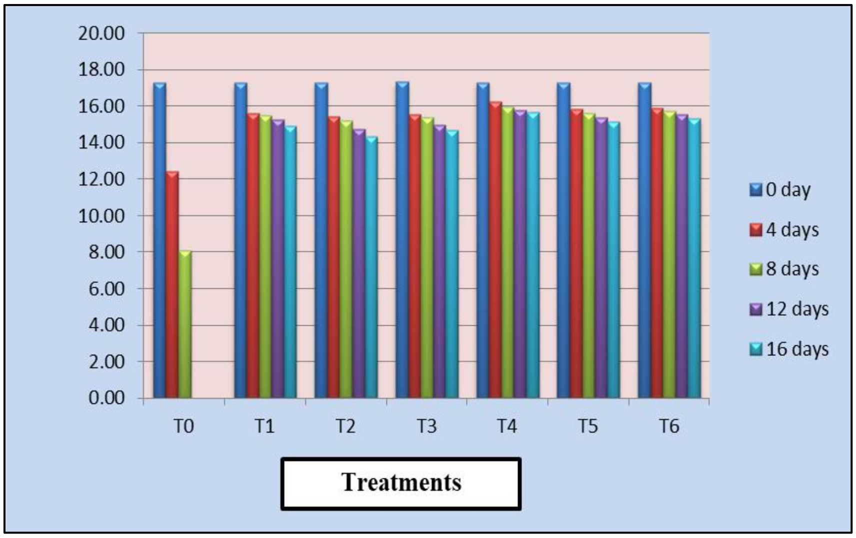

Figure 1. The impact of a composite edible coating on the weight (g) of Ber cv. Umran.

Physiological Loss in Weight (PLW) (%)

The present study showed that the interaction among edible coatings, and different storage significantly affected the physiological loss in weight of ber fruits (Figure 2). It appears that on the fourth day of storage, the uncoated fruits of T_0 (control) showed the greatest physiological loss in weight i.e., 28.08%, which increased to 50% on the eighth day and 100% by the sixteenth day of storage. T_4 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE (Non-perforated)] performed the best, with the lowest physiological loss in weight for ber fruits being 9.47% (16 days). T_6 treatment (*Aloe vera* gel at 75% + ascorbic acid at 1% + LDPE bag (Non-perforated) + $KMnO_4$ at 2%)], which showed an 11.45% physiological loss in weight on the sixteenth day of storage at room temperature, performed statistically similarly to this result.

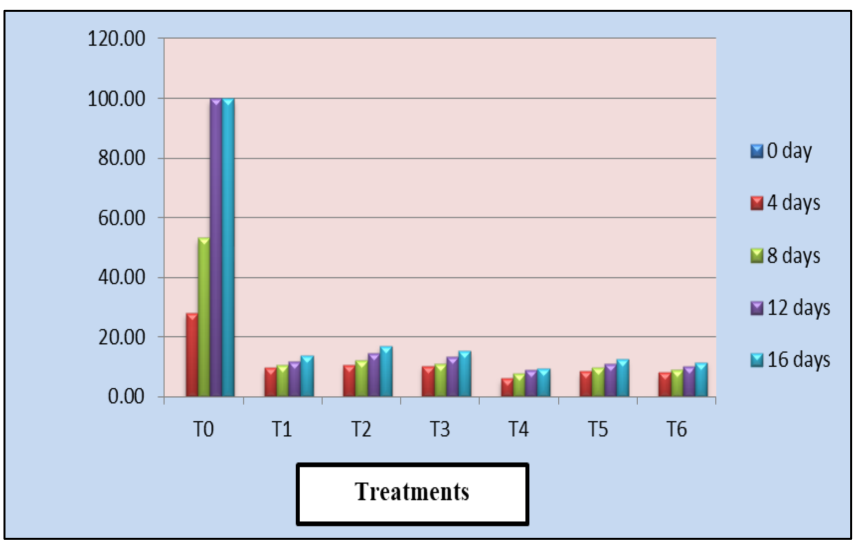

Figure 2. Displays the influence of a composite edible coatings on the percentage of Physiological loss in weight (PLW) in Ber cv. Umran.

Fruits weight loss mostly as a result of respiration and moisture evaporating through their skin. The results of these coatings functioning as semi-permeable barriers against oxygen, carbon dioxide, moisture, and solute movement are probably responsible for the decrease in weight loss seen in this experiment. Thus, respiration, water loss, and the rate of oxidation reactions are all decreased [3]. This study reported the physiological weight loss of ber fruits, and a similar observation was reported by Kumar and Bhatnagar [6] in guava fruits during storage.

Fruit diameter (cm)

Regardless of the treatment, the decrease in fruit diameter occurred gradually as the storage period grew. Fruit size decreased as a result of the loss of moisture, which also contributed to the decrease in fruit diameter (Figure 3). After the 16th days of the storage period, it was observed that T_4 [(*Aloe vera* gel @ 75% + ascorbic acid 1% + LDPE (Non-perforated)] showed best results by least reduction in diameter of fruits *i.e.*, 2.51 cm, followed by T_6 [(*Aloe vera* gel @75 % + ascorbic acid @ 1% + LDPE bag (Non-perforated) + $KMnO_4$ @2%)] *i.e.*, 2.45 cm, while uncoated fruits showing maximum reduction in diameter of fruits even after 8th days of storage *i.e.*, 1.25 cm. By forming a semi-permeable film, the composite edible coating successfully controlled gaseous exchange and lowered the rate of transpiration. As reported by Galus et al., [14], this control is reliant on the variation in water vapor pressure between the fruit and the ambient air. Similar results were reported in studies on peach fruits by different researchers [6, 12, 15-16], where they looked into the effects of various calcium postharvest treatments and storage circumstances on the Shan-e-Punjab peach variety quality.

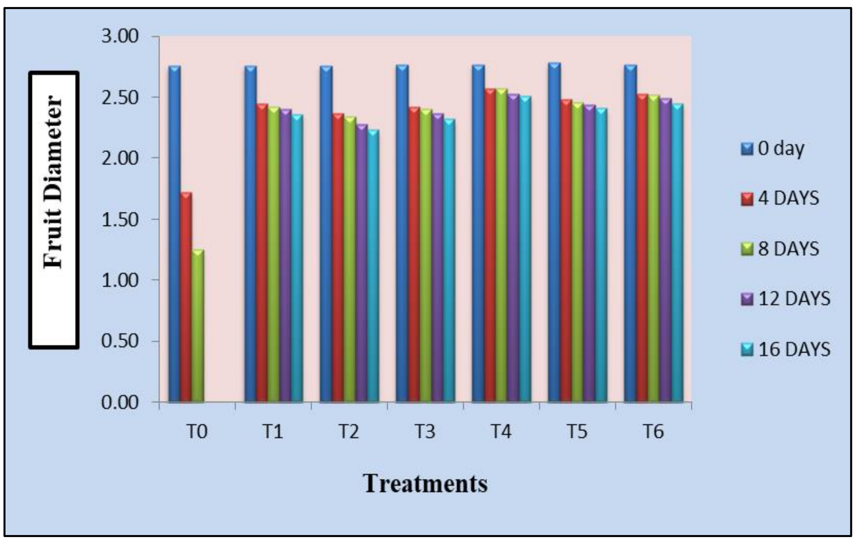

Figure 3. Demonstrates the impact of composite edible coating on the diameter (cm) of Ber cv. Umran

Shrinkage (%)

The data presented in Figure 4 indicated that every treatment had a significant effect on fruit shrinkage except uncoated fruits. T_4 [(*Aloe vera* gel @ 75% + 1% ascorbic acid + LDPE (Non-perforated)] showed the least shrinkage, at 9.39%, while the largest percentage of shrinkage, at 54.71%, was noted in T_0 (control) under 16 days of storage. This might be explained by the coating's anti-senescent characteristics, which inhibited the production of ethylene and decreased the activity of the ripening-related enzymes. According to Baraiya et al., [15], the prevention of degradation of cells consequently allowed for less moisture loss and respiratory gas exchange, delaying senescence and lowering the percentage of shrinkage. Subsequently might have been due to coatings possessing anti-senescent characteristics that prevent ethylene biosynthesis and decrease the activity of ripening-related enzymes. By preventing cell degradation, less moisture was lost and less respiratory gas exchange occurred, delaying senescence and reducing the shrinkage percentage [12].

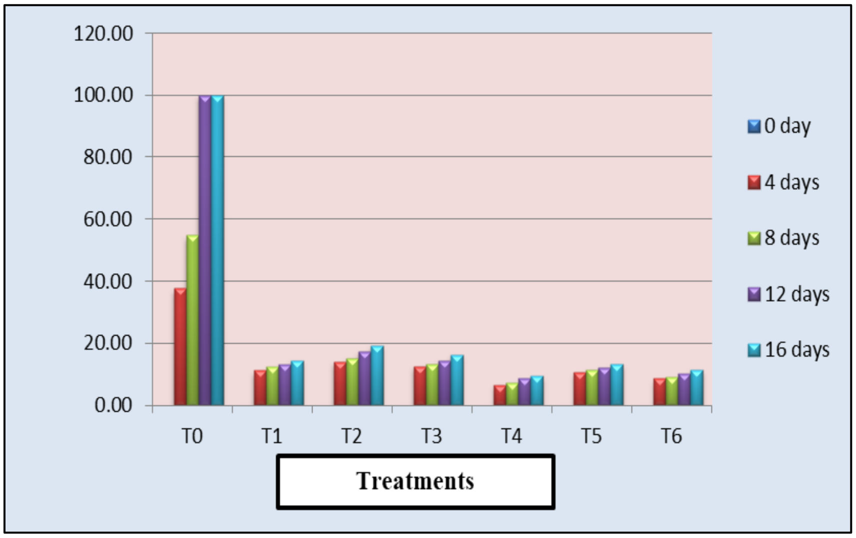

Figure 4. Demonstrates the impact of a composite edible coatings on the shrinkage (%) of Ber cv. Umran

Decay (%)

After 8 days of storage, the deterioration of fruits coated with a composite coating that included *Aloe vera* gel was apparent (Figure 5). Ber fruits coated with a mixture of (T_4) 75% *Aloe vera* gel + 1% ascorbic acid + LDPE (Non-perforated) showed the lowest percentage of fruit decay (32.47%). The uncoated control samples, on the other hand, showed the maximum decay percentage 100% (16 days). There are various reasons why *Aloe vera* gel composite coating treatments operate so well at preventing decay. *Aloe vera* gel greatly inhibited the growth of bacteria, fungi, and molds common causes of fruit deterioration during storage in addition to slowing down the respiration and ripening processes.

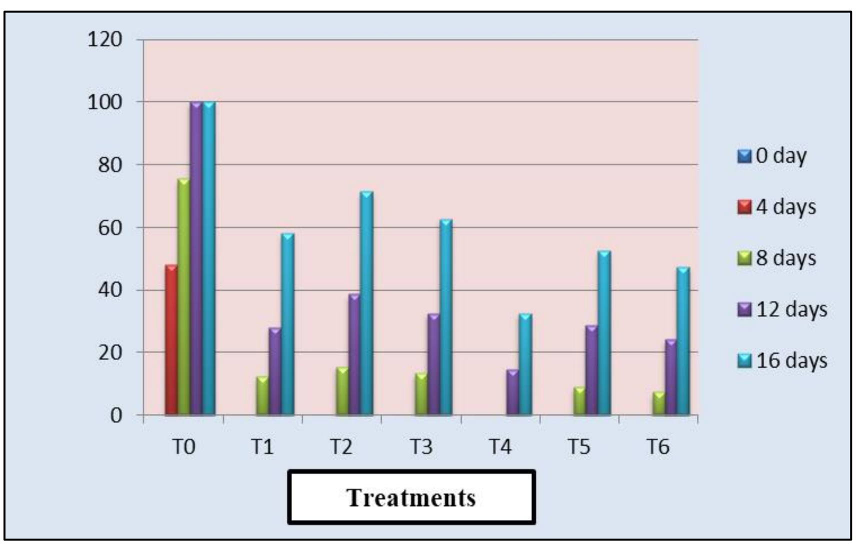

Figure 5. Demonstrates the impact of composite edible coatings on the decay (%) of Ber cv. Umran

Conclusion

The results of the research, applying a composite coating consisting of 75% *Aloe vera* gel with 1% ascorbic acid and LDPE (Non-perforated) had an advantageous impact on the weight, diameter, and percentage of physiological weight loss, shrinkage, and decay rate of ber fruit after harvesting up to 16 days of storage. Thus, it can be stated that *Aloe vera* gel significantly increased the shelf life of ber fruits. Furthermore, it showed even more promise for preserving the ber fruits aesthetic appeal when paired with vitamin C, a natural antioxidant.

References

[1] Indiastat **(2020)**. Selected State-wise Area and Production of Ber in India 2021- 2022-3rd Advance Estimates.

[2] J. M. Valverde, D. Valero, D. Martínez-Romero, F. Guillén, S. Castillo and M. Serrano **(2005)**. Novel edible coating based Aloe vera gel to maintain table quality and safety. J. Agric. Food Chem., **53:** 7807-7813.

[3] E. A. Baldwin, J. K. Burns, W. Kazokas, J. K. Brecht, R. D. Hagenmaier, R. J. Bender and E. Pesis **(1999)**. Effect of two edible coatings with different permeability characteristics on mango (*Mangifera indica* L.) ripening during storage. Postharvest Biol. Technol., **17:** 215-226.

[4] M. A. Pascall and S.-J. Lin **(2013)**. The application of edible polymeric films and coatings in the food industry. Int. J. Food Process. Technol., 4: 2. doi: 10.4172/2157-7110.1000e116.

[5] A. Kader **(1986)**. Biochemical and physiological basis for effects of controlled and modified atmospheres on fruit and vegetables. Food Technology**., 40:** 99-104.

[6] S. Kumar and T. Bhatnagar **(2014)**. Shelf life of fruits using aloe vera based herbal coatings. Int. J. Agric, Environ. Technol., **5:** 211-218.

[7] M. J. Ahmed, Z. Singh and A. S. Khan **(2009)**. Postharvest aloe vera gel-coating modulates fruit ripening and quality of 'arctic snow' nectarine kept in ambient and cold storage. Int. J. Food Sci. Technol., **44:** 1024-1033.

[8] F. Habeeb , E. Shakir, F. Bradbury, P. Cameron, M. R. Taravati, A. J. Drummond and A. I. Gray et al., **(2007)**. Screening methods used to determine the anti-microbial properties of Aloe vera inner gel methods. Methods, **42:** 315-320.

[9] S. Bautista-Baños, A. N. Hernandez-Lauzardo, M. G. Velazquez-Del Valle, M. Hernández-López, E. A. Barka, E. Bosquez-Molina and C. L. Wilson **(2006)**. Chitosan as a potential natural compound to control pre and postharvest diseases of horticultural commodities. Crop Prot., **25:** 108-118.

[10] G. A. Snedecor and W. G. Cochran **(1980)**. Statistical methods. Oxford and J. B. H. Bub Com., 7th edn. State University Press, Iowa.

[11] N. Singh, K. K. Misra, A. Dongariyal, A. Rani and V. Nirgude **(2018)**. Response of different coating material on post-harvest life and quality of guava (*Psidium guajava* L.). Int. J. Chem. Stud., **6:** 2635-2639.

[12] A. Mani, N. Jain, A. K. Singh and M. Sinha **(2017)**. Effects of Aloe vera edible coating on quality and postharvest physiology of Ber (*Zizyphus mauritiana* Lamk.) under ambient storage conditions. Int. J. Pure Appl. Biosci., **10:** 138-146.

[13] O. Yaman and and L. Bayoindirli **(2002)**. Effects of an edible coating and cold storage on shelf- life and quality of cherries. LWT-Food Sci. Technol., **35:** 46-150.

[14] S. Galus, M. Mikus, A. Ciurzyńska, E. Domian, J. Kowalska, A. Marzec and H. Kowalska **(2020)**. The effect of whey protein-based edible coatings incorporated with lemon and lemongrass essential oils on the quality attributes of fresh-cut pears during storage. Coatings, **11:** 745. doi: 10.3390/coatings11070745.

[15] N. S. Baraiya, T. V. R. Rao and V. R. Thakkar **(2014)**. Enhancement of storability and quality maintenance of carambola (*Averrhoa carambola* L.) fruit by using composite edible coating. Fruits, **69:** 195-205.

[16] S. Kaur, S. K. Jawandha and H. Singh **(2014)**. Response of baramasi lemon to various postharvest treatments. Int. J. Agric. Environ. Biotechnol., **7:** 895-902.