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Post-harvest Studies Employing Composite Herbal Edible Coating Based on Chitosan, Aloe vera and Mint Leaf Extract on Sponge Gourd (*Luffa cylindrica* L.) Fruits

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ABSTRACT

Edible composite coatings utilizing herbal components recently have triggered interest in the research field of post-harvest technology. Hence, present research aimed at investigating the formulation of composite edible herbal coating i. e. chitosan (0.5, 0.75, 1%), aloe vera (1.5, 2.5%) and mint leaves extract (1%) and its outcome on the shelf-life of sponge gourd fruits with different treatments including control during 10 days of storage period. The observations on various physical and physiological attributes were recorded at alternative days of storage period. The results revealed that T_4 chitosan (0.75%) + aloe vera (2.5%) + mint leave extract (1%) were found to be significant and maintained better firmness. It also reduced the respiration rate than other concentrations of herbal composite coatings. These treatments also had ability to perform better in maintaining other physico-chemical and sensory parameters.

Key words : Firmness, herbal composite coating, post-harvest quality, shelf life, sponge gourd

INTRODUCTION

Sponge gourd (*Luffa cylindrica* L.), commonly referred to as vegetable sponges, smooth gourd and nenua (in Hindi), is a crucial member of the Cucurbitaceae family belonging to the genus Luffa with other members as ridge gourd (*Luffa acutangula* L.). Both have a chromosome number of 26 and are perishable vegetable that is susceptible to microbial degradation once harvested (Han *et al.,* 2017). In fresh vegetables, post-harvest losses of between 5-16% have been documented (NAAS, 2019). The most obvious criteria affecting the time of the product is weight loss (WL), however, in certain vegetables, enzymatic activity resulting in flesh browning promotes consumer acceptance. It results in a reduction in sale prices, marketability, and export potential due to a loss of nutritional quality and visual appeal (NAAS, 2019). Fruit quality declines as a result of appearances such as wilting and yellowing, making marketing difficult. As a result, effective ways for retaining the typical qualities of luffa during handling, packaging and distribution are required, such as the use of herbal edible coatings. Edible coatings on fruits and vegetables, such as cherries and tomatoes, aid to reduce microbial development and prevent oxidative browning. Edible coatings may be supplemented with a variety of additives, primarily active substances, to improve their performance and efficiency.

Herbal coatings, with the help of a semi-porous layer on the surface, slow down the decaying process, lowering the transpiration rate and respiration rate, reducing water loss, and therefore assisting in accommodating the market commodity for a higher level (Bakliwal *et al.*, 2019). Because of its antibacterial characteristics, burn plant gel is widely utilized as an edible coating. Aloe vera is a semi-tropical plant that includes aloin and aloe-emodin, both of which have antifungal and antibacterial characteristics. Chitosan (amino-polysaccharide) has the potential to be a non-toxic, biodegradable, antimicrobial edible and effective film-forming substance (Khatri *et al.*, 2020). Mint extract has been shown to have antibacterial properties against penicillium expanses and leak fungus when

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applied to the cherry tomato's fruit surface and mint volatile oil is also used to improve the physical, chemical and hydrophobic component that minimises water vapour permeability of coatings (Guerra *et al.*, 2015). In review of the above, the current study was taken to investigate the physical and physiological changes as well as the post-harvest quality of composite herbal coated sponge gourd fruits stored in refrigerated conditions.

MATERIALS AND METHODS

The research study was conducted in the Post-harvest and Food Processing Research Laboratory of Lovely Professional University, Phagwara, Punjab, during 2021. Sponge gourd fruits (variety Alok) at commercial maturity were harvested from the university field. Total seven herbal coating treatments (Table 1) with three replications were used at low temperature (10°C). The herbal coating was applied on sponge gourd fruits by using the dipping method for 3 min and air-dried at room temperature (25±2°C) before applying the herbal edible coating.

The mature leaves of aloe vera plants were procured from agricultural farm and the internal aloe gel was extracted and homogenized using an electric blender. Then concentrations incorporating aloe vera gel at 1.5, 2.5% v/v were prepared with distilled water. Mint extract was prepared as per standard methods. It was then dissolved in distilled water to make the required concentration. Chitosan solution was made in 1% glacial acetic acid. Fruits were immersed in different treatment liquids/emulsions for 5 min and then were dried for 2 h at room temperature and stored at ambient conditions (25±2°C temperature and 80±5% relative humidity). The fruits were assessed every alternative day for 10 days storage period. Physiochemical analysis included physiological loss in weight, pH, TSS, firmness, and sensory evaluation (hedonic scale).

The experiments were set up in a tactorial completely randomized design (FCRD) under controlled conditions. Data were subjected to statistical analysis using OPSTAT software at P=0.05 significance level.

RESULTS AND DISCUSSION

Irrespective of storage period, physiological loss in weight (PLW) was significantly altered by different herbal composite coatings being the highest PLW of 6.490% was recorded in control fruits (T_0) during storage of 10 days. Due to the protection layer provided by chitosan-based coating with incorporated aloe vera and mint leaves extract, sponge gourd coated with T_4 [Chitosan (0.75%) + Aloe vera (2.5%) + Mint leaves extract (1%)] had low weight loss of 5.339% followed by T_3 as 5.392% PLW (Table 2) as this coating formulation was optimal in confined gaseous exchange and water loss. The primary cause of fruit weight loss during storage is commonly thought to be direct flow of water rate from fruit to the environment. Weight loss was much greater in the control group than in the chitosan-aloe vera-mint leaves extract group, which could be related to the inclusion of mint leaves juice, which was hydrophobic. The similar effects of postponing weight loss in chitosan pullulan composite coating treated tomatoes were observed by Kumar *et al.* (2021).

The pH value of uncoated sponge gourds and coated gourds was analyzed regularly during the storage period. There was a significant difference among the treatments at 5% level of significance, although the chitosan, aloe-vera, mint leaves extract based herbal edible coating indicated the higher pH as compared to uncoated cucumbers stored at low temperature (10°C). The maximum pH of 6.172 was observed in gourds coated with T_4, whereas

Table 1. Different coating combinations used in experimental research studies

Treatment	Compositions
Control (T_0)	Distilled water
T_1	Chitosan (0.5%) + Aloe vera (1.5%) + Mint leave extract (1%)
T_2	Chitosan (0.5%) + Aloe vera (2.5%) + Mint leave extract (1%)
T_3	Chitosan (0.75%) + Aloe vera (1.5%) + Mint leave extract (1%)
T_4	Chitosan (0.75%) + Aloe vera (2.5%) + Mint leave extract (1%)
T_5	Chitosan (1%) + Aloe vera (1.5%) + Mint leave extract (1%)
T_6	Chitosan (1%) + Aloe vera (2.5%) + Mint leave extract (1%)

Table 2. Impact of herbal composite coatings on PLW of sponge gourd fruits during cold storage

Treatment	0 day	2 days	4 days	6 days	8 days	10 days	Mean
Control (T_0)	0.000	2.730	6.523	7.687	9.510	12.490	6.490
T_1	0.000	2.013	5.697	6.507	8.483	10.473	5.529
T_2	0.000	1.983	5.677	6.377	8.347	10.407	5.465
T_3	0.000	1.883	5.503	6.373	8.293	10.297	5.392
T_4	0.000	1.820	5.450	6.273	8.253	10.237	5.339
T_5	0.000	2.230	5.887	6.567	8.560	10.567	5.635
T_6	0.000	2.173	5.830	6.533	8.473	10.473	5.581
Mean	0.000	2.119	5.795	6.617	8.560	10.706	

LSD (P<0.05) for Treatment (T)=0.017, Days (D)=0.016 and T × D=0.042.

minimum pH of 6.096 in uncoated gourds (Table 3). Due to the herbal coating forming a semi-permeable covering on vegetables surface caused a decrease in the pH and the concentration of carbon dioxide and oxygen was modified i. e. internal atmosphere of fruits and vegetables, thus delayed the ripening process. Kumar *et al.* (2021) found comparable results in chitosan coated tomatoes.

Total soluble solids (TSS) was significantly influenced irrespective of storage period by the different edible coating, being the highest in fruit without any coating 6.094 °B and lowest in fruit coated T_4 (5.953 °B) followed by T_6 (6.024 °B). The control treatment (T_0) with 6.094 °B resulted in more sugar content during initial days than other treatments (Table 4). The total soluble content of treatment T_4 coated luffa fruits increased. This was due to the higher respiration rate; speeded up ripening that caused breakdown of complex carbohydrates into simple ones and also moisture loss due to transpiration and evaporation processes constituting in more TSS content in (T_0) control fruits. In the present study, herbal based chitosan, aloe vera, mint leaves extract based coating were effective treatments as it delayed senescence in sponge gourd by inhibiting respiration rate at higher rate, control over ripening, avoid moisture degradation and other gases exchange (Ullah *et al.,* 2017).

Generally, the firmness of fruit considerably decreases during the storage period. However, the speed of decline was higher within the control fruit than those coated with different

Table 3. Impact of herbal composite coatings on pH of sponge gourd fruits during cold storage

Treatment	0 day	2 days	4 days	6 days	8 days	10 days	Mean
Control (T_0)	5.237	5.493	6.170	6.420	6.543	6.713	6.096
T_1	5.240	5.477	6.153	6.390	6.527	6.683	6.078
T_2	5.243	5.480	6.127	6.367	6.517	6.657	6.065
T_3	5.237	5.533	6.207	6.420	6.617	6.763	6.129
T_4	5.243	5.607	6.237	6.463	6.667	6.813	6.172
T_5	5.243	5.517	6.180	6.430	6.597	6.763	6.122
T_6	5.237	5.567	6.217	6.440	6.633	6.787	6.147
Mean	5.240	5.525	6.184	6.419	6.586	6.740	

LSD (P<0.05) for Treatment (T)=0.017, Days (D)=0.016 and T × D=0.041.

Table 4. Impact of herbal composite coatings on total soluble solids of sponge gourd fruits during cold storage

Treatment	0 day	2 days	4 days	6 days	8 days	10 days	Mean
Control (T_0)	6.137	6.193	6.247	6.127	6.110	5.753	6.094
T_1	6.137	6.177	6.210	6.107	6.103	5.600	6.056
T_2	6.137	6.167	6.200	6.073	6.100	5.587	6.044
T_3	6.137	6.137	6.173	6.077	6.093	5.550	6.028
T_4	6.137	6.113	6.147	6.033	5.743	5.547	5.953
T_5	6.137	6.163	6.170	6.110	6.103	5.610	6.049
T_6	6.137	6.130	6.147	6.077	6.067	5.587	6.024
Mean	6.137	6.154	6.185	6.086	6.046	5.605	

LSD (P<0.05) for Treatment (T)=0.036, Days (D)=0.034 and T × D=0.089.

Table 5. Impact of herbal composite coatings on firmness of sponge gourd fruits during cold storage

Treatment	0 day	2 days	4 days	6 days	8 days	10 days	Mean
Control (T_0)	11.227	10.323	8.193	7.243	6.583	4.583	8.026
T_1	11.227	10.823	10.523	9.833	9.523	8.733	10.111
T_2	11.227	10.850	10.623	9.857	9.530	8.787	10.146
T_3	11.227	10.873	10.630	9.897	9.577	8.797	10.167
T_4	11.227	10.923	10.623	9.930	9.587	8.840	10.188
T_5	11.227	10.923	10.683	9.930	9.623	8.837	10.204
T_6	11.227	10.930	10.717	9.923	9.583	8.830	10.202
Mean	11.227	10.807	10.285	9.516	9.144	8.201	

LSD (P<0.05) for Treatment (T)=0.012, Days (D)=0.011 and T × D=0.029.

Table 6. Impact of herbal composite coatings on overall acceptability of sponge gourd fruits during cold storage

Treatment	0 day	2 days	4 days	6 days	8 days	10 days	Mean
Control (T_0)	8.667	7.267	6.067	5.267	4.967	4.067	6.050
T_1	8.667	7.567	6.500	5.567	5.167	4.167	6.272
T_2	8.667	7.433	6.367	5.333	5.333	4.133	6.211
T_3	8.667	7.667	6.667	5.667	5.267	4.267	6.367
T_4	8.667	7.767	6.767	5.700	5.367	4.367	6.439
T_5	8.667	7.467	6.500	5.433	5.267	4.267	6.267
T_6	8.667	7.367	6.267	5.267	5.167	4.133	6.144
Mean	8.667	7.505	6.448	5.462	5.219	4.200	

LSD (P<0.05) for Treatment (T)=0.177, Days (D)=0.164 and T × D=NA.

concentrations of herbal composite coating. Among different coatings applied, the minimum fruit firmness of 8.026 was recorded in control treatment and maximum of 10.204 in fruits coated with T_5 followed by T_6 (10.202) as shown in Table 5. During the storage, a rise in pulp firmness was noticed under all treatments followed by external wilting and internal fibrosis. Chitosan treatment considerably delayed the firmness loss of mango, and this performance could also be because of controlled gas and water transpiration as explained by Zahedi *et al.* (2019).

On the 10th day of storage, the maximum acceptability of 4.367 was found in T_4 coated fruits and minimum of 4.067 in control (Table 6). The overall acceptability score decreased with the rise in storage period, with the highest sensory acceptability of 6.439 and the lowest of 6.050 in uncoated fruits. The research work was in line with findings of Raghav and Saini (2018) who reported that cucumbers when treated with aloe vera herbal composite coating showed better organoleptic properties than the untreated ones.

CONCLUSION

It may be concluded from the present study that coating of sponge gourd var. Alok with chitosan (0.75%) + aloe vera (2.5%) + mint leaves extract (1%) was most effective in maintaining fruit firmness and overall acceptability than control fruits. Hence, coating of sponge gourd fruits either with 0.75% chitosan, 2.5% aloe vera and 1% mint leaves extract can be recommended to increase the shelf life of sponge gourd till 10 days and preserving its quality would have more consumer's acceptability and economic profits.

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