Comparative Estimation of Alginate and Soy Based Coatings on Ph and Vitamin C Contents of Strawberry (Fragaria Ananassa L) at Controlled Climate Chamber

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Abstract

In the present study, effort was made to address the alarming situation of postharvest losses. For the purpose, alginate and soy based coatings were prepared and their effect on minimizing the postharvest losses and allied nutritional attributes in strawberry was observed. Meanwhile, a comparison with the commercial wax coating was also estimated. Results showed that pH differed significantly with respect to storage for both the experiments. However, non momentous variations were observed with respect to treatments kept at room temperature ranging from 4.18 to 4.26 for the treatments. Meanwhile, ascorbic acid (vitamin C) levels differed appreciably as a factor of storage among all the treatments. For controlled climate chamber kept strawberries, vitamin C levels ranged from 42.67 to 46.43 mg/100 gm whilst for room temperature the values for the parameter ranged from 36.87 to 39.58 mg/100 gm. Conclusively, it may be inferred that edible coatings hold potential to be adopted as a tooling aid in addressing the alarming situation of postharvest and nutritional losses in fruits that may ultimately lead help earn foreign exchange reserves in return.

Keywords: Edible coatings; Postharvest losses; Strawberry

Introduction

Pakistan has been blessed with fertile lands and environment conducive for the growth of array of fruits and vegetables all the year round. It is assumed that proper handling and export of fresh horticultural commodities especially fruits may help improve socioeconomic status of the country. Furthermore, geographical diversity of the region ensures growth of a broad variety of fruits including mango, citrus, apple, strawberry, apricot etc. Domestically, prospect to increase fruit production is at the high probably due to profits associated with the fresh produce [1]. But to our dismay, due to mismanagement and inadequate handling and processing conditions, a large amount of this perishable commodity is going as waste. Furthermore, lack of proper storage, transportation and handling facilities further exacerbate this catastrophic situation. These detrimental changes often result in loss of nutrients, thus deteriorating the quality of fruits. It has been estimated that post harvest losses account for about 25-40% of the total production thereby leading to greater monetary loss [2].

Strawberry (Fragaria ananasa), is cultivated globally and widely appreciated for its characteristic aroma and juicy texture. Being delicious and refreshing fruit with great dietetic value, strawberry is quite profitable for small land owners. Generally, fruit is consumed as fresh; however it can be preserved for making jam, jellies and squashes for use in off-season. Major varieties cultivated in Pakistan include Noor, Duglus, Chandler, Tufus, Karoz, Pajaro, Commander and Corona [3]. Nutritionally, strawberry is laden with many health endorsing phytoneutrients, minerals and vitamins that are essential for optimum health. Largely containing anthocyanins and ellagic acid, consumption of strawberry has been linked to be effective against cancer, aging, inflammation and neurological diseases. Fresh berries are an excellent source of vitamin-C (about 98% of RDI), that helps body develop immune system and resistance against inflammation and scavenge free radical species [4].

Quite a number of storage techniques have been developed till date aimed at extending the marketing distances thereby increasing holding periods for fresh horticulture produce of the various approaches, refrigeration, controlled atmosphere packaging, fungicides, chemical preservatives and additives [5]. Of the various preservation techniques, edible coating is one of the most promising methods with greater consumer interest. It involves an intact transparent edible film acting as a barrier to solute movement and oxygen permeability. Additionally, these films can be used as a host for additives in conserving the properties of product and to improve its overall appearance [6].

In order to curtail the challenges, quite a number of techniques have been studied aimed at extending the shelf life of fresh produce. Of the approaches, storage at low temperature, high relative humidity and controlled/ modified atmosphere packaging is deemed to be the most promising one. Edible coatings can act as moisture and gas barriers, control microbial growth, preserve the color, texture and moisture of the product, and can effectively extend the shelf life of the product [7]. Edible coatings as oxygen and lipid barriers at low to intermediate relative humidity as the polymers can effectively make hydrogen bonds [8]. An edible coating must have good sensory profile, acceptable color, flavor, taste and texture with shiny look.

However, with the progression and advancement in technology, there was arisen a concept of biodegradable and edible coatings that

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would not only serve as to address the moisture loss and improving shelf life but would extend further apart in being edible and not associated with any physiological disorder [9]. Examples of such type of coatings are carbohydrate, protein based and certain lipid types.

The present research is an attempt to probe the variations in pH and vitamin C levels of strawberry kept at room temperature and as well as at controlled climate chamber. The findings of instant investigation will be an attempt to enlighten growers, processors and exporters about the use of latest techniques of preservation as edible coating to extend the shelf life of fruits thereby help generate foreign exchange in return.

Methodology

Procurement of raw material

Fresh strawberry was procured from local market in Faisalabad. Selection of fruit was based on uniformity in size, shape, color, absence of physical damage or any evidence of abrasion. Meanwhile chemicals and other expendables for coatings formulation were purchased from local market.

Preparation of whole fruits

Procured fruit was subjected to sorting and grading on the basis of physical appearance to prepare a uniform lot in the Postgraduate Research Laboratory of the National Institute of Food Science & Technology, University of Agriculture, Faisalabad. Fresh strawberry was washed to loosen the dirt and grits adhered to the surface. Later on, sorted fruit was stored at refrigeration temperature to avoid undesirable biochemical changes.

Development of coatings

Alginate based coatings: Alginate coatings were prepared following the protocol of [7]. Film forming solution was prepared by dissolving alginate powder (2g/100 mL water) in distilled water and heated at 70°C with continuous stirring until the clear solution formed. Glycerol was added as plasticizer (1.5g/100 mL) in alginate solution. Film forming solution was emulsified with sunflower oil (0.025g/100 mL) and emulsion was used for fruit coating. N-acetyl L-cysteine (1g/100 mL) was added to the calcium chloride (2g/100 mL water) required for cross linking of carbohydrate polymers. The concentrations of ingredients used in these formulations are shown in Table 1.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Soy coating</th>
<th>Alginate coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soy protein</td>
<td>1g</td>
<td>1%</td>
</tr>
<tr>
<td>Glycerol</td>
<td>2.5g</td>
<td>2%</td>
</tr>
<tr>
<td>Ascorbic acid</td>
<td>1g</td>
<td>3%</td>
</tr>
<tr>
<td>Sunflower oil</td>
<td>0.025g</td>
<td></td>
</tr>
<tr>
<td>Distilled water</td>
<td>100mL</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Soy protein based coatings formulation.

Soy protein based coatings: Soy protein based edible coatings were prepared according to the method of [10]. Soy protein was dissolved in distilled water (100mL). By continuously stirring the mixture, glycerol (2.5 g) was added to the solution. The film forming solution was heated for 20 min at 90°C in a water bath to denature soy protein. Film forming solution was emulsified with sunflower oil (0.025g/100 mL) to improve water vapor barrier properties (Table 2). Enzymatic browning was prevented by the addition of ascorbic acid (1 g/100 mL).

Commercial wax coating: Commercial wax coating was procured from Aroma citrus processing industry, Bhalwal, Sargodha. The obtained commercial wax coating was homogenized using homogenizer to give a better flow and consistency to the emulsion (Table 3).

Application of edible coatings

After completing the desired preparatory operations, selected strawberry was immersed in distilled water and divided into various lots. One lot without edible coating application was considered as control whilst other was dipped into commercial wax coating. Likewise, for alginate and soy based coatings different concentrations like 1, 2, and 3% were prepared and the selected fruits were immersed in coating solutions for 2 minutes. Residual solutions of each treatment were allowed to drip off for 1 minute and resultant coated strawberry was left for drying for about 15- 20 minutes.

Storage

Both coated and uncoated strawberries were placed in controlled climate chamber (4-6°C and 85% relative humidity). The objective of storage was to study the effect on quality of different types of coatings and optimization of the coating formulations. During storage, different physicochemical and sensory tests were performed at regular intervals.

Physicochemical analysis

Following physicochemical analysis were conducted at selected intervals to examine the shelf life stability of coated fruits.

Extraction of juice

For juice extraction, 100g of fruit was blended in 200 mL distilled water followed by filtration to remove solid contents. The obtained juice was subjected to chemical analyses like pH, titratable acidity, vitamin C and total soluble solids.

pH

The pH of each sample was determined with the help of digital pH meter following the guidelines of [11].

Ascorbic acid

The ascorbic acid content was estimated using 2, 6-dichlorophenolindophenol dye, according to the prescribed method.

**Preparation of Solutions**

Weigh 0.04 g dye and dissolve in distilled water to make volume to 100 ml.

Weigh 0.4 gm oxalic acid and make volume up to 100 ml

**Preparation of standard ascorbic acid solution**

Prepare 0.1% solution i.e. 10 g of ascorbic acid in 1000 ml of solution

**Procedure**

Firstly, titrate the prepared standard ascorbic acid solution and oxalic acid solution against the dye (2, 6-dichlorophenolindophenol). The obtained reading served as standard. Afterwards, extracted juice sample along with oxalic acid solution was titrated against indophenol dye and noted the volume used.

Vitamin C contents will be determined using the formula as under

\[
\text{Ascorbic Acid} = \frac{1 \times R \times V}{R_1 \times W \times V_1} \times 100
\]

Where, \( R = \) ml of dye used against sample (juice) titration
\( V = \) volume of filtrate
\( R_1 = \) ml of dye used for titration against standard ascorbic acid solution
\( W = \) weight of sample
\( V_1 = \) volume of filtrate

**Statistical Analysis**

The data obtained for each parameter was subjected to statistical analysis to determine the level of significance and comparison of means was also carried out according to the methods as described by Steel [12].

**Results and Discussion**

**pH**

Mean squares for pH of strawberry coated with alginate and soy based coatings kept at controlled climate chamber are given in Table 4. It is evident that coatings had a significant impact due to treatment and storage except for their interaction that emerged to be non-momentous. Mean values regarding pH of strawberry treated with various coatings stored at controlled climate chamber narrates a systematic increase in the values (Table 5). The maximum value for the trait was observed in \( T_0 \) (Control) and \( T_7 \) (Commercial wax) as 3.96 ± 0.05 and 3.94 ± 0.04, respectively. However, for treatments \( T_1 \) (Alginate 1%), \( T_2 \) (Soy 3%), \( T_3 \) (Alginate 2%) as 3.83 ± 0.03 and 3.84 ± 0.04, respectively. Over the storage, there was seen a gradual increment in the value for the parameter ranging from 3.79 ± 0.04 at 0 days to 3.88 ± 0.04 and 3.98 ± 0.04 at 10th and 20th day of storage, respectively. Likewise, amongst treatments a similar decrease in the value for the trait was recorded ranging from 3.78 ± 0.04 to 3.97 ± 0.03 and 3.78 ± 0.04 to 3.89 ± 0.04 in \( T_3 \) and \( T_2 \), respectively. However, the maximum of the increase in pH was noticed in \( T_0 \) and \( T_7 \) varying from 3.78 ± 0.04 to 4.11 ± 0.06 and 3.80 ± 0.02 to 4.10 ± 0.05 at 0 to 20 days, respectively. The treatments \( T_0 \) and \( T_7 \) served as an appreciable attempt in maintaining the ingress in pH as ranged from 3.78 ± 0.04 to 3.94 ± 0.03 and 3.78 ± 0.04 to 3.96 ± 0.02 at initiation to termination of the trial, respectively.

The findings of instant investigations are in line with the previous work of Tapia [13] they used alginate and gelan based coatings on fresh cut papaya to investigate their ability to improve water vapor resistance (WVR), and gas permeability. Moreover, they delineated a non-significant interaction on pH of the coated commodity due to factor of storage. Our results are also supported by the previous work of Vachon [14] who quoted gamma-irradiation and effect of various edible coatings on fresh strawberries (Fragaria spp.) for keeping fruit quality and extending shelf life. In their experiment, four coatings were involved; based on irradiated caseinate was more effective than that of

**Table 4: Mean squares for pH and acidity of coated strawberry kept at controlled climate chamber.**

<table>
<thead>
<tr>
<th>Treatments (T)</th>
<th>Days (D)</th>
<th>Mean squares for pH of strawberry coated with alginate and soy</th>
<th>Ascorbic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Treatments (T)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Means</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( T_0 )</td>
<td></td>
</tr>
<tr>
<td>0 day</td>
<td></td>
<td>3.78 ± 0.04</td>
<td>3.80 ± 0.02</td>
</tr>
<tr>
<td>3 days</td>
<td></td>
<td>3.85 ± 0.04</td>
<td>3.82 ± 0.04</td>
</tr>
<tr>
<td>7 days</td>
<td></td>
<td>3.90 ± 0.04</td>
<td>3.85 ± 0.04</td>
</tr>
<tr>
<td>10 days</td>
<td></td>
<td>3.95 ± 0.06</td>
<td>3.88 ± 0.03</td>
</tr>
<tr>
<td>14 days</td>
<td></td>
<td>4.03 ± 0.07</td>
<td>3.92 ± 0.03</td>
</tr>
<tr>
<td>17 days</td>
<td></td>
<td>4.06 ± 0.06</td>
<td>3.92 ± 0.03</td>
</tr>
<tr>
<td>20 days</td>
<td></td>
<td>4.11 ± 0.06</td>
<td>3.89 ± 0.04</td>
</tr>
<tr>
<td>Means</td>
<td></td>
<td>3.96 ± 0.05</td>
<td>3.86 ± 0.03</td>
</tr>
</tbody>
</table>

Where, \( T_0 \) = Control; \( T_1 \) = Alginate 1%; \( T_2 \) = Alginate 2%; \( T_3 \) = Alginate 3%; \( T_4 \) = Soy 1%; \( T_5 \) = Soy 2%; \( T_6 \) = Soy 3%; \( T_7 \) = Commercial wax.

**Table 5: Means for pH of strawberry treated with different edible coatings kept at controlled climate chamber.**

<table>
<thead>
<tr>
<th>Days</th>
<th>Treatments (T)</th>
<th>pH</th>
<th>Ascorbic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 day</td>
<td></td>
<td>0.045</td>
<td>38.97</td>
</tr>
<tr>
<td>3 days</td>
<td></td>
<td>0.122</td>
<td>468.12</td>
</tr>
<tr>
<td>7 days</td>
<td></td>
<td>0.003</td>
<td>1.80</td>
</tr>
<tr>
<td>10 days</td>
<td></td>
<td>0.00134</td>
<td>2.32</td>
</tr>
</tbody>
</table>

*significant **highly significant ns = non significant.
unirradiated caseinate. In a 2nd experiment, 3 irradiated coatings based on calcium caseinate and whey proteins were evaluated. The coating formulation based on 1:1 caseinate-whey was found to be more effective than those based on calcium caseinate. Addition of calcium chloride or a mixture of pectin and agar increased the effectiveness of the coating by delaying molds’ apparition.

**Vitamin C**

As evident from mean squares regarding ascorbic acid, it is explicated that there observed a significant variations due to treatments and storage. Furthermore, interaction differed non-momentous (Table 4).

It is explicated from means that there was a gradual decline the ascorbic acid contents on strawberry underwent numerous coating techniques (Table 6). It can be seen from the table that the maximum value for vitamin C was observed T2 (Alginate 2%) as 46.29 ± 0.94mg/100gm. However, the lowest values for the parameter were recorded in T0 (Commercial wax).

**References**

