Effect of Some Edible Coating on Quality of Fresh Pear Slices during Cold Storage

1Asrar, Y.I. Mohamed and 2Fatma K. M. Shaaban

1 Food Engineering and Packaging Dept., Food Tech. Res. Inst., Giza, Egypt

ABSTRACT

This experiment was carried out on fresh pear (Pyrus communis, L.) slices during 2012 and 2013 seasons, to extend postharvest life and maintain their quality. Uncoated control samples and those coated with guar or xanthan gum based coating were stored at 5°C and 90% relative humidity for 12 days. The changes in weight, texture, total acidity, TSS, the activity of polyphenol oxidase (PPO) and peroxidase (POD), and total colony and Moulds & yeasts counts were evaluated for the coated and uncoated samples during storage. Samples were withdrawn every 3 days in order to determine the delay in the deterioration time. Coatings based on guar and xanthan gums were effective in reducing weight loss and maintaining texture of pear slices. The coatings decreased the soluble solids%, titratable acidity%, and total counts of microbes and Moulds & yeasts of coated pear slices during storage compared with untreated control. Also, the lowest activity values of enzymes (PPO and POD) were recorded for coated samples.

Key words: Xanthan and guar gum, cold storage, activity of PPO and POD, total Moulds & yeasts count

Introduction

Le Cont pear (Pyrus communis, L.) is the main cultivar grown in Egypt with other minor cultivars (El-Kady et al., 2007). In Egypt, its area reached about 11500 faddans with total area production amounted 38192 tons according to the statistics of Ministry of Agriculture (MALR, 2011). There has been an increasing market demand for minimally processed fresh cut fruit and vegetables due to their freshness, convenience, good taste and human-health benefits (Wunwisa & Mabumrung, 2008).

Lightly or minimally processed agricultural products present a special problem to the food industry and to scientists involved in postharvest and food technology research, such as cutting, slicing, coring, peeling, trimming, or sectioning of agricultural produce. These products have an active metabolism that can result in deteriorative changes, such as increased respiration and ethylene production. If not controlled, these changes can lead to rapid senescence and general deterioration of the product.

Edible coatings have the potential to reduce moisture loss, restrict oxygen entrance, lower respiration rate, retard ethylene production, seal in flavor volatiles, and carry additives that retard discoloration and microbial growth (Elizabeth et al., 1995). The use of polysaccharide-based edible coatings increased the water vapor resistance and reduced ethylene production of coated fresh-cut pears (Orns-Oliu, et al., 2008).

Dipped pears (cv.'Bartlett') slices in various solutions (citric acid, ascorbic acid, and/or calcium chloride) and stored in air or in controlled atmospheres (CA) for 7 days at 2.5°C followed by one day at 20°C resulted a higher respiration rate of fruit slices than whole fruits at both temperatures. Calcium chloride at 1% maintained pear slices firmness also resulted in lighter color than in the control treatment fruits (Rosen and Kader, 2008).

Edible films and coatings have received much attention in recent years because they can extend shelf-life and improve food quality by providing a barrier to mass transfer, carrying food ingredients, and /or improving the mechanical integrity or handling characteristics of a food (Krochta & Johnston 1997). An edible coating ethyl cellulose (EC) is a thin layer of edible material formed as a coating on a food product, (Gonzaley-Aguilar et al., 2010) while an edible film is a preformed, thin layer, made of edible material, which once formed can be placed on \ or between food components (McHugh, 2000). The main difference between these food systems is that the EC are applied in liquid form on the food, usually by immersing the product in a solution generating substance formed by the structural matrix (carbohydrate, protein, lipid or multi-component mixture), while edible film are first molded as solid sheets, which are then applied as a wrapping on the food product.

The envelope (packaging, wrapping or coating) plays an important role on the conservation, distribution and marketing of foodstuff. Some of its functions are to protect the product from mechanical damage, physical, chemical and microbiological activities. Some studies have recognized the importance of assessing the preformed matrix of edible films in order to quantify various parameters such as mechanical,
optical and antimicrobial properties, since this envelope creates a modified atmosphere (MA) restricting the transfer of gases ($O_2$, $CO_2$) and also becoming a barrier for the transfer of aromatic compounds (Osman, 2011).

The edible films are classified into three categories taking in consideration account the nature of their components: hydrocolloids (containing proteins, polysaccharides or alginates), lipids (constituted by fatty acids, acetylgluceros or waxes) and composites (made by combining substances from the two categories (Donhowe and Fennema, 1994). Polysaccharide-based coatings have been used to extend the shelf-life of fruits and vegetables by reducing respiration and gas exchange due to selective permeability to $O_2$ and $CO_2$ (Nussinovitch, 2000).

Numerous studies have carried out to study the properties of films made from single hydrocolloid components as polysaccharides or proteins. The most frequently utilized polysaccharides were cellulose and starch (and their derivatives), chitosan, seaweed extracts (carrageenan and alginate), exudate (arabic gum), seed (guar gum) or microbial fermentation (xanthan and gellan gum) and pectin (Krochta et al., 1994). In particular, pectin are used in edible films to inhibit lipid migration in confectionery products (Brake & Fennema, 1993).

Edible coatings are gaining importance as an alternative to reduce the deleterious effects imposed by minimal processing on fresh-cut fruits. Edible coatings may also serve as carriers of food additives such as antibrowning and antimicrobials agents, colorants, flavors, nutrients and spices (Pranoto et al., 2009). Several studies have been done to determine the effects of polysaccharides –based edible coatings on fresh – cut fruits such as mango (Chien et al., 2007) papaya (Tapia et al., 2008), and pear (Oms -Oliuet al., 2008).

Gums affect viscosity of batter, which is a key characteristic for quality of coating (Fiszman and Salvador, 2003). Adhesion performances of coating materials are related to viscosity of their solutions (Kilincceker et al., 2009).

Bianca et al., (2012) investigate the effectiveness of xanthan gum based coating treatments containing glycerol, in the preservation of strawberries. Data revealed that xanthan gum based coating is effective in extending shelf life of refrigerated strawberries. Xanthan is a high molecular weight exopolysaccharide composed of a cellulose backbone with trisaccharide side chains attached to alternate glucose residues in the backbone the side chains are composed of two mannose and one glucuronic acid molecule (Chien et al., 2007). Owing to its high viscosity, it has stable properties in extreme chemical and physical environment, and pseudoplastic behavior, this biopolymer has a variety of applications as a stabilizing, viscosifying, emulsifying, thickening and suspend agent (Kennedy and Bradshaw, 1984).

The coating of prickly pear surfaces with films formed by different emulsions containing xanthan gum or guar gum as a hydrophilic polymer was carried out. The guar and xanthan gum emulsion coatings decreased the soluble solids, firmness, titratable acidity, loss and increased the total carotenoids in comparison to the uncoated prickly pear, also contributed to a reduction in total count of microbes (Moulds & Yeasts) and also becoming a barrier for the transfer of aromatic compounds (Donhowe and Fennema, 1994). In particular, pectin are used in edible films to inhibit lipid migration in confectionery products (Brake & Fennema, 1993).

Materials and Methods

This study was carried out on fresh Le Cont pear (Pyrus communis, L.) during 2012 and 2013 seasons. The fruits were picked at maturity stage, and transported to the laboratory of Food Engineering and packaging Dept. Food Technology Research Institute, Agriculture Research Center. Each treatment was replicated three times. All samples were packed in plastic trays, wrapped with polyvinylidiene chloride film and stored at 5±1°C and 90% relative humidity for 12 days. Samples were withdrawn at 3 days intervals up to 12 days for evaluation.

Preparing of guar and xanthan solutions were done as followed: Solutions were done as followed:
One gram of guar or xanthan were added to 100ml of distilled water containing one gram of citric acid and half gram of glycerol and 0.25 ml oleic acid, then the solution was heated gradually to 85 °C while stirring by using a magnetic stirrer then the solution was filtrated (Azarakhsh et al., 2012). The experiment was ended when the decay percentage exceeded 50% of the stored fruits in each package.

**Preparation of sample**

Pear fruits were washed, peeled and cut into slices (3×5 cm). The pear slices were washed using chlorinated water (150 ppm) for three min. and drained for 15 min. The samples were then immersed in any of the two coating emulsions for three min., and air flow dried for one hour. The control (uncoated samples) were submerged in sterile distilled water under similar conditions.

**Physical properties**

**Fruit weight loss Percentage (FWL %):** The plastic trays of fruits were weighed before cold storage to get the initial weight, and then weighed after each period of cold storage. Fruits weight was recorded, then percentages of weight loss were calculated according to the following equation:

\[
FWL\% = \frac{Wi - Ws}{Wi} \times 100
\]

Where:

- \(Wi\) = fruit weight at initial period.
- \(Ws\) = fruit weight at sampling period.

**Pulp Texture**

Pulp Texture was recorded by Ifra texture analyzer instrument, using a penetrating cylinder of 1 mm of diameter, to a constant distance 2 mm inside the pulp, and by a constant speed, 2 mm/sec, and the results were expressed as the resistance force to the penetrating tester, in units of pressure (per gram).

**Chemical properties**

**Soluble Solids content (SSC %):** Abbe refractometer was used to determine the percentage of total soluble solids in fruit juice.

**Titratable Acidity %:** Titratable acidity (%) was determined by titrating the juice against 0.1 N sodium hydroxide using phenolphthalein as an indicator. Results were expressed as percentage of malic acid in fresh pulp weight (A.O.A.C., 2000).

**PPO Enzyme extraction and activity determination:** PPO (EC 1.14.18.1) was extracted by homogenizing treated or untreated fruit samples with 1.5- fold their weight sodium phosphate buffer (0.1 M, pH 6.5) containing 30 mM sodium ascorbate and 0.4 M sucrose at 25°C. The crude extraction was filtered and refrigerated till used within 24 h. Enzyme activity was determined (Dogan et al., 2002) by mixing catechol, as a substrate (1.5mL, 80.0 mM) dissolved in the phosphate buffer, with 0.5 mL of enzyme extract and 0.25 distilled water (control) or inhibitor solution. Phosphate buffer was used instead of the enzyme extract as blank. All of the enzymatic reactions were kept at the optimum condition (substrate saturation, pH 6.5 and 25°C). The increase in absorbance of 0.01 per min. at 420 nm at the specified condition was defined as one unit of PPO activity.

**Activity of peroxidase:** The POD activity was determined according to the method described by Clemente (1998). 0.2 mL of the sample, 2.7 mL of 0.1% solution of H₂O₂ in sodium phosphate buffer (100 mM, pH6.0), and 0.1 mL of alcoholic solution of ortho- dianisidine 1.0% were then mixed with the extracts. The reading was performed at \(\lambda = 460\) nm. The unit of activity of POD was defined as the increase of a unit of absorbance per minute mL⁻¹ of sample.

**Total microbiological count:** were determined according to Marshall (1992). The microbiological analysis is comprise total colony count and moulds & yeasts as following: Under aseptic conditions, 50 gram of each sample were added to 450 ml of sterilized peptone water (1 gm/liter) in sterilized glass blender jar and blended for 5 min. Appropriate serial dilution were done and then 10 ml of every sample was plated by standard microbiological pour plat technique. All microbiological counts were carried out in duplicates.

**Total colony count:** Colonies of bacteria were estimated using plate count agar medium. The plates were incubated at 37°C for 48 hours.

**Moulds and yeasts count:** The mould and yeast were determined using the methods for the microbiological examination of foods described by the American public Health association (A.P.H.A, 1976) by using malt extract agar medium.
Statistical analysis

The treatments were arranged as a randomized complete design. All data were subjected to statistical analysis using the MSTAT statistical software according to the procedures reported by Snedecor and Cochran (1989) and means were compared by Duncan’s Multiple range test at the 5 % level of probability in the two seasons of experimentation (Duncan, 1955).

Result and Discussion

Physical properties

Weight loss percentage

Results present in table (1) indicated that effect of some edible coating on weight loss % in fresh pear slices stored at 5±1°C and 90% RH, during 2012 and 2013 seasons.

In general a gradual increase in weight loss was shown towards the end of the storage period (12 days). Significant differences were detected between all treatments during different storage periods in both seasons. At the end of storage period, the least weight loss percentage (7.20%) was recorded by guar in the 1st season and (7.68%) by xanthan in the 2nd season, while untreated fruit group exhibited the highest weight loss value in the both seasons. The loss in weight may be attributed to respiration and other senescence related metabolic processes during storage (Watada and Qi, 1999). Xanthan samples much retained their weight during storage as compared to guar and control (minimally Prickly pear) samples (Mohamed et al., 2013).

Edible coatings have the ability to control the moisture loss, and providing other functions (Thompson, 2003), and consequently the weight loss. It was observed an increase in mass loss during storage; the samples which were coated (guar and xanthan gums) had losses significantly lower than in the control sample (Cortez-Vega et. al. 2014). Aleryani-Raqeeb et al. (2008) worked with chitosan coating on papaya, and observed that it prevented weight loss.

Table 1: Effect of some edible coating on weight loss % in fresh pear slices during storage for 12 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Guar</td>
<td>1.17 *</td>
</tr>
<tr>
<td>Xanthan</td>
<td>1.42 a</td>
</tr>
<tr>
<td>Control</td>
<td>1.48 a</td>
</tr>
<tr>
<td>Guar</td>
<td>1.36 a</td>
</tr>
<tr>
<td>Xanthan</td>
<td>1.23 a</td>
</tr>
<tr>
<td>Control</td>
<td>2.26 a</td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Texture

Data in table (2) showed the effect of some edible coating on texture in fresh pear slices stored at 5±1°C and 90%RH, during two seasons 2012 and 2013. A gradual decrease in texture was shown towards the end of the storage period. However, significant differences were noted between all treatments during different storage periods in the two seasons. Control fruits recorded the less texture value, while guar and xanthan treatments gave the highest value of texture without significant difference between them in the two seasons. The pumpkins coated texture ranged from 75.65 to 100.09 N. There was an increase in the firmness of the control sample at the end of twelve days of storage (Cortez-Vega, et al. 2014). Sarzi (2002) assessed the papaya texture verifying a significant increase in firmness, associated with the moisture loss with the formation of surface layer firmer. Sasaki et al (2006) observed no loss of firmness pumpkins minimally processed stored at temperatures of 1°C and 5°C, however when the samples were stored at 10 °C, an increase of this parameter was observed, reaching values of 83.3 N. For the treatments with edible coating it was observed a decrease in firmness.

Mohamed et al. (2013) found that significant reduction in prickly pear fruits firmness loses during storage in all coated guar and/or xanthan samples compared with the control samples. These results are in agreement with those obtained by Rodriguez et al (1992).
Table 2. Effect of some edible coating on Texture at 2mm depth (gm/cm²) in fresh pear slices during storage for 12 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guar</td>
<td>67.6</td>
<td>65</td>
<td>55</td>
<td>46</td>
<td>20</td>
</tr>
<tr>
<td>Xanthan</td>
<td>67.6</td>
<td>52</td>
<td>50</td>
<td>41</td>
<td>22</td>
</tr>
<tr>
<td>Control</td>
<td>67.6</td>
<td>43</td>
<td>42</td>
<td>38</td>
<td>17</td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Table 3: Effect of some edible coating on soluble solid content (SSC %) in fruit juice of fresh pear slices during storage for 12 days

<table>
<thead>
<tr>
<th>Treatments</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guar</td>
<td>11.7</td>
<td>13.3</td>
<td>13.2</td>
<td>13.6</td>
<td>13.7</td>
</tr>
<tr>
<td>Xanthan</td>
<td>11.7</td>
<td>13.3</td>
<td>13.4</td>
<td>13.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Control</td>
<td>11.7</td>
<td>13.3</td>
<td>13.3</td>
<td>14.0</td>
<td>14.2</td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Table 4: Effect of some edible coating on titratable acidity (T.A %) in fruit juice of fresh pear slices stored at 5±1°C and 90%RH, during 2012 and 2013 seasons.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guar</td>
<td>12.2</td>
<td>13.2</td>
<td>13.3</td>
<td>13.7</td>
<td>13.9</td>
</tr>
<tr>
<td>Xanthan</td>
<td>12.2</td>
<td>13.3</td>
<td>13.4</td>
<td>13.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Control</td>
<td>12.2</td>
<td>13.3</td>
<td>13.5</td>
<td>13.8</td>
<td>14.3</td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Chemical properties-

Soluble solid content percentage (SSC %)

Table (3) indicated the SSC% increased gradually throughout the storage periods. It reached the highest percentage on the last sampling date. However no significant differences were detected between all treatments in the most cases in the two seasons. Control treatment gave the highest value of SSC% in the two seasons. While the least value were recorded by guar treatment (13.73%) in the first season and xanthan (13.80%) in the second season. Mohamed et al. (2013) found that a non-sigificant differences about the decreasing in total soluble solids percent loses due to wrapping by Guar or xanthan coated samples as compared to control but there were a significant differences in TSS increasing during storage and larger in coated Guar samples than xanthan samples. Wrapping by Guar or xanthan play a role in O2 reduction within the wrapped sample, therefore there were a significant differences were detected between all treatments in the most cases in the two seasons. Control treatment gave the highest value of SSC% in the two seasons.

Soluble solids reduction of minimally processed pumpkins during storage at different temperatures was observed by Sasaki et al. (2006) and had been attributed to breathing through which oxidative decomposition of complex substances (polysaccharides, simple sugars, organic acids, proteins and lipids) into simple molecules (CO2 and H2O) and energy (Kluge et al., 2002). Chitarra & Chitarra, (2005) indicated that drastic reductions in levels of soluble solids can be avoided through storage of fresh-cut at low temperature which affect metabolism by slowing down respiration rate.

Contrary to occurring with most minimally processed products, Silva et al. (2009) found that pumpkin did not show a linear increase in soluble solids which was, according to Silva et al. (2009), the common fact is due to loss of water from the product, which may occur immediately after the processing. Shellie and Saltveit (1993) disagree with this progressive behavior and found a constant behavior of the soluble solids content of melon throughout the storage period.

Titratable acidity percentage (T.A %)

Data found in table (4) showed the Effect of some edible coating on titratable acidity (T.A) % in fruit juice of fresh pear slices stored at 5±1°C and 90%RH, during 2012 and 2013 seasons. T.A percentage decreased throughout the storage periods without significant differences between all treatments in the most cases. In the end of storage guar treatment gave the highest value of T.A% in the two seasons. Mohamed et al. (2013) found that there was a slight decrease in T.A loses of coated prickly pear fruits during storage periods. Without significant differences between all treatments and or the control. A slow decrease in T.A may be due to Material variability among cultivars. These results are in agreement with those of Barbera et al. (1992). Cortez-Vega et al., 2014 noted that, the values of acidity of minimally processed pumpkin showed inverse behavior to that of pH. As for the pH values, no relation the coatings used were found. It was found range 0.054 to 0.118 in minimally processed pumpkin. The acidity in vegetables is mainly attributed to organic acids which are dissolved in the vacuoles of the cell, either in free form, as combined with salts, esters and glycosides (Chitarra and Chitarra, 2005).
Sasaki et al. (2006) evaluated the acidity of samples of minimally processed pumpkin, stored at different temperatures, for twelve days. According to these results, levels of acidity remained stable throughout the storage period, regardless of temperature. The initial values were 0.078% (day 0) and remained at values of 0.083%, 0.104% and 0.093% for temperatures of 1°C, 5°C and 10°C, respectively. Silva et al. (2009) studied types of packaging and storage temperatures on minimally processed pumpkins, and acidity values ranging from 0.110 to 0.158, higher than obtained in this work with edible coatings.

Table 4: Effect of some edible coating on Acidity % in fruit juice of fresh pear slices during storage for 12 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period per day</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
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<tbody>
<tr>
<td></td>
<td>2012 season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guar</td>
<td>0.192 ±a</td>
<td>0.128 ±b</td>
<td>0.160 ±a</td>
<td>0.128 ±a</td>
<td>0.160 ±a</td>
<td></td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.192 ±a</td>
<td>0.224 ±b</td>
<td>0.160 ±a</td>
<td>0.128 ±a</td>
<td>0.128 ±a</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.192 ±a</td>
<td>0.160 ±b</td>
<td>0.128 ±a</td>
<td>0.128 ±a</td>
<td>0.128 ±a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013 season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guar</td>
<td>0.160 ±b</td>
<td>0.160 ±b</td>
<td>0.160 ±b</td>
<td>0.160 ±b</td>
<td>0.128 ±a</td>
<td></td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.160 ±b</td>
<td>0.192 ±b</td>
<td>0.192 ±b</td>
<td>0.096 ±b</td>
<td>0.096 ±b</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.160 ±b</td>
<td>0.160 ±b</td>
<td>0.160 ±b</td>
<td>0.128 ±b</td>
<td>0.096 ±b</td>
<td></td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Polyphenol oxidase activity (PPO)

Data in table (5) indicated that effect of some edible coating on activity of polyphenol oxidase in fresh pear slices stored at 5±1°C and 90%RH, during 2012 and 2013 seasons. A gradual increase in polyphenol oxidase activity was showed towards the end of the storage periods. However, significant differences were noted between all treatments in the two seasons. Fruit treated by guar and xanthan gave the lowest value of polyphenol oxidase activity in the two seasons. On the other hand control treatment recorded the highest values (0.62, 0.59) in the first and second seasons, respectively.

Table 5: Effect of some edible coating on activity of polyphenol oxidase in fresh pear slices during storage for 12 days.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period per day</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012 season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guar</td>
<td>0.27 ±a</td>
<td>0.28 ±a</td>
<td>0.32 ±a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.27 ±a</td>
<td>0.29 ±a</td>
<td>0.31 ±a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.27 ±a</td>
<td>0.36 ±a</td>
<td>0.50 ±a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013 season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guar</td>
<td>0.25 ±b</td>
<td>0.32 ±b</td>
<td>0.36 ±b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.25 ±b</td>
<td>0.33 ±b</td>
<td>0.34 ±b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.25 ±b</td>
<td>0.39 ±b</td>
<td>0.54 ±b</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at P ≥ 0.05.

Peroxidase activity

Table (6) noted the activity of peroxidase in fresh pear slices, increased gradually throughout the storage periods. Significant differences between all treatments in the most cases. Guar and xanthan treatments were recorded the lowest values in activity of peroxidase in the two seasons, without any significant differences between them. While, control treatment gave the highest values (0.62, 0.59) in the first and second seasons, respectively.

Microbiological evaluation of coated pear slices during storage

Total counts

Figure (1) depicts a continuous increase in mesophyllc microbial counts determined as total plate count (TPC) of pear slices during storage. TPC of the control was higher than the other coated samples. Differences between the TPCs of the two coated samples were not significant. Differences in TPCs between the two seasons were not significant. The analysis of variance showed significant interaction between the two main factors; storage period and type of coating. This indicated that the effect of the type of gum on TPC depended on the period of storage and vise versa. In this respect, the uncoated control samples showed the highest values of...
TPC near the end of storage periods. Also, the guar coated pear slices showed slightly higher values than the xanthan coated samples by the end of storage periods. It should be noted that the levels of total counts for all samples were within the accepted authorized levels for food for human consumption (<$10^7$).

Table 6: Effect of some edible coating on activity of peroxidase in fresh pear slices during storage for 12 days

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Storage period per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Guar</td>
<td>0.40 $^a$</td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.40 $^a$</td>
</tr>
<tr>
<td>Control</td>
<td>0.40 $^a$</td>
</tr>
<tr>
<td>Guar</td>
<td>0.38 $^a$</td>
</tr>
<tr>
<td>Xanthan</td>
<td>0.38 $^a$</td>
</tr>
<tr>
<td>Control</td>
<td>0.38 $^a$</td>
</tr>
</tbody>
</table>

Means within each column for each season followed by the same letter(s) are not significantly different at $P \geq 0.05$.

Yeast and mold counts:

Figure (2) depicts also, a continuous increase in yeast and mold counts continuously during storage. The analysis of variance showed significant differences with respect to the main factors; season, coating type, and storage time. The control showed the highest values. It should be noted that total count values were far higher than the yeast and mold values because it enumerates, besides yeast and mold counts, other misophilic bacteria. The values of yeast and mold counts were within the accepted and safe limits for human consumption (<$10^5$). This indicates that all samples were microbiologically acceptable at the 9th day of storage. Sapers and Miller (1997) also indicated that control of browning and suppression of mold growth of fresh-cut pears were enhanced by use of modified atmosphere packaging with a 90% oxygen transmission rates from a laminated polyethylene film. Mohamed et al. (2013) showed that microbial and mould & yeasts growth were increased with increasing the storage period of coated prickly pear fruits. However, Guar coating treatment was the most effective treatments for reducing total microbial and mould & yeasts counts, without significant differences between the two coating treatments. These results are in agreement with those obtained by Pirovani et al. (1996) who found that the atmosphere inside the coating film allowed a slight development of mesophilic and psychrotrophic populations.
Conclusion

In conclusion guar and xanthan coatings are simple, safe, and relatively inexpensive technology that can extend the shelf life of minimally processed pear. The different coatings were effective in reducing weight loss, control of psychrotrophic microorganisms. The presence of guar and xanthan gum produced better texture to samples of minimally processed pear. On the contrary, coatings gave the lowest value in SSC%, acidity% and activity enzymes of PPO and POD in storage periods of slices pear fruits.

References


