Villela Dessimoni Pinto, Nísia Andrade; Batista, Ângela Giovana; Barbosa, Cosme Damião; Vieira, Gilmar; de Barros Silva, Enilson

Effect of packages with biofilms in physicochemical and sensory characteristics of strawberries

Revista Iberoamericana de Tecnología Postcosecha, vol. 12, núm. 2, 2011, pp. 175-184

Asociación Iberoamericana de Tecnología Postcosecha, S.C.
Hermosillo, México

Available in: http://www.redalyc.org/articulo.oa?id=81320900008
EFFECT OF PACKAGES WITH BIOFILMS IN PHYSICOCHEMICAL AND SENSORY CHARACTERISTICS OF STRAWBERRIES

Nísia Andrade Villela Dessimoni Pinto¹; Ângela Giovana Batista²; Cosme Damião Barbosa³; Gilmar Vieira⁴ & Enilson de Barros Silva⁵.

¹Professor of Nutrition Department, Federal University of Jequitinhonha and Mucuri Valleys – UFVJM. Rodovia MGT 367 – Km 583, n° 5000, Alto da Jacuba. 39100-000. Diamantina-MG. Brazil. E-mail: nisiavillela@yahoo.com.br ²Nutritionist and Researcher at Laboratory of Cerrado’s Biomass Technology, Federal University of Jequitinhonha and Mucuri Valleys - UFVJM. Rodovia MGT 367 – Km 583, n° 5000, Alto da Jacuba. 39100-000. Diamantina-MG. Brazil. ³Undergraduate student at Biological Sciences Department, Federal University of Jequitinhonha and Mucuri Valleys – UFVJM. Rodovia MGT 367 – Km 583, n° 5000, Alto da Jacuba. 39100-000. Diamantina-MG. Brazil. ⁴Professor of Agronomy Department, Federal University of Jequitinhonha and Mucuri Valleys – UFVJM. Rodovia MGT 367 – Km 583, n° 5000, Alto da Jacuba. 39100-000. Diamantina-MG. Brazil. ⁵Corresponding author.

Keywords: Strawberry, physicochemical, cassava starch, biofilm.

ABSTRACT

The aim of this study was to evaluate the effect of cassava based edible biofilms on physicochemical and sensory properties of strawberries quality during storage. We evaluated cassava starch biofilms with concentrations at 1%, 3% and control strawberries in terms of these physicochemical properties and the sensory preference and acceptance of panelists. The 3% cassava starch biofilms promoted more efficient protective effect during the 15 days of storage, because do not showed high variations. Strawberries with biofilms 3% showed higher pH values on 9 and 15 storage days. Total acids levels of strawberries on the third day of storage were lower for biofilm 3% strawberries, but there is no statistical difference between the treatments. Biofilm 3% strawberries showed loss of total pectin on day 15. The strawberries biofilm 1% were more accepted by the panelists because its higher acceptability index and the highest average in quantitative descriptive analysis. The use of cassava starch based biofilm influenced the physicochemical and sensory properties of strawberries.

EFEKT DEL EMPACADO CON BIOFILMS SOBRE LAS CARACTERÍSTICAS FISICOQUÍMICAS Y SENSORIALES DE LA FRESA

Palabras clave: fresa, fisicoquímicas, almidón, biofilm

RESUMEN

El objetivo de este estudio fue evaluar el efecto comestible biofilms la base de yuca de las propiedades físico-químicas y sensoriales de la calidad de las fresas durante el almacenamiento. Se evaluaron biopelículas de almidón de yuca con una concentración al 1%, 3% y fresas de control en términos de estas propiedades físico-químicas y sensoriales de la preferencia y la aceptación. Los biofilms yuca 3% de almidón promovido efecto protector más eficaz durante los 15 días de almacenamiento, ya que no mostró grandes variaciones. Fresas con biofilms 3% mostró valores más altos de pH, el 9 y 15 días de almacenamiento. Los niveles de ácidos totales de fresas en el tercer día de almacenamiento es menor para las fresas biofilm 3%, pero no hay diferencias estadísticas entre los tratamientos. Fresas biofilm 3% mostraron una pérdida de pectina total de 15 días. El biofilm fresas 1% era más aceptado por los panelistas, ya que su índice de aceptación más alto y el promedio más alto en el análisis descriptivo cuantitativo. El uso de bio-película basada en el almidón de yuca influencia de las propiedades físico-químicas y sensoriales de las fresas.
INTRODUCTION

The strawberry plant (Fragaria x ananassa Duchesne) is an herbaceous perennial and belongs to the family Rosaceae and the genus Fragaria. The comestible portion of the plant is the strawberry, a pseudo fruit that is non-climacteric and has a pleasant smell and taste (Domingues, 2000). Strawberries are produced in a several regions of the world and function as a small fruit group of economic expression, with a worldwide production of 3.1 million tons. The cultivation of strawberries in Brazil has increased since the 1960s and has particularly increased in regions with a temperate or subtropical climate due to the high profitability of strawberry cultivation in these areas and the intense demand for labor (Santos, 2003).

The cultivation of strawberries has been developing rapidly in regions with small farms and without an agricultural tradition, as in the High Jequitinhonha Valley. With the decrease in mining, an activity undertaken by many farmers for many years inDatas (a city in the High Jequitinhonha Valley) and the surrounding region, unemployment has become a serious social problem for the region. This has caused the families of these small farmers to look for new sources of income and has spurred the development of strawberry cultivation and processing.

Edible films can be made with various thicknesses and are composed of different natural substances and/or synthetic fibers that polymerize and insulate the food. Biofilms do not cause risks to consumer health because they are not metabolized by the body and because their passage through the gastrointestinal tract is innocuous (Maia et al., 2000). They are not meant to totally replace synthetic packaging films, however they do have the potential to replace the conventional packaging in some applications. The use of a biopolymer such as starch can be an interesting solution because this polymer is quite cheap, abundant, biodegradable and edible (Mali et al., 2002).

The characteristics of the product to which the edible film will be applied and the goal of film application will determine the method of obtention that is convenient to be used (Flores et al., 2007). The strawberry is a highly perishable fruit. Loss of water in this fruit results not only in weight loss but also in a decrease in sensory quality primarily due to changes in texture (Chitarra & Chitarra, 2005). In order to avoid a loss of postharvest quality, studies about cassava starch biofilm have suggested that their using were great to preserve the original characteristics of many fruits (Henrique & Cereda, 1999; Maciel et al., 2004; Souza et al., 2009). The cassava starch is considered the most suitable raw material for the development of edible biofilms, because it forms tough and transparent pellicles (Hojo et al., 2007). The starch extracted from cassava has good features for training films, besides being edible, are low cost compared to commercial waxes. The acquisition of cassava starch film is based on the principle of starch gelatinization, which occurs above 70° C with excess water. Once cooled, forms a transparent film and resistant due to retrogradation properties. This biofilm has good looks, is not sticky, is bright and transparent, improving the visual appearance of the fruit, and can be removed with water (Cereda et al., 1996; Henrique & Cereda, 1999; Nunes et al., 2004).

Faced with these properties of based starch biofilms, we hypothesized that strawberries would be better preserved with this protective film, prolonging their shelf life and preventing postharvest losses. This study therefore was done to evaluate the effect of using biofilms based in cassava starch on the physicochemical characteristics of strawberries during fifteen days of storage, as well as to verify their sensory properties.
MATERIAL AND METHODS
Strawberries of the Ventana variety were collected in Datas County, Minas Gerais state, Brazil, at latitude of 18°26'44", a longitude of 43°39'21" and an altitude of 1.231m and were taken to the Laboratory of Biomass Technology of the Cerrado, Campus JK, UFVJM. Approximately 17 kg of strawberries were collected according to their size (medium), maturity (approximately 70% red) and degree of damage according to the specifications for the classification of strawberries under the Technical Regulation of Strawberry Identity and Quality (MERCOSUL, 1996).

After radon selection of the fruits, they were disinfected and cleaned by immersion in chlorinated water at 10μg/L, manually, for two minutes. Thirty fruits were separated for physical characterization. The longitudinal and transverse diameters of the fruits were measured with the aid of a digital Stainless Hardened® caliper and weighed using a Shimadzu® precision analytical balance.

Preparation of fruits
The strawberries, approximately 900 fruits in all, were separated into three portions and subjected to treatments with the following substances: 1) without coating (the control, C); 2) 1% biofilm (B1); and 3) 3% biofilm (B3). After the treatments the C, B1 and B3 strawberries were stored at 2°C.

The formulations of cassava starch biofilm were obtained by heating under stirring the suspension of starch in water with a volume of 5 liters completed in flasks. To obtain the proposed concentrations, was suspended in 5 liters of distilled water the following amounts: 1% starch - 50g, 3% - 150g (dry material). The suspensions were heated to maximum temperature of 70 ± 5° C with constant stirring until gelation of starch, which occurred between 15 and 20 min. After geling suspensions at rest until cooled to room temperature. The fruits were immersed for 2 minutes in these suspensions, and dried on a stainless steel screen to allow for drainage or runoff, and after packed on plastic trays of 17.0 x 11.5 cm. Each plate with about 8 pieces of strawberry, properly coded (C, B1 and B3), was wrapped with PVC (polyvinyl chloride) plastic of 0.012mm thick and stored in refrigerated conditions at 2 ± 0.5° C and 90% ± 5% RH. Strawberries from the control group received no biofilm.

The trays with fruits and their treatments (plots) were evaluated with respect to their physicochemical at 0, 3, 7, 9 and 15 days of storage and sensory characteristics at day 1.

The biofilms of cassava starch were obtained by gelation by gradually increasing the temperature to 70 ± 5°C, cooling to room temperature and immersing for two minutes in either a 1% biofilm solution (B1), a 3% biofilm solution (B3) or water (C). After receiving the treatments, the strawberries were placed on a stainless steel screen to allow for drainage or runoff and were then covered on trays before being coded and stored. The trays with fruits and their treatments (plots) were evaluated with respect to their physicochemical and sensory characteristics as described below.

Physicochemical ratings
Physicochemical and chemical evaluations were performed as follows:

Mass loss: Mass loss was quantified by successive determinations of the masses of each plot (bins) using a Shimadzu® analytical balance during the storage period.

Total Acidity: To determine total titratable acidity (TA), we weighed approximately 5.0 g of strawberries and added 20mL of distilled water and three drops of phenolphthalein. The resulting solution was titrated with a standardized 0.01 NaOH solution until a color change was observed. Results were expressed as g citric acid/100 g sample according to the analytical norms of the Institute Adolfo Lutz (IAL, 2005).
**Effect of packages with biofilms in...**

**Nísia Andrade Villela Dessimoni Pinto y Cols. (2011)**


---

**pH:** pH was determined in fruits by reading the values from a digital Peagtek® pH meter (IAL, 2005).

**Soluble Solids:** total Soluble Solids (SS) were determined in fruits by filtering the pulp with cotton and reading the value from a manual refractometer with a measurement range of 0-32° Brix (IAL, 2005).

**Ascorbic acid:** The amount of ascorbic acid was determined by titration with Tillmans solution using ascorbic acid as a standard, according to IAL (2005).

**Total and soluble pectin:** Total and soluble pectin were identified by spectrometry by reaction middle with carbazole according to the technique of Bitter & Muir (1962). Results were expressed as mg galacturonic acid/100g sample.

**Sensory Research**

In the sensory evaluation, we used randomly selected panelists of both genders who were between 18-60 years of age and were non-smokers. The panelists were students or staff of UFVJM, had no relationship to the researchers, and signed the informed consent form that was drafted according to Resolution 196/96 of the Ministry of Health proceeding 053/2009 of the Ethics Committee of UFVJM. The samples were coded by three random digits and were served one unit of each strawberry group, in individual booths. Sensory analyses were performed at day 1, as follows:

**Test acceptability:** We used 43 untrained panelists who evaluated strawberries from different treatments using a five-point hedonic scale (IAL, 2005).

**Acceptability Index:** The Acceptability Index (AI) was used to calculate the percent acceptance of the strawberries using the following formula:

\[ AI\% = \frac{\text{Average acceptance score} \times 100}{\text{Maximum acceptance score}} \]

**Ranking test:** Forty-three panelists participated in this study. The volunteers received the samples that were coded and ordered them according to preference (ABNT, 1994; Carneiro & Minin, 2005).

**Description of attributes (Descriptive Quantitative Analysis):** This descriptive quantitative analysis relied on the participation of 16 panelists who were trained in descriptive terminology for the sensory analysis of strawberries based on the description of ABNT (1998) and IAL (2005). The panelists gave scores for the following attributes using a scale of one to five in which one is the lowest score and five is the highest score: appearance, color, brightness, smell and flavor (ABNT, 1998; IAL, 2005).

**Experimental design and statistical analysis**

We used a randomized design (CRD), and the treatments were arranged in a 3 x 4 factorial design (three treatments: 1% biofilm, 3% biofilm and water; and four storage periods: 0, 3, 7 and 15 days). All evaluations were performed in triplicate. The results of the physicochemical analysis were analyzed using an analysis of variance (ANOVA) in the statistical program Sisvar 4.3 (Ferreira, 2003). When results were significant, means were compared using a Student Newman Keuls test (SNK) at a 5% probability. For sensory testing, the difference between the means was analyzed using the Tukey test at a 5% probability. The results of the ranking test were analyzed according to the sum of orders using a Friedman test (Carneiro & Minin, 2006) and the results were interpreted according to a table of the sum of orders at 5% probability as described in Roessler et al. (1978).

**RESULTS AND DISCUSSION**

The strawberries (Fragaria x ananassa Duchesne) studied by Fernandes Jr. et al. (2002) displayed an average mass of 9.1 grams, which was lower than that of the strawberries in the present study (Table 1).
Table 1. Physical characteristics of strawberry fruits of the Ventana cv. (n=30) from Datas, Minas Gerais, Brazil.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of fruits (g)</td>
<td>16.086 ± 7.928</td>
</tr>
<tr>
<td>Longitudinal diameter (mm)</td>
<td>31.723 ± 6.648</td>
</tr>
<tr>
<td>Transverse diameter (mm)</td>
<td>27.117 ± 5.054</td>
</tr>
</tbody>
</table>

The strawberries that did not undergo treatment with biofilm lost more mass than the controls at 9th day (p<0.05). The mass loss of strawberries treated with 3% biofilm (B3) was statistically lower (p<0.05) than B1 at 15th storage day. Already during the days of storage, B1 obtained significant losses (Figure 1).

Figure 1. Mass loss (g) of control strawberries (C) and strawberries treated with cassava based biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.

Figure 2. pH values of control strawberries (C) and strawberries treated with cassava based biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.

The pH of fruits is commonly used to determine their acidity and to quantify the concentration of viable hydrogen ions in order to determine the quality of the processed products (Nunes, 2001). The average pH of the Ventana cv. fruits observed in this study ranged from 3.25 to 3.51. These values were close to those observed by Conti et al. (2002), which varied from 3.58 to 3.85 in five cultivars of strawberries, and were also close to the results of Days (2002). Studies of strawberries in northern Minas Gerais (Brazil) found pH levels between 3.59 to 3.65 for the Dover cv. and the Sweet Charlie cv.

On day 0, B1 strawberries showed higher values of SS compared to the control and B3, but on the 15th day of storage, the strawberries displayed similar values in all treatments (p<0.05). With regard to the number of days of treatment, all of the strawberries showed an increase in SS, except the B1 pH content that shows the similar values (p<0.05; Figure 3).

Figure 3. Soluble solids (°Brix) of control strawberries (C) and strawberries treated with biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.
The quantity of total soluble solids is important in determining fruit quality and indicates the quantity of sugars, organic acids, vitamins, amino acids and some soluble pectins, which provide sweetness during maturation (Silva, 2007). These solids are indicative of fruit maturity and, therefore, the quality of the fruit and the factors that determine their flavor (Hobson & Grierson, 1993). According to Silva (2007), increases in SS during storage are due to the transformation of reserves into soluble sugars in the fruit but are also due to the loss of water vapor through transpiration from the pulp, which leads to a greater concentration of these solids. The average values observed in this study were close to the levels reported by Mangnabosco et al. (2008), who also used the Ventana cv., and ranged from 5.92 to 7.75°Brix. These values were also similar to the results produced by Virmond & Resende (2007), that found a value of 6.90°Brix in strawberries of the Oso Grande cv., 9.84°Brix for the lower Oso Grande cv., 10.06°Brix for the Tudlla cv. and 11.13°Brix for the Toyorrinho cv. studied by Silva (2007).

There were no significant differences between treatments over days of storage (p>0.05). However B3 showed a decrease in total acidity on the third day (p<0.05) without further modifications (Figure 4).

**Figure 4. Total acidity (g.100g⁻¹) of control strawberries (C) and strawberries treated with biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.**

There was a decrease in the TA of B3 strawberries on the third day of storage, which coincided with an increase in SS and pH. This result suggests that organic acid is used during metabolism and is either converted into sugars or serves as a substrate for the breathing process (Varoquaux & Wiley, 1997). The average level of TA found in the Ventana cv. was 0.54 mg citric acid/100 g sample, which was within the range described in the literature, 0.42 to 1.10 mg citric acid/100 g pulp (Domingues, 2000).

For ascorbic acid, there was no statistical difference between treatments and between days of storage (p>0.05; Figure 5).

**Figure 5. Ascorbic acid (mg.100g⁻¹) of control strawberries (C) and strawberries treated with biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.**

The ascorbic acid content of strawberries can vary depending on the cultivar, maturity stage, growing conditions, duration and storage conditions (Silva, 2007). The ascorbic acid values of the Ventana cv. were lower than the values found by Silva (2007) for the Tudla cv. (44.13 mg ascorbic acid/100 g pulp). Perhaps, a longer storage period, would detect significant losses of the ascorbic acid content (Tosun & Yucecen, 2008).

Strawberries treated with 3% biofilm showed decrease in total pectin on the 15th day of storage (Figure 6), being the lowest among the treatments (p<0.05). Strawberries treated with biofilms had higher values of average soluble pectin as compared to the control on the 0 day of storage, and on the 15th day, B3 showed a lower value. Towards the days of treatment, there were decrease on the soluble pectin values for both treatments (p <0.05; Figure 7).
Effect of packages with biofilms in…  Nísia Andrade Villela Dessimoni Pinto y Cols. (2011)

Figure 6. Total pectin (mg.100g⁻¹) of control strawberries (C) and strawberries treated with biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.

Figure 7. Soluble pectin (mg.100g⁻¹) of control strawberries (C) and strawberries treated with biofilms (B1 - 1%, B3 - 3%) as a function of the number of storage days.

With maturation, the protopectin of cell walls becomes more soluble and, consequently, the texture becomes modified, causing fruits to gradually become softer. These transformations occur not only during maturation, but also during storage for some fruit and vegetables (Chitarra & Chitarra, 2005). Antunes et al. (2006) found reduced levels of pectin in blackberries with increased storage time; by studying strawberries treated with ionizing radiation. Françoso et al. (2008) found 574.53 mg/100g soluble pectin and 754.56 mg/100g total pectin on the first day of storage. In the remaining days of storage, they found increased levels of pectin, unlike the results of the present study. The values of pectin observed in the present study were close to those reported by Silva (2007), who studied strawberries stored and found levels of total pectin ranging from 0.37 to 0.55 mg/100g and between 0.35 to 0.45 mg/100g for soluble pectin.

Preference tests, such as ordination, are widely used in food industries to develop new products, improve products, change production processes and to formulate new products (Carneiro & Minin, 2006). The ranking test showed that the use of cassava starch as a biofilm for strawberries did not adversely affect the preference of the panelists; there was no significant difference between the scores of the treated and control strawberries (p>0.05). However, the acceptance test indicated that the strawberries treated with 1% biofilm were preferred by the panelists (Table 2).

Table 2. Results of the ranking test and acceptance tests (n= 43) of strawberries exposed to one of the three postharvest treatments with biofilms.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Results</th>
<th>A</th>
<th>B1</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranking test</td>
<td>Sum of orders</td>
<td>96</td>
<td>79</td>
<td>91*</td>
</tr>
<tr>
<td>Acceptance</td>
<td>Averages notes</td>
<td>3.53</td>
<td>4.23*</td>
<td>3.44*</td>
</tr>
<tr>
<td></td>
<td>Acceptability Index (%)</td>
<td>70.57</td>
<td>84.65</td>
<td>68.76</td>
</tr>
</tbody>
</table>

*Sum of pairs of orders followed by a same letter do not differ according to a Friedman test (p>0.05). "Acceptance averages followed by same letter do not differ according to a Tukey test (p<0.05)."

In all the attributes, the strawberries treated with 1% biofilm (B1) received the highest scores, according to the Tukey test (p<0.05), confirming the results of the acceptance test. In terms of taste, the control strawberries (A) were similar to the strawberries treated with B1 and B3 (p>0.05; Figure 8).

Henrique & Cereda (1999) evaluated the sensory attributes of strawberries treated with biofilms produced from cassava starch at several concentrations. According to these authors, the 3% biofilm retained the color of strawberries for a longer period of time, providing a higher quality in the postharvest life. Of these study participants, 85% identified changes in texture between treatments (different concentrations of biofilm). In the
sensory evaluation of grapes treated with different biofilms, Fakhouri et al. (2007) observed an acceptance that was equal to or greater than the untreated grapes when the smell, flavor, texture, brightness and color were considered. The study by D'Amato et al. (2010) showed that the chitosan coating, either alone or combined with thermal treatments, did not affect the taste and flavor of mangoes slices. Thus, the strawberries treated with biofilm at 1% showed a good quality in all attributes evaluated, indicating a preference in comparison to the control.

Many of the chemical properties of strawberries with 1% cassava starch biofilm were preserved during storage, but there is a need to investigate the sensory characteristics and microbiological preservation throughout this time and thus determine the actual shelf life.

Acknowledgments
We received financial support from the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

REFERENCES


Brasil (1996). Ministério da Saúde. Resolução n° 196, de 10 de outubro de 1996 - Aispõe sobre diretrizes e normas regulamentadoras de pesquisas...
Effect of packages with biofilms in...


184


