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The Effect of Psyllium seed gum as an edible coating and in comparison to Chitosan on the textural properties and color changes of Red Delicious Apple

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ABSTRACT: The effect of using edible coatings Psyllium seed gum in three concentrations of 0.05, 0.1 and 0.2 percent and the comparison to the effect of Chitosan trade gum on Red delicious apple in concentration of 1% was studied. Factors evaluated in the study of color and textural properties of the apples during 8 days of storage were after coating. Test results showed that the enzymatic browning factor of native gum coated by Psyllium in concentration of 0.2% and 1%Chitosan concentration was the lowest and the ability of clearly edible coatings to relay the enzymatic browning and preservation color of apples was illustrated. Textural factors evaluated in the study included firmness and TPA factors such as adhesiveness, cohesiveness, chewiness and hardness were measured. In all evaluated factors, commercial Chitosan gum showed better characterization in preservation of texture and depending on the other concentrations of Psyllium seed gum after Chitosan showed the better characterization in maintaining primary texture of apples. In this study, the effect of Psyllium native gum in preventing enzymatic browning and maintaining the relative quality of the texture was confirmed.

***Keywords*:** Psyllium seed gum, Chitosan, texture, apple, color test

INTRODUCTION

Edible films are defined as thin layers that can be used as edible coatings on food or as a barrier between the food and the surrounding environments. Over the last ten years, because of more consumers demanding higher quality and shelf-life of food good research by food engineers on the edible coatings is done (Kilincceker et al., 2009; Skurtys et al., 2010). Psyllium (Plantago ovate) is mucilage substance that is found in Psyllium seed husk made of Plantago which is good source of both soluble and insoluble fibers (Guo et al., 2009; Skurtys et al., 2010).

Recently, Psyllium is known as the material including properties such as lowering cholesterol, laxative and improving insulin sensitivity. Some food products benefits from Psyllium as an active material in their composition and introduced as cholesterol lowering properties of the products (Farahnaky et al., 2010; Moreaux et al., 2011). An important factor in the physiological behavior of Psyllium fiber is high viscosity and its gel-like behavior in water. The alkali separation of Psyllium gel-forming polysaccharides shows that its components contain Xylose, Arabinose and other minimal sugars. Psyllium seeds for hundreds of years as a medicinal substance were used in

Iranians' medical treatments (Farahnaky et al., 2010). It has been determined that available fibers in Psyllium husk cause to stimulate weight and fat loss by acting as a mass storage and reducing caloric intake (Kang et al., 2007). Due to the pharmacological effects of food in which are used Psyllium mucilage, In terms of consumer, is more acceptable (Farahnaky et al., 2010).The following table represents the results of chemical compounds formed by the Psyllium husk (Guo et al., 2008).

In a research in 2005 of Alvyaset is investigated effects of alginate coating on the minimally processed Gala apples. Apples are coated in a solution of calcium chloride and after by one of three different solutions and formulations. During storage, factors such as weight loss, color, texture, microbial load and titerable acidity was determined (Olivas et al., 2007). In a similar survey in 2009 Haiping et**.** tested the effect of Chitosan edible coatings with anti-browning compounds deposited on fresh cut Fuji apples, the result showed that these coatings put into effect on enzymatic browning on apples over maintaining time (Olivas et al., 2007). In this paper, the effect of edible coating gum extracted Psyllium seed at three different concentrations on Red delicious apple and the comparison of effect of Chitosan 1% and control sample (deionized water) were studied on the same apple.

Table 1. Chemical constituents of Psyllium husk

Moisture (%)	Lipid (%)	Protein (%)	Soluble ash (%)	Total ash (%)	Total carbohydrate (%)
6.83±0.04	0.00±0.11	0.94±0.00	4.07±0.02	2.62±0.03	84.98±4.26

MATERIALS AND METHODS

A. Extraction of Psyllium Plantago gum

Psyllium seeds are provided from Shiraz Grocery shop, and then in the Food Research Laboratory were divided into three parts which each was 50 grams, each part was placed in a 2 liter bottle and triple of its weight added distilled water and at 60 to 70 ° C water bath for 30 minutes were placed to remove husk gum of Psyllium seed as a mucilage. After this step, filtrating the extracted gel (gum) by using special filters is done, the considered filter is put in a Buchner funnel and is put into the flask under vacuum and filtrating is done by connecting the vacuum pump to flask. The considered gel can be washed by using 97% ethanol to separate impurities and additional materials. In the last step of gel extraction, separated impurities by alcohol is decant in special container and it is put in the oven at 50 to 60 ° C for 24 hours and after drying the obtained powder is grinded.

B. Preparing solution required for coating

In this study were used three concentrations 0.05, 0.1, 0.2 of Psyllium seed gum for coating apples respectively. Solution required for Psyllium gum is:

- 2% ascorbic acid, 0.5% calcium chloride, 0.05% Psyllium gum
- 2% ascorbic acid, 0.5% calcium chloride, 0.1% Psyllium seed gum
- 2% ascorbic acid, 0.5% calcium chloride, 0.2% Psyllium seed gum (Qi et al., 2011; Szczesniak, 2001).

The control solution and gum solution of Chitosan are as follows:

- Deionized water
- 2% ascorbic acid, 0.5% calcium chloride, 1% Chitosan

Volume of 2 liters was used for each treatment, maximizing the volume of each solution was determined by using citric acid. Use of the citric acid causes to delay Phenolase enzymes, lowering pH, and the Pectic texture integrity. The use of ascorbic acid in the maintenance treatment of color and slices of apples and calcium chloride are also used for texture integrity. All above solutions associated with the control are put in different containers, and they been put 24 hours in refrigerator at 4 ° C and they are put out in coating day.

C. Coating the apple with the solutions of gum

Required apples after buying, washed and handily dried in laboratory after sorting by using Slicer Solingen EK-4009 and also Potato Chopper machines were sliced and were formed into cubes and put into in mentioned solutions for 2 minutes and for 1 minute allowed excess water to be removed, then all coated slices and cubes depending on the desired concentrations and tests were put into zip kip plastic containers (package) and were kept in the refrigerator at 4 ° C. On day 1 after coatings of samples, rheological tests were initiated. On days, 3, 5, 7, TPA texture tests and on days 2, 4, 6, 8 cutting and punch tests were done. For each test, three replicates of each concentration of each gum were done. In this study, color tests were performed on coated slices. On days 2, 4, 6 and 8 sheets of each concentration of Psyllium seed gum and Chitosan and the control were placed in Lavi band and they were photographed by a digital camera.

RESULTS AND DISCUSSION

A. color change during storage

Generally, enzymatic browning of apple slices during storage time is due to the breakdown of cell walls and releasing enzymes such as Polyphenol Oxidase (Olivas et al., 2007), and association with increased colorimetric of a^*, b^* densities and decreasing L^*values. Browning factor that is relevant in assessing the color change and is calculated as follows (Olivas et al., 2007).

$$BI = \frac{100(x - 0.31)}{0.172}$$

$$x = \frac{a* + 1.75L*}{5.645L* + a* - 3.012b*}$$

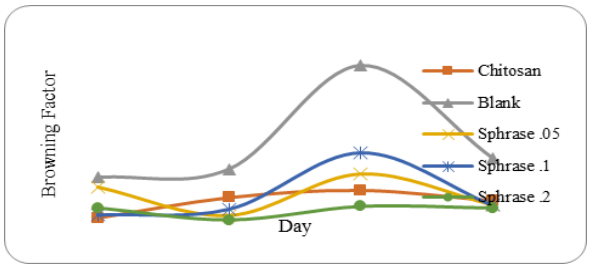

Figure 1. presents the coating effect on color changes of apples by Psyllium seed gum compared with Chitosan during the 8 days

As you can see in Figure 1, control shows the highest rate of browning index that it due to the disuse of the materials presence in the coating solution such as ascorbic acid, calcium chloride and also gum, is used. By comparison a^* values of different treatments an increasing proceeding in different concentrations of all Psyllium treatments are obvious, In another hand in Chitosan treatment we see an decreasing proceeding in L^*, lightness or L^* decreased from 84.15 at the first day to 81.11 at the eight day due to enzymatic reactions and color change. Ascorbic acid due to prevention of the conversion of Phenolic compounds to quinon is the most important ingredients used in preventing enzymatic browning (Perez-Gago et al., 2006). Mechanism of calcium chloride in preventing enzymatic browning with the release chloride inion resulted in environment and reaction with copper metal ions in the active site of the Polyphenol Oxidase (Olivas et al., 2007). According to the figure using Chitosan and Psyllium seed gum in concentration of 0.2 % percent, are the best results. Ability of edible coatings on the rate of decreasing enzymatic browning primarily is related to their ability to a barrier against oxygen (Olivas et al., 2007). Clearly the figure at concentration 0.2% of Psyllium seed gum shows the best inhibitory effect against enzymatic browning and after it; Chitosan has the next place in the same situation. Inhibitory effect of Chitosan against gases and also its antimicrobial properties has been found in studies (Skurtys et al., 2010; Vásconez et al., 2009). The better effect of concentration 0.2 % of Psyllium seed gum probably is due to inhibitory effect of Psyllium seed gum against passing of oxygen in this concentration, because oxygen is one of the required elements in the enzymatic browning process.

B. Analysis of textural properties

1) Firmness

Figure 3 presents the firmness changes by using coating of Psyllium seed gum. As can be seen, Chitosan had shown the best consistency in apple texture during 8 maintaining days, and given both coating solution of Psyllium seed gum and Chitosan gum, the similar materials such as ascorbic acid and calcium chloride applied with equal percentages and bringing the solution to volume with 1% citric acid was used, so can be concluded that Chitosan difference with different percentages of Psyllium seed gum is because of the gum ability to better coating and preventing water outflow in apple texture (Qi et al., 2011; Rojas-Graü et al., 2008).

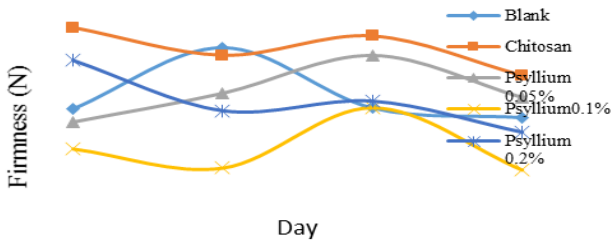

Figure 3. Effect of storage time on the firmness of apple

In various concentrations of Psyllium seed gum except concentration of 0.1% in other cases statistically exist no significant difference in the level of 0.05%, but although the concentration of 0.05% of the gum has no significant difference in the concentration of 0.2 % on different days relatively has shown better results in the preservation of texture. At all concentrations used gum after 6 days, a sharp drop is seen in Figure that is probably due to Pectoltic enzymes activity and severe loss of texture integrity and thinning of the cell wall due to this enzyme activity.

2) Adhesiveness

Adhesiveness is according to the work required to overcome the attractive force between the surfaces in contact with food and other materials that are used (13).

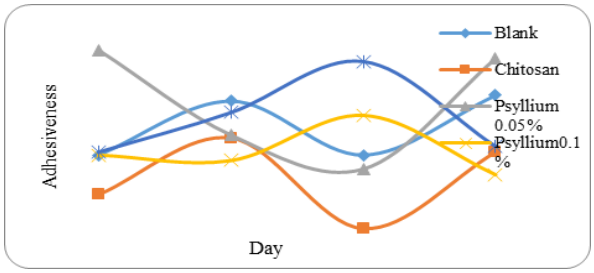

Figure 4. Change of Adhesiveness factor during storage time

As you can see in Figure 4, this factor has increased on average. Between control sample and various percentages of Psyllium seed gum during various days, there is no significant difference statistically in the level of 0.05%, but although the treated Psyllium 0.1% reported less values for this factor. Adhesiveness factor for this treatment on days 1, 3, 5 and 7, was being 0.22 gs, 0.12 gs, 0.8 gs and 0.21 gs respectively. But in the case of samples coated with Chitosan towards Psyllium seed gum, statistically significant difference exists. For this factor, the amount of Chitosan gum 0.05 gs in the first day, 0.12 gs on the third day and is reached on 0.01 gs at the fifth day and 0.1 gs on the seventh day has increase (Aday et al., 2011).It seems that dissolution and Depolymerization constituent compounds and cell wall of apple is mainly pectin the main factor responsible the higher levels of adhesiveness of control and coated samples with Psyllium seed gum. Lower values of these parameters on the Chitosan show the better ability of its coating and better preservation of cell wall components.

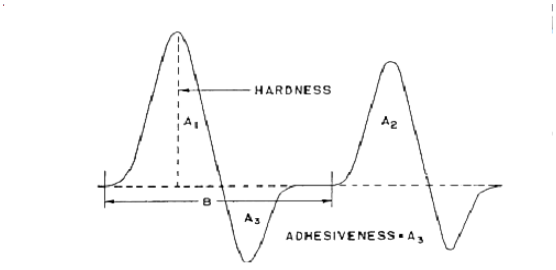

Figure 2. general changes curve in TPA test (Szczesniak, 2001)

3) Cohesiveness

Textural factor is defined as the amount of deformation of the food before it is disjoint and it is equal with the push of a positive force in stage 2 to stage 1 a positive force in pressing (Guine et al., 2011). As it is clear what the ratio is closer to 1, the object has more elastic properties and how these factors have less effect on the material, its plasticity is greater.

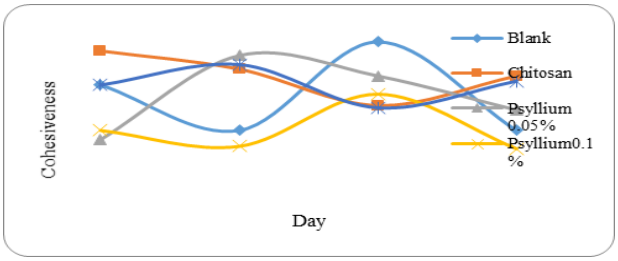

Figure 5. Change of cohesiveness factor during storage time

In figure 5 the chart of cohesiveness changes over time in samples is shown. Concentration of 0.05% of Psyllium seed gum clearly established in the days after coating than other samples have statistically significant difference. The general changes process is a decreasing process in all the samples except that Chitosan has been shown to have higher amounts on different days. Cohesiveness Chitosan from day one to eight was 0.26, 0.24, 0.18 and 0.23, respectively. The changes process in Psyllium 0.1% has been the nearest percentage toward Chitosan. Cohesive factor is also indicative of the affinities strength (Aday et al., 2011). One can say that the existence of significant difference between control samples and other samples the first and fifth days referred to ability to coating in preventing of cell wall structural changes. Chitosan changes process and Psyllium concentration 0.1% near in keeping higher these two factors referred to their better ability and specially Chitosan in preserving better texture on different days. Also according to the values of this factor in various samples can be concluded that the apple texture changes during different days of storage does not have much elasticity property. by Similar results from two factors adhesiveness and cohesiveness in cases, two treatments of 1% Chitosan and 0.1% Psyllium both shows better results in preserving the initial texture of the apple,so it can be said that there is more correlation between measurable results of these two factors.

4) Chewiness

Energy required is chewing a solid food until to reach the swallowing stage and combination of factors such as hardness, cohesiveness and elasticity (Guine et al., 2011).

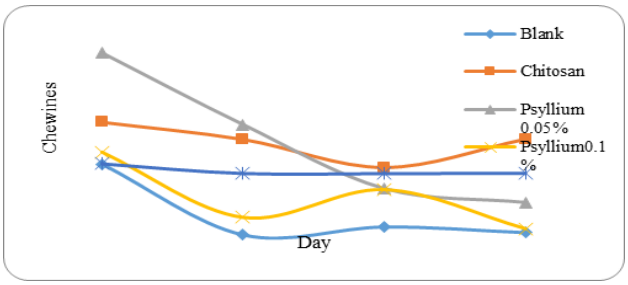

Figure 6. Change of Chewiness factor during storage time

In figure 6 is shown chewy factor changes process. Chitosan clearly held these factors in higher amounts. This factor for Chitosan in various days was 11.82 g, 10.3 g and 10.32 g respectively that compared to control sample values 8.12 g, 1.82 g, 2.53 g and 2.02 g clearly shows their differences. After Chitosan treatment 0.2% Psyllium seed gum has better results. Chewiness factor is directly related to primary cell wall and middle lamella structure (Aday et al., 2011). Changes process in the cell wall and the middle lamella demonstrated the ability of gum to maintain quality of texture gum after coating during days and represented a better ability of Chitosan and concentration of 0.2% Psyllium gum in maintaining textural chewiness index of apple.

5) Hardness

According to the definitions, it is force required to cause a food deformation and in fact is essential force to push and comprise a food between molar teeth (Szczesniak, 2001). Figure 2 identifies the general shape of TPA and hardness place. In figure 7 is shown the hardness changes process toward time.

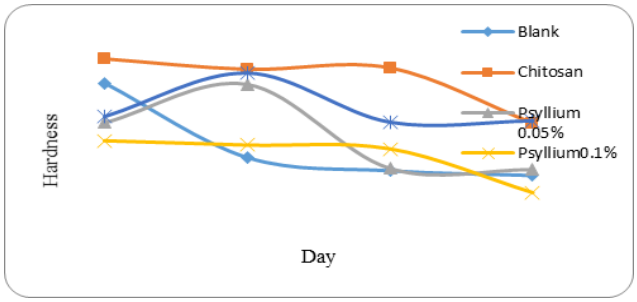

Figure 7. hardness modification of apple texture during storage time

As can be seen, the highest degree of hardness is referred to Chitosan and compared hardness of control texture in the first day that actually the texture of refresh apple is equal to 2742N with comparing Chitosan hardness in various days have been concluded that the amount of Chitosan hardness is closely near to texture hardness of fresh apple and this shows the ability of Chitosan in maintaining the apple texture at maintenance days to the original texture of fresh apples. In addition to Chitosan, treatment 0.2% Psyllium seed gum showed the good ability to maintaining texture and primary hardness of apple texture. Hardness values in control samples after first day has suffered a loss due to enzyme activity during storage days and lack of edible coatings to preserve the original texture and prevent the loss of water in the textures and thereby was weakening the cell wall structure (Qi et al., 2011). By comparing the results of two factors of chewiness and hardness that are the best results of the two treatments of 1% and Psyllium gum 0.2, can say that in this study, these two factors have a direct relationship to each other. By comparing results in enzymatic browning of different treatments by storage time and physical or textural properties a correlation can be seen. As we said in color changes parts of this article the two treatments of Psyllium in concentration 0.2 and Chitosan in concentration of 1% had the best results as an edible coatings because of their ability to inhibit enzymatic browning and fortifying apple slices. Generally by observing textural factors of different treatments we can conclude that the two treatments of Psyllium in concentration 0.2% and Chitosan in concentration of 1% also had the best results in fortifying textural properties. The correlation between enzymatic browning and physical properties shows Psyllium in concentration of 0.2% and Chitosan in concentration of 1% had the best effects as an edible coating in this research.

CONCLUSION

The results of this study show that the use of edible coatings to preserve quality better than the original apple and preventing of enzymatic browning effect is obvious. Commercial use of Chitosan and extraction of native Psyllium seed gum and its use as an edible coating and compare both in this study revealed that firstly Chitosan and then the concentration 0.2% Psyllium seed gum cause to maintaining the original texture of apple according to hardness and chewiness. The two factors, cohesiveness and adhesiveness showed the best results of two treatments of 1% Chitosan and 0.1% Psyllium. According to enzymatic browning factor, extracted Psyllium seed native gum at a concentration of 0.2% could show the best results in maintaining color of apples during storage days.

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