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ORIGINAL ARTICLES

Utilization of edible coating in extending the shelf life of minimally processed prickly pear

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ABSTRACT

This experiment was carried out on fruits during 2011 and 2012 seasons ,to extend postharvest life and to maintain their quality, respectively. Samples were stored at refrigerator (0 C°) for 9 days and at relative humidity of 90%. Samples were taken at regular intervals for analysis. The changes in weight loss, firmness, total carotenoids, total acidity, TSS, total colony count and Moulds & yeasts count of the coated and uncoated samples with storage time were investigated to determine the delay in the deterioration time of the samples every 3 days. The coatings contributed to a lower reduction in weight. The coatings decreased the soluble solids, firmness, titratable acidity, loses and increased the total carotenoids in comparison to the uncoated prickly pear. The coating of prickly pear also contributed to a lower increase in total count of microbes and Moulds & yeasts during 9 days of storage. It was found that guar gum emulsion has a some what non significant effect on maintenance the postharvest life of fruits compared with xanthan gum emulsion, but not significant, and there is no significant difference between the results obtained from the two seasons under investigation .The results suggest that the coating prolong the preservation of minimally processed prickly pear with commercial quality up to 9 days.

Key words: minimally Prickly pear, xanthan and guar gum, weight loss, firmness, total carotenoids, total acidity, TSS, total colony count and Moulds & yeasts count

Introduction

Prickly pear (opuntia sp) is an excellent alternative because of its high content of antioxidant ,fiber and other bioactive compounds, which give a special quality as functional food. There is a difficulty in the process of peeling fruit makes this unattractive to the consumer who is not known how to avoid content with the many thorns that has in its shell. The coating of prickly pear surfaces with films formed by different emulsions containing xanthan gum \or guar gum as a hydrophilic polymer was carried oat .

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 characterizes of a food (Krochta and Jechnol 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 multicomponent mixture), and 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 (O2, CO2) and also becoming a barrier for the transfer of aromatic compounds, Osman (2011).

The edible films are classified into three categories taking into account the nature of their components: ydrocolloids (containing proteins, polysaccharides or alginates), lipids (constituted by fatty acids, acylglycerols 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 permeabilities to O2 and CO2 Nussinovitch, 1997, (2000). Numerous studies have carried out to study the properties of films made from single hydrocolloid

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components as polysaccharides or proteins. The most frequently utilized polysaccharides were cellulose and starch (and their derivatives), chitosan, seaweed extracts (carrageenans and alginates),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 and Fennema, (1993).

Ilter *et al* (2008) studied the effects of guar gum ,xanthan gum ,corn flour, and soy flour on the quality of turkey nuggets. As a result, nuggets that were well coated were found to show a higher cooking yield and desired color when they were coated with guar and xanthan gums as a batter, Kilincceker and Kucukoner (2007) determined that utilizing coating with different gums (guar, xanthan, locust bean) provided more resistance against fat absorption and moisture loss in chicken drum- sticks during deep frying .

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*, 2005). Several studies have been done to determine the effects of polysaccharide –based edible coatings on fresh – cut fruits such as mango (Chien *et al*., 2007) papaya (Tapia *et al* ., 2008), pear (Oms -oliu *et al*., 2008) and banana (Bico *et al*., 2009).

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. Fruit coated with xanthan gum and glycerol had a weight loss of 10.38% after 12 days ,while fruits without coating lost 20.99% of their weight in the same period .Xanthan gum coating maintained firmness, color, pH, titratable acidity, soluble solids and anthocyanin concentration and did not stimulate fungal growth. 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 cellulosic 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, stable properties in extreme chemical and physical environment, and pseudoplastic behavior ,this biopolymer has a verity of applications as a stabilizing ,viscosifying, emulsifying , thickening and suspend agent (Kennedy and Bradshaus,1984).

The objectives of this study were : (1) to study the use of xanthan gum and guar gum as a hydrophilic polymer in retardation of deterioration of minimally prickly processed pear by extending postharvest life (2) to examine the change in Weight loss, firmness, total soluble solids,titratable acidity, total caroteniods and microbial count of coated and uncoated processed prickly pear with storage time and (3) to develop a mathematical model for Weight loss of minimally processed prickly pear during storage .

Materials And Methods

This research was conducted in private orchard at giza governorate during two successive seasons 2011and 2012. Balady prickly pear cultivar was used in this study. The fruits were picked at yellow –green stage,and transported to the laboratory of Food engineering and Packaging Dept. Food Technology Research Institute Agriculture Research Center. A complete randomized and factorial design with three replicates was used.The fruit were peeled and divided into three groups :-

The firsts group was coated with guar gum

The second group was coated with xanthan gum

The third group was untreated fruit (control)

Twelve replicates were prepared for each treatment .Each replicate contained eight fruits .The fruit, were packed in plastic trays (capacity of each 4-6 fruits), All treatments were stored at refrigerator(0 C°) and 90% relative humidity. Three replicates from each treatment were taken and examined every 4 days for quality parameters during 9 days of storage .

Preparing of guar and xanthan solutions were done as followed:

One gram of guar or xanthan were added to 100ml of distilled water contining 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° by using a magnetic stirrer then the solution was filtrated (Azarakhsh, *et al*., 2012).

The followed data were recorded:

1- **Weight loss**.Weight loss percentage was estimated according to the method of Han *et al* (2004)

2- **The firmness:** the firmness was measured by Magness and Rollout Pressure Tester with a plunger of 3116 inch expressed as lb/in^2 and adjusted in newton According to the method of (Han *et al.* 2004)

3- **Total carotenoids contents:**The total carotenoids were determined in the fresh fruits according to Askar and Treptow (1993).

4- **Total acidity:** was measured by titration against Na oH (0.1N) using phenolphthalein as indicator (A.O.A.C,2000)

5- **Total soluble solids** (TSS) **:** was determined by the refractometric method at room temperature using an Abbe refractometer (carl-zeiss jena) in juice pressed from a sample of homogenized fruit slices according to Konopacka and Plocharski,(2004).

6**- Total microbiological count:** were determined according to Marshall,(1992) The microbiological analysis comprised 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. Appropriety serial dilution were done and then 10 ml of every sample was plated by standard microbiological pour plat technique . All the microbiological counts were carried out in duplicates.

1-Total colony count: The total colonies of bacteria were estimated using plate count agar medium. The plates were incubated at 37ºC for 48 hours.

2-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.

7- **Statistical analysis:** All data obtained were subjected to the proper statistical analysis using the MSTAT statistical software and the treatments means were compared by using the LSD at 0.05 level of probability as described by Snedecor and Cochran (1989).

Results and Dissection

From table(1) We can showed that control fruits during 9 days of storage have more weight loses than that of Guar or xanthan coated ,but the percent of loss is non significant between the two treatment s. The loss in weight may be attributed to respiration and other senescence related metabolic processes during storage (Watada and Qi, 1999). However, xanthan samples much retained their weight during storage as compared to guar and control samples

Table 1: Effect of Edible coating on Weight loss (%)of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	1.91	3.19	4.76	6.48	4.09
	Xanthan	0.75	3.95	5.01	5.22	3.73
	Control	1.08	4.24	5.32	6.42	4.27
Mean		1.25	3.80	5.03	6.04	
LSD at 5% level		A=0.5884	B= 0.6794	A*B= 1.177		
2012	Guar	1.08	3.48	3.93	5.16	3.41
	Xanthan	0.69	3.41	4.44	4.65	3.30
	Control	0.66	3.45	4.65	5.17	3.48
Mean		0.81	3.44	4.34	5.00	
LSD at 5% level		A=0.5674	B= 0.6551	A*B= 1.135		

(A): Edible coating treatment (B): Storage periods

From table (2) There were a non significant 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 0_2 reduction within the wrapped sample, therefore can protect these characters ,presumably through prevention of oxidation, Wong (1994).

From table (3) We can revealed that firmness(N) 0f prickly pear fruits was decreased during storage Guar and xanthan coated samples have a clear significant different on firmness(N) than that of control samples. Data in table (3) revealed that prickly pear fruits before storage were firmness than by the end of storage period. There was significant reduction in fruit 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 Edible coating on total soluble solids (TSS)of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	10.50	11.27	11.60	12.87	11.56
	Xanthan	10.60	10.77	11.10	12.10	11.14
	Control	10.80	11.60	12.27	12.50	11.79
Mean		10.63	11.21	11.66	12.49	
LSD at 5% level		A= 0.1442	B= 0.1665	A*B= 0.2884		
2012	Guar	10.90	11.87	12.27	12.47	11.88
	Xanthan	10.70	11.20	11.50	11.90	11.33
	Control	10.90	11.50	12.30	13.20	11.98
Mean		10.83	11.52	12.02	12.52	
LSD at 5% level		A=0.0254	B= 0.0293	A*B= 0.0508		

(A): Edible coating treatment (B): Storage periods

Table 3: Effect of Edible coating on Firmness (N) of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	72.33	74.00	60.67	56.33	65.83
	Xanthan	63.00	72.33	58.33	52.33	61.50
	Control	54.67	55.34	57.67	52.33	55.00
Mean		63.33	67.22	58.89	53.67	
LSD at 5% level		A=3.805	B=4.393	A*B= 7.609		
2012	Guar	73.67	79.00	59.33	54.33	66.58
	Xanthan	64.33	67.00	59.33	51.33	60.50
	Control	57.00	56.00	55.00	51.33	54.83
Mean		65.00	67.33	57.89	52.33	
LSD at 5% level		A=2.938	B=3.393	A*B= 5.876		

(A): Edible coating treatment (B): Storage periods

There was a slight decrease in titratable acidity loses of prickly pear fruits during storage periods. (Table,4) without significant differences between all treatments and or the control. A slow decrease in titratable acidity may be due to Matural variability among cultivars. These results are in agreement with those of Barbera *et al*, (1992)

Table 4: Effect of Edible coating on acidity(g/100g) of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	0.75	0.53	0.43	0.36	0.52
	Xanthan	0.75	0.59	0.47	0.43	0.56
	Control	0.75	0.59	0.46	0.42	0.55
Mean		0.75	0.57	0.45	0.40	
LSD at 5% level		A=0.0708	B=0.0818	A*B= 0.1417		
2012	Guar	0.85	0.59	0.47	0.43	0.58
	Xanthan	0.75	0.59	0.46	0.39	0.55
	Control	0.85	0.59	0.47	0.42	0.58
Mean		0.82	0.59	0.47	0.41	
LSD at 5% level		A=0.0656	B=0.0757	A*B= 0.1312		

(A): Edible coating treatment (B): Storage periods

From table (5) ,there was an evident increase in total carotenoids during 9 days of storage in coated samples compared with the control without significant differences between the two coating treatments. (Chang *et al* 2003) and (Figueiredo *et al* 2002), reported that the increasing of carotenoids during refrigerator storage due to chlorophyll degradation and converted it carotenoids at minimized rate.

Table 5: Effect of Edible coating on total Carotenoids of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	12.20	13.60	14.40	15.00	13.80
	Xanthan	11.80	12.80	14.00	15.40	13.50
	Control	11.00	12.00	12.50	13.00	12.13
Mean		11.67	12.80	13.63	14.47	
LSD at 5% level		A=0.0120	B=0.0138	A*B= 0.0240		
2012	Guar	12.10	13.30	14.50	14.90	13.70
	Xanthan	11.90	13.20	14.10	15.70	13.73
	Control	11.00	11.80	12.60	13.20	12.15
Mean		11.67	12.77	13.73	14.60	
LSD at 5% level		A=0.0169	B=0.0196	A*B= 0.0339		

(A): Edible coating treatment (B): Storage periods

Data in table (6,7) Show that microbial and mould & yeasts growth were increased with increasing the storage period . 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 psychotropic populations.

Table 6: Effect of Edible coating on total count microbial(CFU x 10^{-1}/ g) of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	6.20	6.30	11.10	13.20	9.20
	Xanthan	6.20	6.90	11.60	14.90	9.90
	Control	6.20	8.90	14.40	11.65	10.29
Mean		6.20	7.35	12.15	6.60	
LSD at 5% level			A=7.80	B=12.85	A*B= 7.22	
2012	Guar	6.50	6.30	11.00	13.15	9.24
	Xanthan	6.50	6.80	11.45	14.44	9.80
	Control	6.50	8.80	14.25	11.25	10.20
Mean		6.50	7.33	12.05	6.58	
LSD at 5% level			A=0.04697	B=0.05753	A*B= 0.08136	

(A): Edible coating treatment (B): Storage periods

Table 7: Effect of Edible coating on total count of Mould & yeasts (CFU x 10^{-1}/ g) of minimally processed prickly pear during storage

Seasons	Edible coating	Storage period per days				Mean
		1	3	6	9	
2011	Guar	1.25	1.30	2.20	3.00	1.94
	Xanthan	1.25	1.50	2.50	3.30	2.14
	Control	1.25	1.80	3.40	3.00	2.36
Mean		1.25	1.75	3.05	1.65	
LSD at 5% level			A=0.05037	B=0.06169	A*B= 0.08725	
2012	Guar	1.30	1.22	2.15	2.45	1.94
	Xanthan	1.30	1.42	2.35	3.15	1.78
	Control	1.30	1.88	3.47	3.00	2.41
Mean		1.30	1.55	2.80	1.50	
LSD at 5% level			A=0.04331	B=0.05304	A*B= 0.07501	

(A): Edible coating treatment (B): Storage periods

Conclusion:

In conclusion guar and xanthan coatings are a simple, environmentally friendly, and relatively inexpensive technology that can extend the shelf life of minimally processed prickly pear. The application of coating reduced respiration rate and weight loss. This implies that the guar & xanthan gum coating may form a protective barrier on the surface of prickly pear and reduce the supply of oxygen .we may propose that the application of coating on minimally processed prickly pear in the conditions of lower temperatures and higher relative humidities could be more beneficial in extending postharvest life and maintaining quality and, to some extent, controlling decay of prickly pear.

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