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UTILIZATION OF SOME EDIBLE COATINGS FOR EXTENDING SHELF- LIFE OF MINIMALLY PROCESSED PEAR SLICES

Osman, M. F.
Food Technology Dept., Fac. of Agric., Kafr El- Sheikh Univ., Egypt.

ABSTRACT

Sodium alginate (SA), xanthan gum (XG) and carboxymetyhl cellulose (CMC) containing 5% glycerol alcohol were used as edible coatings forms. These coating materials were used to extend the shelf- life and enhance the nutritional values of minimally processed pear (*Pyrus communis*) slices stored at 5 ± 1^{0}C and 70-75% relative humidity (RH) for 13 days. Dipping of fruits in antibrowning agents solution were advantageous in maintaining color during storage. The dipping of pear slices coated with sodium alginate in 2% calcium chloride as hardening agent inhibited the loss of firmness. Generally, all coating materials were effective in reducing the loss of weight, ascorbic acid, microbial contamination and maintenance of firmness and titratable acidity. All used coatings in combination with antibrowning agents were effective in maintenance of skin color of pear slices during storage. Sodium alginate was the best in maintenance of pear slices obtaining the highest storage periods for 11 days followed by xanthan gum (7 days), then carboxymethyl cellulose (5 days) comparing with control sample (3 days).

INTRODUCTION

Recently, there has been an increasing market demand for minimally processed fruits and vegetables due to their fresh –like character, convenience and human health benefits. Minimal processing include grading, washing, sorting, peeling, slicing, chopping and then packaging. Since minimal processing results in deterioration associated with water loss, softening, microbial contamination, increased respiration and ethylene; and cut- surface browning, minimally processed products become more perishable (Rolle and Chism, 1987).

The use of edible coatings can reduce respiration, thus prolonging product shelf- life (Baldwin *et al.*, 1995 and 1997). Edible coatings provide a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement; thereby reduction respiration, water loss, and oxidation reactions (Park, 1999).

Ascorbic acid, citric acid, and some sulfur- containing amino acids were used as substitutes for sulfite to prevent enzymatic browning (Lee *et al.*, 2003). Coatings are also useful as carrier of additives, such as antioxidants, acidulants, fungicides and preservatives (Cuppett, 1994).

Edible coatings can be made from food materials regarded as generally recognized as safe (GRAS) such as proteins, cellulose derivatives, starch and other polysaccharides (Krochta and De Mulder, 1997).

The minimally processed fruits were demanded in confectionery and big hotels for decoration and we need to extend the shelf- life of these fruit slices without any deterioration. Therefore, this study was undertaken to slices without any deterioration. Therefore, this study was undertaken to investigate three types of edible coating materials in combination with antibrowning agents to extend the shelf- life and enhance the nutritional values of minimally processed pear slices during cold storage at 5 ± 1 ^{0}C and 70- 75% RH.

MATERIALS AND METHODS

MATERIALS:

Fruits:

Fruits used in this investigation were pears (*Pyrus communis x Pyyus pyrifolia*), variety Le Conte. The fruits were purchased from the local market in Kafr El -Sheikh for two seasons 2004 and 2005.

Packaging materials:

Foam trays were used as a packaging materials (12.5 x 17.5 cm) and low density polyethylene films as a over wrapped materials (56 porous, 0.6mm diameter) were purchased from the local market at Kafr El -Sheikh.

Coating materials:

Coating materials namely, carboxymethyl cellulose (CMC), sodium alginate (SA), xanthan gum (XG) and soy protein isolate were obtained from Mifad Company, Giza, Egypt. Ascorbic acid (AA), citric acid (CA), calcium chloride and glycerol alcohol (GA) were purchased from El- Gomhoria Company for Chemicals and Drugs at Tanta city, Egypt.

METHODS:

Preparation of edible coatings formulation:

Three edible coating solutions were prepared as follows:

Sodium alginate as an edible coating:

Sodium alginate coating was prepared according to the method outlined by Matuska *et al.* (2004) as follows: 2% sodium alginate in distilled water was prepared. The solution was heated to 70 ^{0}C then, the solution was cooled at room temperature. This solution was modified by addition 5% (v/v) glycerol as plasticizer after cooling.

Xanthan gum as an edible coating:

Xanthan gum coating was prepared by dissolving 0.3% (w/v) xanthan gum into distilled water. The solution was heated to 60 ^{0}C, then cooled at room temperature (Mei *et al.*, 2002). This solution was modified by addition 5% (v/v) glycerol alcohol as plasticizer after cooling.

Carboxymethyl cellulose as an edible coating:

Carboxymethyl cellulose was used with other additives as an edible coating by the method outlined by Baldwin *et al.* (1996). (1% w/v) CMC was dissolved in distilled water, then 0.5% (w/v) of soy protein isolate was added. The solution was heated on hot-plate with stirring at 70 ^{0}C, then cooled at room temperature. This solution was modified by adding 5% (v/v) glycerol alcohol as plasticizer.

Preparation of pears for coating:

Selected pears of uniform size and color were washed in distilled water preceding treatments. Pears were peeled and the core tissue completely removed. The flesh cut into 1.5 cm- thick slices lengthwise before dipping directly. A sharp stainless-steel knife was used to reduce to a minimum the harm produced by mechanical bruising.

Coating procedure of pears:

Pear slices were dipped for one min. into mixture of 1% (w/v) L-ascorbic and 1% (w/v) citric acids solution as antibrowning agents, at the same time, pear slices were dipped into distilled water (control sample). The excess liquid was gently removed by draining for 5 min. at room temperature. Then the samples were dipped into three test coating solutions (SA, XG and CMC) for three min. and drained for 5 min. at room temperature using air drier. The tested samples in sodium alginate coating were dipped into 2% (w/v) calcium chloride solution as solidifying agents. The samples were removed, air dried, then placed on tissue-lined styrofoam trays(12.5 x 17.5 cm) and over wrapped with polyethylene films (LDPE). These films contained 54 porous with 6 mm diameters. The tested pear and control samples (40 trays) were stored in a refrigerator at 5 ± 1 ^{0}C and 70 – 75% relative humidity (RH). Samples were taken at 0, 1, 3, 5, 7, 9, 11 and 13 days for analysis.

Chemical properties:

Weight loss, moisture, TSS, pH, total titratable acidity and ascorbic acid were determined according to the methods of A. O. A. C. (1995).

Measurement of firmness:

Fruit firmness (kg/mm^2) was determined by Magnus pressure tester (Push- Pull Dynamometer, Model FDN, Italy) and its diameter was 1.5 mm (**A. O. A. C., 1995**).

Organoleptic properties:

Sensory properties were evaluated by the method outlined by **Simpson *et al.*, (1965).**

Microbiological examination:

Nutrient agar and potatoes- dextrose agar media were prepared according to Difco Manual (1977). Total viable bacteria were determined according to Deng *et al.* (1974). Mold and yeast counts were determined according the method outlined by Nottingham, (1971).

Statistical analysis:

The obtained data were statistically analyzed using General Linear Models Procedure Adapted by SPSS (1997) for user's Guide Duncan Multiple Range Test was used to test the difference among means (Duncan, 1995).

RESULTS AND DISCUSSIONS

Effect of coating types on chemical properties of pear slices:

Weight losses, total soluble solids, pH values, total titratable acidity and ascorbic acid contents of pear slices as affected by coating types during cold storage at 5 ± 1 ^{0}C and 70 – 75% RH for 13 days were determined and the results are tabulated in Tables (1, 2, 3 and 4).

Weight losses:

Data in Table (1) show the percentage of weight loss of pear slices of both uncoated and coated samples as affected by coating types and storage increased as a function of storage time for both uncoated and coated samples. All coatings had significantly a beneficial effects in reduction the weight loss during storage comparing with control samples. These effects could be attributed to the presence of pores and cracks on these coatings. Also, addition of glycerol alcohol (5%) to the coatings reduced weight loss, because it related to the decrease of intermolecular attractions and increase of polymer chain mobility. Also, it may fill pores and vacancies within the polymer matrix. Generally plasticizer improves flexibility and extensibility while increasing the barrier properties of films (Garcia *et al.*, 1998 a& b).

Table (1): Weight loss (%) of pear slices as affected by three types of edible coatings and storage time*.

Coating materials / Storage time (days)	Control sample	Sodium alginate	Xanthan gum	Carboxymethyl cellulose
0	$^{h}0.00^{N.S}$	$^{h}0.00$	$^{h}0.00$	$^{h}0.00$
1	$^{g}2.61^{A}$	$^{g}1.25^{B}$	$^{g}1.68^{B}$	$^{g}2.89^{A}$
3	$^{f}9.61^{A}$	$^{f}4.44^{D}$	$^{f}6.25^{C}$	$^{f}7.35^{B}$
5	$^{e}16.48^{A}$	$^{e}5.68^{D}$	$^{e}7.24^{C}$	$^{e}10.37^{B}$
7	$^{d}22.35^{A}$	$^{d}8.07^{D}$	$^{d}11.52^{C}$	$^{d}15.82^{B}$
9	$^{c}26.21^{A}$	$^{c}12.22^{D}$	c14.12^{C}	$^{c}20.81^{B}$
11	$^{b}41.11^{A}$	$^{b}14.37^{D}$	$^{b}18.78^{C}$	$^{b}23.65^{B}$
13	$^{a}49.50^{A}$	$^{a}26.11^{D}$	$^{a}30.26^{C}$	$^{a}33.54^{B}$

Within a raw (capital letter) means of treatments having the same right case letter(s) are not significantly different ($p > 0.05$).
Within a column (small letter) means of storage periods having the same left case letter(s) are not significantly different ($p > 0.05$).
***Stored at 5 ± 1 ^{0}C and 70 - 75% RH for 13 days**

From data in Table (1) it can be seen that SA coating was found to be significantly the best among all of the other used coating materials, which reduced the weight loss to 26.11% after 13 days of storage comparing with 49.50% for control sample. It may be due to the presence of thin layer around the fruits which lowered water vapor permeability. XG coating was significantly the second in reducing weight loss during storage, while CMC coating was found to be the lowest one in reducing the weight loss. It may be explained that hydrophilic polymers, especially highly polar types like carboxymethyl cellulose have poor moisture barrier properties, therefore are not efficient at reducing weight loss of coated produce (Baldwin *et al.*, 1996).

Total soluble solids (TSS):

The results in Table (2) show the changes in total soluble solids of pressed juices from uncoated (control) and coated pear slices during cold storage. The results cleared that TSS of both uncoated and coated samples significantly increased as a function of storage time. This finding might be due to the weight losses during storage especially moisture losses and degradation of insoluble components to soluble components during ripening.

Table (2):Changes of total soluble solids (TSS) of pear juices as affected by three types of edible coatings and storage time*.

Coating materials / Storage time (days)	Control sample	Sodium alginate	Xanthan gum	Carboxymethyl cellulose
0	$^{f}9.0^{N.S}$	$^{g}9.0$	$^{e}9.0$	$^{f}9.0$
1	$^{e}12.5^{A}$	$^{g}9.0^{C}$	$^{e}9.0^{C}$	$^{e}11.0^{B}$
3	$^{e}12.5^{A}$	$^{f}9.5^{C}$	$^{e}9.0^{D}$	$^{e}11.0^{B}$
5	$^{d}13.0^{A}$	$^{e}10.0^{D}$	$^{d}10.5^{C}$	$^{d}11.5^{B}$
7	$^{d}13.0^{A}$	$^{d}10.5^{D}$	$^{c}11.0^{C}$	$^{c}12.0^{B}$
9	$^{c}13.5^{A}$	$^{c}11.0^{C}$	$^{c}11.0^{C}$	$^{c}12.0^{B}$
11	$^{b}15.0^{A}$	$^{b}11.5^{C}$	$^{b}11.5^{C}$	$^{b}13.0^{B}$
13	$^{a}23.0^{A}$	$^{a}12.0^{D}$	$^{a}13.0^{C}$	$^{a}14.5^{B}$

Within a raw (capital letter) means of treatments having the same right case letter(s) are not significantly different ($p > 0.05$).
Within a column (small letter) means of storage periods having the same left case letter(s) are not significantly different ($p > 0.05$).
***Stored at 5 ± 1 °C and 70 - 75% RH for 13 days.**

Generally, all coatings had significantly a beneficial effects in maintenance of fruits from TSS increment and over ripening. The slices coated with SA coating increased slightly from 9.0 to 12.0% comparing with uncoated samples from 9.0 to 23.0% during storage from zero to 13 days; respectively. XG coating was significantly the second in reducing TSS development, it increased from 9.0 to 13.0%. CMC coating was significantly the lowest in maintenance of TSS development; it increased from 9.0 to 14.5% during storage from zero to 13 days; respectively. The slightly increment of TSS for coated samples comparing with control may be due to the barrier properties of coatings which lowered permeability of water and oxygen that delay ripening development.

Effect of coating materials on pH and total titratable acidity (TTA) values:

Table (3) show the changes in pH and TTA values of pressed juices in pear slices. The results revealed that pH values significantly increased and TTA significantly decreased in both uncoated and coated samples as a function of storage time. The increment of pH values (decrement of acidity) of coated samples was lower than those of uncoated samples. A decline in acidity demonstrates maturation development, thus coating delayed fruit maturation (Garcia *et al.*, 1998a). Since organic acids are substrates for the enzymatic reactions of respiration, a reduction in the acidity and an increase in pH values (decrease of acidity) are expected. Coatings reduce the respiration rate, therefore delay the utilization of organic acids (Garcia *et al.*, 1998, b).

SA coating was found to be significantly the best among all of the used coatings in maintenance the pH and acidity changes compared to control. It may be due to the presence of film on slices surface that prevent oxygen permeability. XG coating was significantly the second. CMC coating was significantly the lowest in maintenance of maturation developments.

Table (3): pH and total titratable acidity (TTA) of pear juices as affected by three types of edible coatings and storage time*

Storage time (days)	Control sample		Sodium alginate		Xanthan gum		Carboxymethyl cellulose	
	pH	TTA	PH	TTA	PH	TTA	pH	TTA
0	$^{d}5.56^{A}$	$^{a}0.25^{D}$	$^{d}5.26^{C}$	$^{a}0.36^{A}$	$^{d}5.54^{A}$	$^{a}0.29^{B}$	$^{e}5.41^{B}$	$^{a}0.27^{C}$
1	$^{d}5.60^{A}$	$^{b}0.21^{D}$	$^{cd}5.28^{D}$	$^{b}0.34^{A}$	$^{c}5.54^{B}$	$^{b}0.27^{B}$	$^{d}5.44^{C}$	$^{b}0.25^{C}$
3	$^{d}5.62^{A}$	$^{bc}0.20^{D}$	$^{c}5.30^{C}$	$^{c}0.32^{A}$	$^{c}5.55^{B}$	$^{b}0.27^{B}$	$^{c}5.55^{B}$	$^{b}0.25^{C}$
5	$^{d}5.64^{A}$	$^{bc}0.20^{D}$	$^{b}5.38^{C}$	$^{c}0.32^{A}$	$^{c}5.56^{B}$	$^{bc}0.26^{B}$	$^{b}5.60^{AB}$	$^{c}0.23^{C}$
7	$^{c}5.69^{AB}$	$^{cd}0.19^{D}$	$^{b}5.39^{C}$	$^{d}0.30^{A}$	$^{bc}5.67^{AB}$	$^{c}0.25^{B}$	$^{a}5.72^{A}$	$^{c}0.23^{C}$
9	$^{b}5.76^{A}$	$^{cd}0.19^{D}$	$^{b}5.40^{C}$	$^{d}0.29^{A}$	$^{b}5.69^{AB}$	$^{c}0.25^{B}$	$^{a}5.72^{AB}$	$^{c}0.22^{C}$
11	$^{b}5.77^{A}$	$^{d}0.18^{C}$	$^{a}5.55^{C}$	$^{d}0.29^{A}$	$^{b}5.69^{B}$	$^{d}0.23^{B}$	$^{a}5.74^{B}$	$^{c}0.22^{B}$
13	$^{a}5.80^{A}$	$^{e}0.16^{D}$	$^{a}5.56^{C}$	$^{e}0.25^{A}$	$^{a}5.72^{AB}$	$^{e}0.21^{B}$	$^{a}5.75^{AB}$	$^{d}0.19^{C}$

Within a raw (capital letter) means of treatments having the same right case letter(s) are not significantly different ($p > 0.05$).
Within a column (small letter) means of storage periods having the same left case letter(s) are not significantly different ($p > 0.05$).
***Stored at 5 ± 1 °C and 70 - 75% RH for 13 days.**

Effect of coating materials on ascorbic acid contents:

Ascorbic acid is lost due to the activities of phenol oxidase and ascorbic acid oxidase enzymes during storage (Salunkhe *et al.*, 1991). It should be noted from Table (4) that ascorbic acid contents in both uncoated and coated samples decreased as a function of storage time. Generally, ascorbic acid losses of coated samples were lower than those of uncoated samples. This may be due to the dipping in ascorbic and citric acids solution before dipping in coating solution which plays an important role as antioxidants and can be attributed to the low oxygen permeability (Ayranci and Tunc, 2003).

Table (4): Changes of ascorbic acid contents (mg/100g sample) of pear slices as affected by three types of edible coatings and storage time*.

Coating materials / Storage time (days)	Control sample	Sodium alginate	Xanthan gum	Carboxymethyl cellulose
0	$^{a}8.29^{N.S}$	$^{a}8.76$	$^{a}8.85$	$^{a}8.61$
1	$^{b}5.41^{C}$	$^{b}7.89^{A}$	$^{b}7.21^{B}$	$^{b}7.00^{B}$
3	$^{b}4.80^{C}$	$^{b}7.22^{A}$	$^{c}6.40^{B}$	$^{c}6.11^{B}$
5	$^{c}3.11^{B}$	$^{c}5.98^{A}$	$^{d}5.60^{A}$	$^{d}5.37^{A}$
7	$^{c}2.80^{C}$	$^{c}5.40^{A}$	$^{e}4.07^{B}$	$^{e}3.97^{B}$
9	$^{d}1.20^{C}$	$^{d}4.62^{A}$	$^{ef}3.80^{B}$	$^{f}2.48^{B}$
11	$^{d}1.20^{D}$	$^{d}4.69^{A}$	$^{fg}3.37^{B}$	$^{f}2.11^{C}$
13	$^{e}0.85^{D}$	$^{d}4.11^{A}$	$^{g}2.98^{B}$	$^{f}2.00^{C}$

Within a raw (capital letter) means of treatments having the same right case letter(s) are not significantly different ($p > 0.05$).
Within a column (small letter) means of storage periods having the same left case letter(s) are not significantly different ($p > 0.05$).
***Stored at 5 ± 1 °C and 70- 75% RH for 13 days.**

The results indicated that SA coating has the highest effect in reducing the ascorbic acid losses. it decreased from 8.76 to 4.11 mg/100g sample comparing with control, which decreased from 8.29 to 0.85 mg/ 100g sample during storage from zero to 13 days; respectively. The effect of SA coating may be due to the presence of thin layer film on the surface that prevent oxygen permeability. No significant differences ($p > 0.05$) were found between XG and CMC coatings in reducing ascorbic acid losses until 9th days; while at 11 and 13 days XG was better than CMC. It may be due to that CMC coating have poor oxygen barrier properties that activate oxidation reactions.

Effect of coating materials on firmness:

Texture degradation has been closely correlated to ripening processes. Retention of firmness can be explained by retarded degradation of insoluble protopectins to the more soluble pectic acid and pectin by increase in pectin esterase and polygalactouronase activities. High oxygen permeability increase the activities of the enzymes and decrease the firmness of fruits and vegetables (Salunkhe *et al.*, 1991).

The results in Table (5) revealed that the firmness significantly decreased as a function of storage time for both uncoated and coated samples. All coatings significantly showed a beneficial effects on firmness retention comparing with control. The best results were significantly found with SA coating, which decreased from 360.0 to 292.5 kg/mm^2 during storage from zero to 13 days; respectively. This may be due to the dipping samples in 2% calcium chloride solution as a hardening agent for SA coating. XG coating was significantly the second in maintenance of firmness. CMC coating was significantly the lowest in maintenance of firmness. Generally all coatings showed a beneficial effects on firmness because it contained 5% glycerol alcohol as plasticizer.

Table (5): Changes of firmness (kg/mm^2) of pear slices as affected by three types of edible coatings and storage time*.

Coating materials / Storage time (days)	Control sample	Sodium alginate	Xanthan gum	Carboxymethyl cellulose
0	^{a}360.0$^{N.S}$	^{a}360.0	^{a}360.0	^{a}360.0
1	^{b}335.5^{C}	^{a}360.0^{A}	^{b}340.0^{B}	^{b}335.5^{C}
3	^{d}268.5^{D}	^{b}330.0^{A}	^{c}322.5^{B}	^{c}302.5^{C}
5	^{c}272.5^{D}	^{c}322.5^{A}	^{d}305.0^{B}	^{d}280.0^{C}
7	^{e}265.0^{D}	^{d}320.0^{A}	^{e}290.0^{B}	^{e}275.5^{C}
9	^{f}260.0^{D}	^{e}317.5^{A}	^{f}287.5^{B}	^{e}275.5^{C}
11	^{g}235.5^{D}	^{g}290.0^{A}	^{g}275.0^{B}	^{f}265.0^{C}
13	^{h}217.5^{D}	^{f}292.5^{A}	^{h}270.0^{B}	^{g}260.5^{C}

Within a raw (capital letter) means of treatments having the same right case letter(s) are not significantly different ($p > 0.05$).
Within a column (small letter) means of storage periods having the same left case letter(s) are not significantly different ($p > 0.05$).
*Stored at 5 ± 1 ^{o}C and 70- 75% RH for 13 days.

Effect of coating materials on organoleptic qualities:

The results in Table (6) and Figures (1, 2 and 3) clear the organoleptic qualities of uncoated and coated samples during storage. The results revealed that, after 3 days of storage there were significant differences ($p \leq 0.05$) among all parameters for pear slices coated with all coatings and control. SA coating was found to be the best among all of the used coatings, XG coating was the second and CMC coating was the third. Control samples had the lowest score and quality parameters deteriorated and it can be stored for 3 days only.

After 5 days of storage, there were significant differences ($p \leq 0.05$) between all coated samples. Pear slices coated with SA coating was the best quality followed by XG coating. Pear slices coated with CMC coating start in deterioration, and it can be stored for 5 days only.

Seven days later, there were significant differences ($p \leq 0.05$) between two coated samples (SA and XG) and SA coating had significantly the best quality. XG coating can be stored not more than 7 days. Pear slices coated with SA coating had the best quality and can be stored for 11 days at $5 \pm 1\ ^0C$ and 70 – 75% RH.

Table (6): Organoleptic qualities of pear slices as affected by coating types and storage time*.

Storage time (day)	Organoleptic qualities	Control sample	Sodium alginate	Xanthan gum	carboxymethyl cellulose
3	Color	5.81^{k}	9.55^{a}	9.00^{c}	8.75^{b}
	Taste	7.35^{f}	9.11^{a}	8.91^{c}	8.11^{e}
	Odor	6.85^{g}	9.09^{a}	8.75^{b}	8.33^{c}
	Texture	6.62^{j}	9.43^{a}	8.47^{c}	7.89^{e}
	Appearance	6.27^{j}	9.53^{a}	9.00^{b}	8.51^{d}
5	Color	-	9.11^{b}	7.32^{g}	6.47^{i}
	Taste	-	8.93^{b}	7.11^{h}	6.75^{j}
	Odor	-	8.00^{d}	6.85^{g}	6.42^{h}
	Texture	-	9.00^{b}	6.75^{h}	6.63^{l}
	Appearance	-	8.95^{c}	7.02^{g}	6.75^{h}
7	Color	-	8.63^{e}	7.00^{h}	-
	Taste	-	8.13^{d}	6.45^{k}	-
	Odor	-	7.33^{e}	6.11^{j}	-
	Texture	-	8.16^{d}	6.31^{k}	-
	Appearance	-	8.00^{e}	6.45^{l}	-
9	Color	-	7.43^{f}	-	-
	Taste	-	7.25^{g}	-	-
	Odor	-	7.00^{f}	-	-
	Texture	-	7.83^{f}	-	-
	Appearance	-	7.13^{f}	-	-
11	Color	-	6.45^{j}	-	-
	Taste	-	7.00^{l}	-	-
	Odor	-	6.35^{l}	-	-
	Texture	-	6.82^{g}	-	-
	Appearance	-	6.15^{k}	-	-

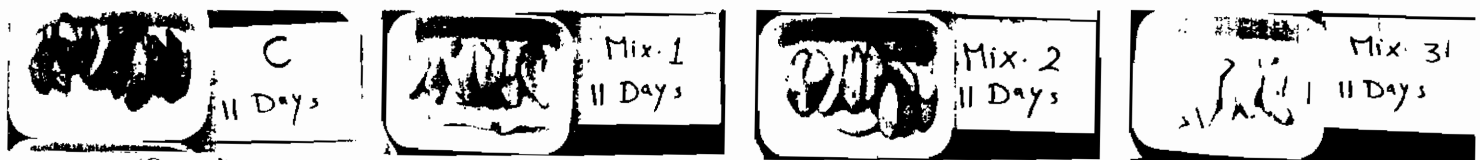
Means of treatments having the same case letter(s) are not significantly different ($p > 0.05$).
***Stored at $5 \pm 1\ ^0C$ and 70- 75% RH.**

(Control) (Sodium alginate) (Xanthan gum) (Carboxymethyl cellulose)

Figure (1): Pear slices coated with three types of edible coatings stored for zero time at 5 ± 1 ^{0}C and 70 – 75% RH.

(Control) (Sodium alginate) (Xanthan gum) (Carboxymethyl cellulose)

Figure (2): Pear slices coated with three types of edible coatings stored for 7 days at 5 ± 1 ^{0}C and 70 – 75% RH.



(Control) (Sodium alginate) (Xanthan gum) (Carboxymethyl cellulose)

Figure (3): Pear slices coated with three types of edible coatings stored for 11 days at 5 ± 1 ^{0}C and 70 – 75% RH.

Generally, it can be concluded that pear slices coated with SA coating was the best and can be stored for 11 days. XG coating was significantly the second and stored for 7 days then, CMC coating was the third and stored for 5 days, while uncoated pear slices can be stored for 3 days only at 5 ± 1 ^{0}C and 70 – 75% RH.

Effect of coating materials on growth microbial populations:

The data presented in Table (7) show total microbial count; yeast and molds of pear slices at the end of shelf- life storage as affected by coating types. The results revealed that, all coatings were effective in reducing levels of total microbial counts comparing with control. SA coating was found to be the best among all of the used coatings in reducing levels of total microbial counts. It recorded 2.0 x 10^3 cfu/g after 11 days of storage compared to 3.0 x 10^3 cfu/g in control sample. XG and CMC coatings were similarly in reducing total microbial counts; they recorded 2.0 x 10^3 cfu/g after 7 and 5 days of storage; respectively.

Table (7): Effect of coating types on pear slices of microbial populations growth (cfu/g) at the end of shelf- life storage*.

Storage time (days)	Control sample		Sodium alginate		Xanthan gum		Carboxymethyl cellulose	
	T. C	Y& M	T. C	Y& M	T. C	Y& M	T. C	Y& M
3	3 X10^3	2 X10^3	-	-	-	-	-	-
5	-	-	-	-	-	-	2 X10^3	1 X10^3
7	-	-	-	-	2 X10^3	2 X10^3	-	-
11	-	-	2 X10^3	1 X10^3	-	-	-	-

T. C = Total counts, Y & M = Yeast and mold.
*Stored at 5 ± 1 ^{0}C and 70 -75% RH.

It should be noted from the same Table (7) that all coatings were effective in reducing yeast and mold counts comparing with control. This may be due to that all coatings had low oxygen permeability. SA and CMC coatings recorded 1.0 x 10^3 cfu/g after 11 and 5 days; respectively, comparing with 2.0 x 10^3 cfu/g after 3 days for control. CMC coating was similar to control but after 5 days of storage. The aforementioned results were in agreement with Anon. (1998) in the hygienic practice of fruits and vegetables. Addition of glycerol alcohol as plasticizer was effective in extending fruit storage life (Garcia *et al.*, 1998b).

From the previous results we can be concluded that SA coating was found to be the best among all of the used coatings because it maintained on weight loss, ascorbic acid loss, acidity loss and TSS development. Also, it lowered loss of firmness and senescence development. This coating maintained organoleptic qualities for pear slices. Xanthan gum coating was the second and carboxymethyl cellulose coating was the third.

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الاستفادة من بعض مواد التغطية الغذائية لمد العمر التخزينى لشـــرائح الكمثـــرى محدودة التجهيز

محمد فوزى عثمان

قسم تكنولوجيا الأغذية – كلية الزراعة – جامعة كفرالشيخ – جمهورية مصر العربية

نظرا" لقصر فترة تواجد الكمثرى فى السوق المصرى أجريت هذه الدراسة على ثمـــار الكمثرى صنف ليكونت في موسم ٢٠٠٤ / ٢٠٠٥ بهدف إطالة العمر التخزينى لشرائح الكمثرى المستخدمة فى تزيين التورتات والجاتوهات المحفوظة في الثلاجة على ٥ ± ١ درجـــة مئويـــة ورطوبة نسبية ٧٠ – ٧٥% وأيضا" الحفاظ على خواصها الطبيعية والكيماوية والعضوية الحسية وتقليل التلوث الميكروبي لها٠ تم في هذا البحث استخدام كل من ألجانات الصـــوديوم وصـــمغ الزانثان وكربوكسى ميثايل سليللوز والمضاف إليهم كحول الجليسرول بنسبة ٥% كمـــادة ملدنـــة كمواد تغطية غذائية لشرائح الكمثرى وذلك بعد غمســـها فـــي محلـــول مـــن حمـــض الســـتريك والأسكوربك كمضادات للتلون البني لزيادة العمر التخزينى لها والمحافظة على الخواص الغذائية لها٠

أوضحت النتائج أن كل من مواد التغطية المستخدمة كانت جيدة مقارنة بالعينات الغيـــر مغطاة (الكنترول) في تقليل الفقد في الوزن والفقد في حامض الأسكوربيك والحموضـــة وكـــذلك المحافظة على اللون والقوام من التدهور والتلوث الميكروبي ٠ كما أوضحت النتائج أن ألجانـــات الصوديوم كانت أفضل مواد التغطية المستخدمة في المحافظة على شرائح الكمثرى من التـــدهور حيث أمكن تخزين الثمار المغطاة بها لمدة ١١ يوم يليها صمغ الزانثان التي أمكن تخزينها لمدة ٧ أيام يليها كربوكسى ميثايل سليللوز والتي أمكن تخزين الثمار المغطاة بها إلى ٥ أيام مقارنة بالثمار الغير مغطاة والتي لا يمكن تخزينها أكثر من ٣ أيام٠