

Evaluation of effect of edible coating base on carboxy methyl cellulose, Pectin and osmotic dehydration on drying of Pumpkin

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ABSTRACT: The pumpkin is an important kitchen garden crop with very high nutritional value and long lifetime for storage and lot of fiber that acts as one of the best preventive factors from morbid obesity, hypertension, and cardiac diseases. As pretreatment for dehydration, osmotic dehydration creates maximum possible quality in the product by transfer of water outside the tissue of the nutrient. In this study, pumpkin slices with dimensions of 1cm³ were immersed in edible coatings of carboxy methyl cellulose CMC (0.5, 1, 2%), and pectin (1, 2, 3%) for 30s and then they were put into sucrose osmotic solution (weight concentration 50 and 60%) by observance of weight ratio 10:1 (osmotic solution/ sample) for 3h and then in oven (80°C) in final drying for 3h. dried samples were analyzed in terms of lost water, absorption of solid materials, tissue hardness, and color. Sense assessment was done by 9 professional and expert raters via 5-point hedonic scale. To analyze data, 13 treatments were utilized with 3 iterations (12 treatments and one control sample) by means of factorial test within fully randomized design and Duncan's multiple-range test. The amount of lost water was reduced in pumpkin slices by increase in concentration of carboxy methyl cellulose and pectin and sucrose osmotic solution. As concentration of carboxy methyl cellulose and pectin was added, the amount of absorbed substance was increased in pumpkin slices and by increase in concentration of sucrose osmotic solution, rate of absorbed substance was reduced in pumpkin slices. Tissue hardness was decreased by rising concentration of pectin. The mean difference in total color (ΔE) was increased following to increase in concentration of carboxy methyl cellulose, pectin, and sucrose osmotic solution. There was totally significant difference in concentration percent and type of edible coating and osmotic solution in terms of sense assessment of pumpkin slices ($p < 0.01$). Treatment C1S2 with coating 0.5 w/w of edible and dehydrated carboxy methyl cellulose solutions including 60% of sucrose osmotic solution lost the maximum amount of water and it comprised of minimum amount of absorbent substance and it was introduced as premium treatment.

Keywords: Carboxy methyl cellulose; Edible coating; Osmotic dehydration; Pectin; Pumpkin

INTRODUCTION

Edible coatings and films can be defined as thin layer of nutrients which are placed on surface of nutrient by im-

mersing, spraying, and wrapping and protect nutrient from gases, water steam, soluble solid materials, and mechanical blows. Compared to control samples, the

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given product by means of combination of edible coating and osmotic dehydration process possesses more suitable organoleptic properties after complementary drying by hot air.

The important factors that are involved in selection of suitable edible coating for nutrient before osmotic dehydration process are as follows: appropriate and strong resistance of gel, favorable sense assessment properties (color and smell), potential to form film easily and quickly, high permeability potential against water and low permeation coefficient versus soluble solid materials as well as insoluble substances in osmotic solution (Khin, *et al.*, 2005). One can refer to some of consumed polysaccharide materials in coating such as corn and potato starch, amylopectin, pectin, carboxy methyl cellulose, sodium alginate, and methyl cellulose (Seraji, *et al.*, 2012). The carboxy methyl cellulose (CMC) is produced by reaction among cellulose and sodium hydroxide and chloroacetic acid and the related films possess favorable physical properties such as relatively high mechanical properties and transparent (Mohammadi, *et al.*, 2013). The carboxy methyl cellulose is a white color, odorless, colorless, and tasteless powder and suspendible in cold and hot water and non-fermentable under normal conditions (Lazaridou, *et al.*, 2007).

Pectin is a derivative sucrose- acid polymer that is extracted from existing plant gelatinous structures in fruits and vegetables. The used pectin in food industry is defined as polymer including galactorunic acid units (Khodaparast, *et al.*, 2008).

Fruits and vegetables are assumed as the healthiest and most nutritional foods. Pumpkin is also a kitchen garden product with very high nutritional value and very long lifetime of storage as well. This product includes a lot of fiber that is one of the best inhibitors from morbid obesity, hypertension, and cardiac diseases. American Heart Association for cardiac patients recommends daily consumption of 25-30g natural fiber to their patient and healthy people in society to prevent from cardiac complication (Yasaei, *et al.*, 2011).

The effect of carboxy methyl cellulose and pectin coatings and osmotic pretreatment was examined on pumpkin slices in this study before drying by hot air to improve quality of dried product and their qualitative properties were analyzed.

MATERIALS AND METHODS

Materials

Preparation of edible coating solutions

CMC solution was prepared with concentrations 0.1, 0.2, and 0.3% as follows: Initially, a beaker including certain amount of distilled water was put on heater and heated to reach temperature 60-70°C. Then, specific quantities of CMC were added to above solution with respect to any test for several times and within certain time intervals and simultaneously it was stirred up by magnet. After solving all of CMC in water, a transparent solution was produced and was cooled by water bath and ice up to temperature 40±2°C (Ghanbarzadeh, *et al.*, 2010). Pectin solution was also prepared with concentrations 1, 2, and 3% by this technique (Ghanbarzadeh, *et al.*, 2010).

Preparation of samples

Primarily, pumpkin was washed, peeled and sliced in cubic form (1cm³). Afterwards, samples were washed by distilled water and dried by filtering paper. After weighting, the prepared samples were immersed in a solution including 0.5, 1, and 2% carboxy methyl cellulose and 1, 2, and 3% pectin w/w for 30s. After removal of surface moisture, samples were put into oven under temperature 70°C for 10min. the coated samples were transferred to a beaker including sucrose osmotic solution with weight concentration of 50 and 60% sucrose (Khodaparast, *et al.*, 2008) and they were transferred with observance of weight ratio 10:1 (osmotic solution/ sample) for 3h. The surface moisture was removed from samples by filtering paper after exiting from osmotic solution and then they were weighted and put into oven at temperature 80°C for 3h. The control sample was directly transferred to oven without coating and osmotic treatment (Seraji, *et al.*, 2012). Then dried samples were analyzed in terms of amount of lost water, absorption of solid materials, tissue hardness, color, and sense assessment properties (appearance, taste, smell, color, tissue, and general approval). Research treatments were prepared as follows listed briefly in Table (1).

Methods

Tests were conducted according to the methods in

Table 1. Research treatments

Rows	Property	Characteristic
1	Control sample (without coating and without osmotic dehydration)	C
2	Control sample (without coating and without osmotic dehydration)	C1s1
3	Coating with concentration 1% of CMC solution + concentration 50% sucrose osmotic solution	C2S1
4	Coating with concentration 2% of CMC solution + concentration 50% sucrose osmotic solution	C3S1
5	Coating with concentration 0.5% of CMC solution + concentration 60% sucrose osmotic solution	C1S2
6	Coating with concentration 1% of CMC solution + concentration 60% sucrose osmotic solution	C2S2
7	Coating with concentration 2% of CMC solution + concentration 60% sucrose osmotic solution	C3S2
8	Coating with concentration 1% of pectin solution + concentration 50% sucrose osmotic solution	P1S1
9	Coating with concentration 2% of pectin solution + concentration 50% sucrose osmotic solution	P2S1
10	Coating with concentration 3% of pectin solution + concentration 50% sucrose osmotic solution	P3S1
11	Coating with concentration 1% of pectin solution + concentration 60% sucrose osmotic solution	P1S2
12	Coating with concentration 2% of pectin solution + concentration 60% sucrose osmotic solution	P2S2
13	Coating with concentration 3% of pectin solution + concentration 60% sucrose osmotic solution	P3S3

Table (2).

Water loss = Sample weight after osmosis – initial weight/ initial weight of sample × 100 (1)

Solid gain = Dry weight of sample after osmosis – Dry weight of control sample / Initial weight of sample × 100 (2)

Measurement of tissue hardness: Resistance of tissue against shear force was measured by histometer (Instran) Hansfeild model so that SS expressed (tissue resistance against shear force), F (vertical force exerted

on surface of tested treatment), d (diameter of exerted surface by force equivalent to diameter of device probe as 4.6mm under conditions of doing test), and L (thickness of sample at point of exertion of maximum force) (Farzaneh, *et al.*, 2013).

$$SS = F / \pi . D . L \quad (3)$$

Colorimetry: The color of shell was measured by Hunterlab device and determination of three indices (a*, b*, and L*). L* index denotes brightness of sample and this ranges varies from zero (pure black)

Table 2. Research tests

Test	Operation technique	Reference
Tissue hardness	Use of histometer (tissue gauge)	(Farzaneh, et al., 2013)
Color	Image processing technique	(Seiiedlou, et al., 2010)
Water loss quantity	Weighting (Formula 1)	(Sunjka and Raghavan, 2015)
Solid gain	Weighting (Formula 2)	(Sunjka and Raghavan, 2015)
Sense assessment	5- point hedonic scale	(Seraji, et al., 2012)

to 100 (pure white). a* index indicates proximity of sample color to green and red colors. The range of this index varies from -120 (pure green) to +120 (pure red). b* index shows proximity of sample color to blue and yellow colors and the given range varies from -120 (pure blue) to +120 (pure yellow). Similarly, total color difference (ΔE) was calculated by Eq. (4) (Seiiedlou *et al.*, 2010).

$$\Delta E = \sqrt{(L^* - L)^2 + (a^* - a)^2 + (b^* - b)^2} \quad (4)$$

-Sense assessment: This test was carried out by 9 professional and expert raters according to 5- point hedonic scale (Seraji, *et al.*, 2012).

Factorial test was utilized within totally random project to analyzed data. This analysis included 13 treatments (12 treatments with one control treatment). Duncan’s multiple-range test was employed for determination of difference between means at significance level 95%. Likewise, SAS software (version 9.2) was utilized for statistical analysis.

RESULTS AND DISCUSSION

Analysis on results of water loss test

With respect to aforesaid results, it was characterized in Diagram (1) that the amount of water loss in coated samples of pumpkin slices with edible pectin solution was significantly smaller than in coated samples with edible carboxy methyl cellulose solution ($p \leq 0.05$). The amount of water loss in pumpkin slices was significantly reduced by increase in percentage (w/w) of carboxy methyl cellulose solution. Similarly, quantity of water loss was significantly reduced by increase of percent (w/w) of pectin solution ($p \leq 0.05$). The amount of water loss was reduced in pumpkin slices following

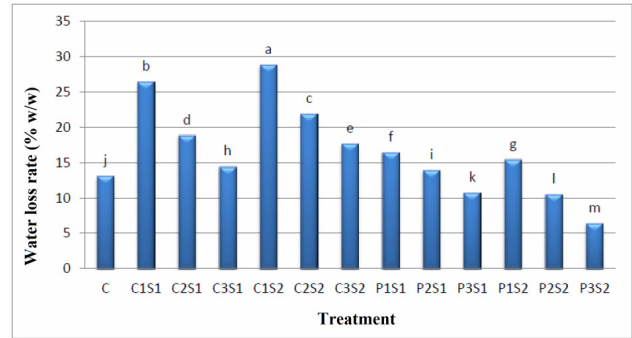


Diagram 1. Effect of treatment on rate of water loss

to rising percent (w/w) of concentration of sucrose osmotic solution. The rate of water loss (WL) is highly favorable in osmosis process (Seraji, *et al.*, 2012).

Seraji, *et al.*, (2012) explored effect of edible coating on carboxy methyl cellulose- ascorbic acid base and osmotic dehydration in drying squash. The results of their investigation indicated that carboxy methyl cellulose-base coating reduced amount of solid gain without reductive impact on rate of dehydration so their given findings were consistent with the results of present research that expressed effect of carboxy methyl cellulose-base coating on rate of water loss in pumpkin.

Sabetghadam and Tavakolipour, (2014) examined optimization of process of drying apple and seasoning and coating them by carboxy methyl cellulose. The given results indicated by addition of coating concentration, rate of water loss increased while quantity of water loss was decreased in osmotic dehydration of pumpkin slices as concentration of carboxy methyl cellulose increased so that osmotic sucrose solution may be assumed as reason.

Akbarian, *et al.*, (2015) explored effect of antioxidant polysaccharide coatings on optimal immersing time, vitamin C-content, and absorption of salt in quince slices during osmotic dehydration. They expressed application of active coating of carboxy methyl cellulose-base,

Table 3. Sense assessment form (Seraji, *et al.*, 2012)

Highest score = 5	Lowest score = 1
The assessed qualitative factors	
Appearance	
Smell	
Taste	
Tissue	
Color	
General approval	

pectin, and with ascorbic acid might improve osmotic dehydration efficiency coefficient and rising water loss in osmotic dehydration of quince slices. Their findings were consistent with the result of current research.

In a study, Lombard, *et al.*, (2008) examined effect of osmotic dehydration on loss of fruit juice of pineapple. They implied water loss was increased by rising temperature and concentration of osmotic solution. Their findings differed from the given results in current research that expressed reduction of water loss following to increase in percent of concentration of sucrose osmotic solution thus application of carboxy methyl cellulose and pectin coatings might be considered as the reason for this difference.

In a survey, Sunjka and Raghavan, (2015) assessed difference in pretreatment techniques for drying cornelian cherry. The results indicated that the best status for studied parameters was when cornelian cherry seeds were divided into four pieces. Time and concentration of osmotic solutions increased noticeably removal of moisture and sugar absorption.

Review on results of quantity of absorbent substance

With respect to the given results, it was identified in Diagram (2) that the quantity of absorbed substance in coated samples with edible pectin solution was significantly greater than in samples coated by edible carboxy methyl cellulose solution ($p \leq 0.05$). The amount of absorbed substance in pumpkin slices was significantly increased by rising percent (w/w) of carboxy methyl cellulose solution. Similarly, quantity of absorbed substance in control sample was increased by rising percent (w/w) of pectin solution ($p \leq 0.05$). The quantity of absorbed substance in pumpkin slices was reduced by increase in percent (w/w) of concentration

of osmotic sucrose solution. Small solid gain (SG) is assumed as favorable in osmosis process (Seraji, *et al.*, 2012). Yazdanpanah, *et al.*, (2013) explored use of osmotic pretreatment for drying of nutrients with hot air. The given results from various sources indicated that rise of studied parameters was led to increase in amount of sold gain in osmotic process and this finding was consistent with results of present research.

Aslnejadi, *et al.*, (2015) examined effect of osmotic dehydration pretreatment on qualitative properties of white button mushroom dried by hot air. The results showed that solid gain was increased following to rise of concentration of osmotic solution and this finding contradicted to results of present research that expressed reduction in rate of solid gain was accompanied to increase in rate of sucrose osmotic solution and this reason might be attributed to use of carboxy methyl cellulose and pectin coatings as pretreatment before osmotic dehydration.

In a study, Garcia, *et al.*, (2010) explored effect of chitosan coating on osmotic dehydration process in papaya slices (Red Maradol variety) at both ripe and raw (green) modes. Chitosan coating improved efficiency of dehydration process in both samples of papaya (ripe and raw) and reduced solid gain so that this finding was consistent with the given results that expressed effect of using amount and type of carboxy methyl cellulose and pectin coatings on solid gain in osmotic dehydration of pumpkin slices.

Analysis on results of tissue hardness

With respect to the given results, it was characterized in Diagram (3) that tissue hardness was greater in the coated samples with edible pectin solution than in coated samples with edible carboxy methyl cellulose.

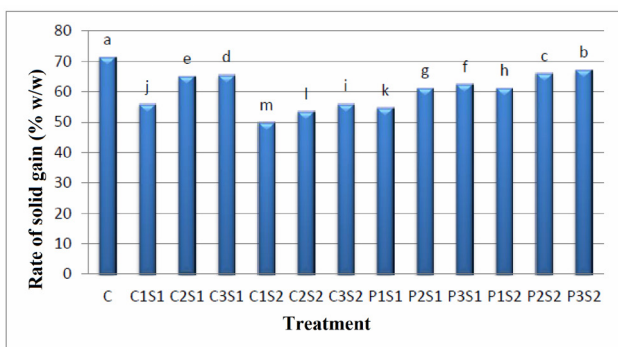


Diagram 2. Effect of treatment on rate of sold gain

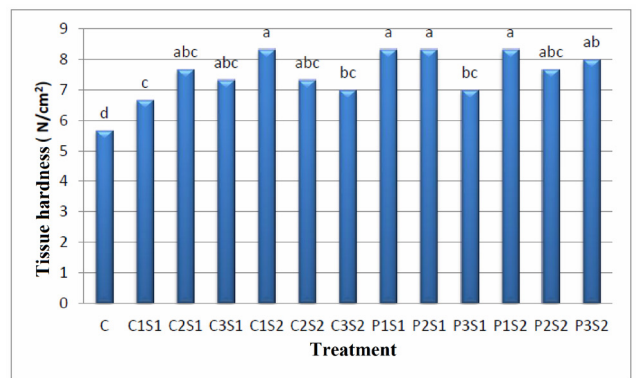


Diagram 3. Effect of treatment on tissue hardness

There was no change in hardness rate among defined samples with 0.5 to 1% increase in carboxy methyl cellulose solution but hardness level was reduced in sample including 2% (w/w) of carboxy methyl cellulose solution although this reduction was not significant ($p \geq 0.05$). Tissue hardness was decreased following to rising percent (w/w) of pectin solution. Percent of concentration of sucrose osmotic solution showed no significant difference versus tissue hardness in pumpkin slices ($p > 0.05$).

Farzaneh, *et al.*, (2013) explored effect of edible coating and techniques for drying on physical and thermodynamic properties of apple. The maximum resistance of tissue was related to the coated frozen coating. The sample without coating possessed less tissue resistance since rise of sucrose absorption is led to reduction of elasticity of tissue and this finding was consistent with the results which expressed reduced tissue hardness in treatment without coating.

Pani, *et al.*, (2008) examined effect of osmotic process and osmotic solution compound on physical, chemical, and synthetic properties of drying and disintegration of structure and color changes in dried tomato slices in hot air. Enrichment of sugar contributes to slow shrinkage of tomato slices during first phase of drying. Adding calcium helped to keeping the surface. This finding was aligned with the given results which implied rise of tissue hardness in treatments coated with carboxy methyl cellulose and pectin.

Analysis on color results

With respect to the aforesaid results, it was identified in Diagram (4) that the mean rate of L-color element was added significantly by increase in percent (w/w)

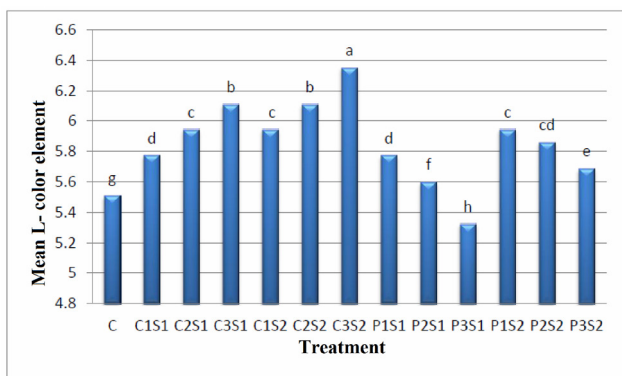


Diagram 4. Effect of treatment on mean rate of L-color element

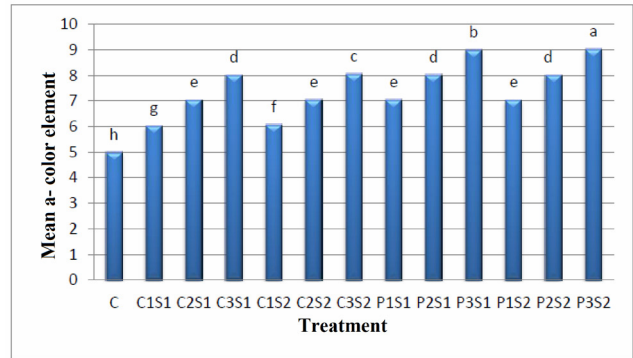


Diagram 5. Effect of treatment on mean value of a-color element

of carboxy methyl cellulose solution ($p \leq 0.05$). Similarly, L- color element of pumpkin slices was smaller in samples coated with edible pectin solution than in coated samples with edible carboxy methyl cellulose solution. Mean rate of L- color element was increased in pumpkin slices following to rise of percent (w/w) in concentration of osmotic sucrose solution.

With respect to the given results, it was characterized in Diagram (5) that the mean value of A-color element was added significantly by rising percent (w/w) in carboxy methyl cellulose solution ($p \leq 0.05$). Likewise, mean rate of a-color element was significantly increased following to rise (w/w) of pectin solution ($p \leq 0.05$). The mean rate of a-color element was added in pumpkin slices by increase percent (w/w) of concentration in osmotic sucrose solution.

Given aforesaid results, it was identified in Diagram (6) that as mean rate of b-color element was significantly added, percent (w/w) of carboxy methyl cellulose solution increased ($p \leq 0.05$). Similarly, mean rate of b-color element was increased significantly in pumpkin slices by rise of percent (w/w) in pectin so-

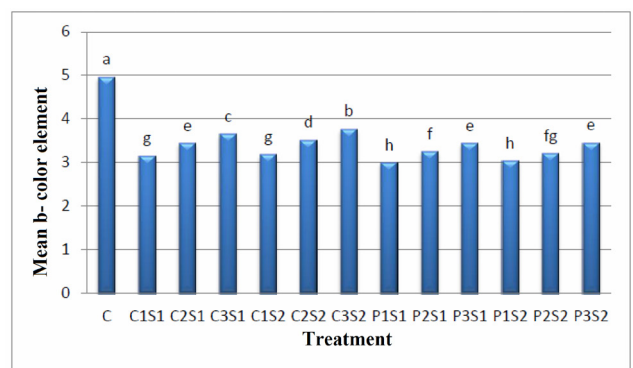


Diagram 6. Effect of treatment on mean value of b-color element

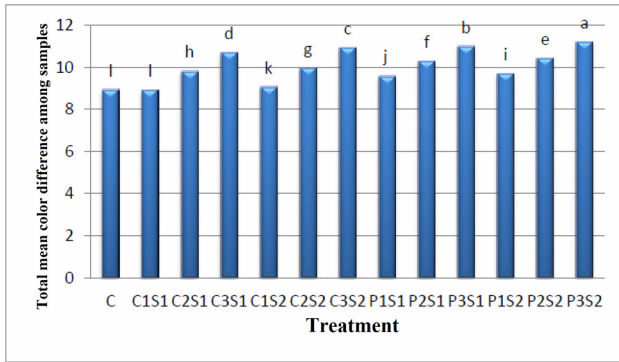


Diagram 7. Effect of treatment on total mean color difference among samples

lution ($p \geq 0.05$). Mean value of b-color element was added in pumpkin slices as percent (w/w) of concentration increased in osmotic sucrose solution.

With respect to the given results, it was identified in Diagram (7) that total mean color difference (ΔE) was added significantly by rise of percent (w/w) of carboxy methyl cellulose solution ($p \leq 0.05$). Likewise, total mean color difference increased significantly in pumpkin slices following to rise of percent (w/w) in pectin solution ($p \leq 0.05$). The total mean color difference was added in pumpkin slices as percent (w/w) concentration increased in osmotic sucrose solution.

Seraji, *et al.*, (2012) explored effect of edible coating with carboxy methyl cellulose-ascorbic acid base and osmotic dehydration on drying squash. Their results showed that the coated and dehydrated samples by osmotic technique possessed higher quality than controlled samples in terms of color and this finding was consistent with the given results in the present research.

Tahmasebipour, *et al.*, (2014) analyzed change in color parameters including during process of drying pretreated grape yellow- red (a) and (b), (L) rate of brightness by ultrasound at three periods (10, 20, and 30min), and carboxy methyl cellulose (CMC) in three concentrations (0.1, 0.2, and 0.3%). The given results showed that rates of b and L elements were reduced and a- element was increased as moisture content was decreased during drying process. Use of two ultrasound and CMC pretreatment improved color indices (total color change) in samples compared to control treatment and this finding was consistent with the results of present research that expressed minimum total mean color difference in coated treatment by carboxy methyl cellulose.

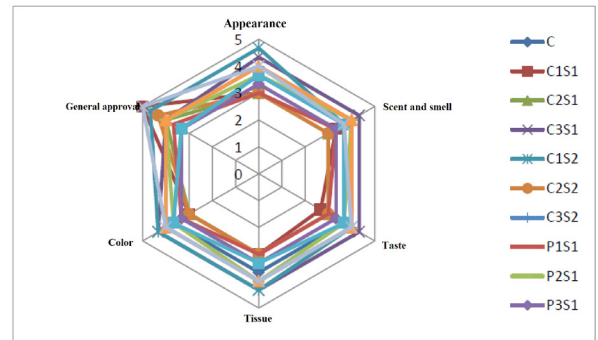


Diagram 8. Effect of treatment on sense assessment of pumpkin slices

Analysis of sense assessment results

With respect to the aforesaid results, it was characterized in Diagram (8) that there was totally significant difference in terms of concentration percent and type of edible coating versus sense assessment of appearance, scent and smell, taste, tissue, color, and general approval of pumpkin slices ($p < 0.01$). There was completely significant difference among percent concentration of osmotic solution and sense assessment of appearance, taste, tissue, and color of pumpkin slices ($p < 0.01$) but no significant difference was shown in terms of sense scores of scent and smell and total approval ($p > 0.05$).

Mohammadpour and Fatemian, (2014) studied on osmotic dehydration of mango fruit. The results of sense testing of color and taste indicated the color and taste of osmotic samples were better than in control sample that was consistent with the given results.

In a survey done by Konopacka, *et al.*, (2009) they analyzed effect of various osmotic factors on approval of cranberry, black grape, and apple (dried- osmotic and osmotic- lyophilized). The osmotic- dried fruits were produced and analyzed in terms of sense profile. The results indicated that the osmotic solutions were noticeably effective on taste and tissue of dehydrated fruits and they might change level of sense approval and acceptance of them. This issue was consistent with the results came from the current research.

GENERAL CONCLUSIONS

The rate of water loss reduced in pumpkin slices by increase in percent of carboxy methyl cellulose solution

and pectin and osmotic sucrose solution. The amount of solid gain increased in pumpkin slices by rise of percent (w/w) of carboxy methyl cellulose solution and pectin while the rate of solid gain decreased in pumpkin slices following to rise of concentration percent (w/w) in osmotic sucrose solution. Tissue hardness reduced in pectin as percent (w/w) was increased in pectin solution. Mean L- color element was added by increase in percent (w/w) in carboxy methyl cellulose solution and mean L- color element decreased in pumpkin slices as percent (w/w) of pectin solution increased. Similarly, the mean L- color element increased in pumpkin slices following to rise of concentration percent (w/w) of osmotic sucrose solution. Mean a-color element increased by rising percent (w/w) of carboxy methyl cellulose solution, pectin, and osmotic sucrose solution. Mean b-color element increased following to rise of percent (w/w) of carboxy methyl cellulose solution, pectin, and osmotic sucrose solution. Total mean color difference (ΔE) was added with rise in percent (w/w) of carboxy methyl cellulose solution, pectin, and osmotic sucrose solution. Concentration percent and type of edible coating and osmotic sucrose solution had totally significant difference from sense assessment of appearance, scent and smell, taste, tissue, color, and general approval of pumpkin slices ($p < 0.01$). C1S2 treatment was introduced as premium treatment with 0.5% coating of carboxy methyl cellulose and dehydrated by 60% of osmotic sucrose solution that included maximum water loss and least amount of sold gain.

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