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Research Article

Thermal Stability and Fat Uptake of Fried Zucchini (*Cucurbita pepo*) Cuttings Coated with Apricot Gum

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The effect of apricot gum-based edible coating at different concentrations (0, 8, 10, and 12%, w/w) during deep-fat frying of zucchini cuttings were evaluated. Physicochemical properties such as moisture, oil uptake, frying yield, coating pick-up, color, vitamin C, shrinkage, oxidation parameters, and sensory properties were determined. The results showed that coating with apricot gum had a significant effect on moisture and oil contents and the frying yield of zucchini cuttings ($P < 0.05$). The highest coating pick-up was observed in the coated sample with 12% gum (S12). Coating with apricot gum resulted in more preservation of vitamin C in fried zucchini cuttings. The lowest shrinkage and ΔE was also observed in the coated samples. The fried coated samples had lower hydrolysis and oxidation rate (acid, peroxide, and anisidine values) during storage. The coated samples had a good overall acceptability similar to the control treatment. In conclusion, apricot gum due to thermal stability, good properties, and its facility to use, suggested for coating and usage in industrial fried zucchini cuttings production.

1. Introduction

Deep fat frying is a thermal processing technique that is defined by the immersing of food in edible oils above the boiling temperature of water. During this process, mass and heat transfer occur simultaneously and some biochemical reactions such as discoloration, protein denaturation, loss of volatile compounds, and Maillard reaction to occur [1]. Today, acrylamides formation as potential carcinogenic agents is important to control this process. Therefore, these factors can reduce the quality of the final product and reduce consumer acceptance. Moreover, reducing the absorption of oil is one of the most important factors in the quality control of the final process. One of the precursors used before frying is coating with hydrocolloids compounds [2].

Hydrocolloids as barrier agents on the reduction of oil absorption have been used [3]. Due to the importance of hydrocolloids in the food industry and the high price of these compounds, attention to native and plant gums has increased dramatically. Many shrubs and trees produce a gum-like liquid that dries in the presence of air and sunlight. Gum arabic, peach and apricot gum, tragacanth, karaya, peach, and apricot are among this group of gums. The secreted gums are among the first stabilizers, emulsifiers, and food stabilizers [4].

One of these polysaccharide hydrocolloids is apricot gum, which can be used in food formulations. Apricots (*Prunus armeniaca* L.) belong to the genus *Rosaceaea* and are native to China and Siberia [5]. The gum is composed of xylose, arabinose, and galactose. In addition, the presence of mannose, glucuronic acid, and methyl glucuronic acid in the structure of this gum was identified [4].

Zucchini (*Cucurbita pepo*) is one of the most vulnerable agricultural crops. It is a rich source of vitamins C, K, thiamine, and riboflavin. Studies show that zucchini contains good antioxidants and antiaging compounds [6].

Various studies on frying food products have been published. Coating potatoes with hydrocolloids or modified starches is a secondary way to reduce oil absorption during frying. Adding cellulose or cellulose derivatives reduces oil absorption due to the properties of thermal gelatinization and film formation [2]. Eissa et al. [7] studied the optimization of oil reduction in fried eggplant cuttings with carboxymethyl cellulose and chitosan. The results showed that the treated sample with chitosan had less oil absorption than the coating of the samples with carboxymethyl cellulose. Daraei et al. [8] investigated the application of edible coatings and hydrocolloids to produce low-fat fried potato slices. The results showed that the coated samples with xanthan gum and pectin and the mixture of pectin and carboxymethyl cellulose had the highest moisture content. Nyun Kim et al. [9] studied hydrocolloids coatings on heat transfer and oil absorption during deep frying of potato pieces. The results showed that coatings significantly reduced oil absorption and heat transfer coefficients.

Since hydrocolloids have the effect on fried products, the aim of this study was to investigate the effect of coating with apricot gum on the quality attributes of fried zucchini cutting.

2. Material and Methods

2.1. Material. The fresh zucchini (*Cucurbita pepo*; 89% moisture, 0.46% fat, 4.32% ash, 3.17 g protein, 5.8 g carbohydrate, 2.37 g fiber, and 3 mg Vitamin C) was obtained from a local grocery store in Neyshabur province of Iran. Apricot gum with a yellowish-orange appearance (6.7% moisture, 1.62% fat, 2.85% protein, 65.79% carbohydrate, and 4.1% ash) was provided from a traditional store. The sunflower oil (acid value: 0.02 mg/g; peroxide value: 0.5 meq/kg; iodine value: 92.5, and refractive index: 1.43) was used as a frying medium was obtained from Laden Co., (Behshahr, Iran).

2.2. Preparation of Gum Suspensions. The apricot gum was grounded in a grinder (Moulinex, Spain). All of the concentrations of gum (0: control, 8, 10, and 12% *w*/*w*) were dispersed in boiled distilled water (1 : 20 ratio) and homogenized for 20 minutes at 70°C. Then glycerol (1.5%) was slowly added to the gel and the solution was kept at 25–30°C.

2.3. Sample Preparation and Deep Fat Frying. Before frying, zucchinis were removed from the cold and stored at ambient temperature (25–30°C). After washing and peeling with a manual peeler, they were converted to slices of $0.7 \times 0.7 \times 0.5$ cm. Then, zucchini slices dipped in the coating suspensions for 5 minutes. The zucchini slices were subjected to a deep frying process at 180°C for 3 min in a fryer (Teafall, Iran). The fried zucchinis were drained and cooled to room temperature. The samples stored at 4°C for 30 days and the following tests were performed on the fried slices of zucchini [10].

2.4. Moisture Content. Moisture content (MC) was determined by weight loss of fried products, upon drying in an oven at 105°C until a constant weight was reached and was calculated as follows:

$$\mathrm{MC} = \frac{\mathrm{MC\,(after\ coating)} - \mathrm{MC\,(before\ coating)}}{\mathrm{MC\,(before\ coating)}} \times 100, \tag{1}$$

where MC-coated and MC-uncoated are the moisture contents of the coated and uncoated samples, respectively [8].

2.5. Oil Uptake. The oil uptake of fried products was determined using the Soxhlet extraction method (AOAC, 2002). For the extraction of lipid, petroleum ether (Merck, USA) was used for 6 h according to the standard. The reduction of oil uptake was calculated as follows:

$$\mathrm{OU\%} = \frac{\mathrm{LC(after\ coated)} - \mathrm{LC(befor\ coated)}}{\mathrm{LC(after\ coated)}} \times 100, \tag{2}$$

where LC-coated and LC-uncoated are the lipid contents of the coated and uncoated samples, respectively [3].

2.6. Frying Yield Calculations. The percentage of frying yield was obtained according to the following Equation (3):

$$Y(\%) = \frac{CW}{C} \times 10, \tag{3}$$

where CW and C are the weight of the cooked and non-cooked coated samples, respectively [10].

2.7. Coating Pick-up Calculations. Coating pick-up was calculated from the following equation:

$$\mathrm{CP}(\%) = \frac{C - I}{I} \times 100, \tag{4}$$

Where CP is the weight of raw coated zucchini cuttings (g) and I is the initial weight of raw non-coated zucchini cuttings (g) [8].

2.8. Color Analysis. The color parameters (L: lightness, a: redness, and b: yellowness) were measured with a data color, a color reader (Text Flash, USA). Total color difference (ΔE) was calculated from the following equation [11]:

$$\Delta E = \left[\left(\Delta L^2\right) + \left(\Delta a^2\right) + \left(\Delta b^2\right)\right]^{1/2}. \tag{5}$$

2.9. Shrinkage Measurements. Zucchini shrinkage was determined from the following equation using toluene as the immersion medium and the ratio of volume change to the initial volume [12]:

$$S = \frac{V_1 - V_2}{V_1} \times 100, \quad (6)$$

where v_1 is the initial volume of raw coated zucchini cuttings (cm^3) and v_2 is the final volume of cuttings after packaging (cm^3).

2.10. Vitamin C Content. Vitamin C was calculated by titration method with potassium iodide and starch solution using the following relationship:

$$C = \frac{0/88 \times V}{2/5} \times 100, \quad (7)$$

where C is the amount of vitamin C (mg/100 ml) and V is volume of consumed potassium iodide (ml) [13].

2.11. Oxidation Analyses. Acid, peroxide, and anisidine values were determined according to AOCS Cd 3-63, AOCS Cd 8-53, and AOCS Cd18-90 methods, respectively [14–16]. Acid and peroxide values were calculated from titration by sodium hydroxide and sodium thiosulfate, respectively. Anisidine's values were read at 350 nm according to the absorption of the sample (isooctane + oil + anisidine) and control (isooctane + anisidine).

2.12. Sensory Properties. A hedonic 5-point scale was performed by a nontrained sensory panel of 15 members to evaluate texture, color, flavor, and overall characteristics.

2.13. Statistical Analysis. Evaluation of changes: moisture, color, shrinkage, vitamin C, and sensory properties was performed in the form of three-factor factorial experiment, in which: sample type (raw and fried), percentage of apricot gum (0, 8, 10, and 12%), and time (1, 15, and 30 days) were the experimental factors and for other properties (relative changes in oil uptake, frying yield, and coating pick-up) that were examined only in the fried sample or raw sample, two-factor factorial experiment was used. Factors included: percentage of apricot gum (0, 8, 10, and 12%) and time (1, 15, and 30 days). Mean comparison for each trait at 5% level was analyzed using SAS statistical software and Duncan's test.

3. Results and Discussion

3.1. Moisture Content. As can be seen from Table 1, raw zucchini cuttings had higher moisture content in comparison with fried slices. The concentration of apricot gum had a significant effect on the moisture content of zucchini cuttings after deep frying ($P < 0.05$). So the maximum moisture content of zucchini cuttings was observed with a significant difference ($P < 0.05$) in the coated samples with 12% gum (S12) and the control samples had the least moisture content after deep frying. The results also showed that the moisture content of coated and uncoated zucchini cuttings decreases with time.

Water retention in apricot-coated zucchini slices can be due to water retention of hydrocolloids and the hydrogen bonding between the molecules in the coating (gum) and their ability to form thermal gels during frying, which acts as a barrier against moisture and reduces the rate of mass transfer phenomena. Coating with hydrocolloids due to their barrier properties led to a decrease in water loss during frying. Moisture retention increases with increasing gum concentration. This could be due to the increased thickness of the film or thermal gel formed by the crosslinking. Crosslinking and the formation of thermal gel during frying promotes the pores formation at the surface, leading to a reduction in mass transfer [17–19].

Our results are in agreement with previous studies that used coating for fried foods [20, 21]. The results showed that coating before frying increase the moisture content of foods.

3.2. Oil Uptake. Figure 1 showed the concentration of apricot gum had a significant effect ($P < 0.05$) on the oil absorption of zucchini slices after frying. So that the maximum amount of oil uptake was observed in control samples (S0) after deep frying with a significant difference ($P < 0.05$) and the coated sample with 12% gum (S12) had the lowest oil uptake after frying. The results also showed that the oil uptake of coated and uncoated zucchini cuttings increases with time.

Recent research has shown that oil absorption during frying is a superficial phenomenon. When the water evaporates, the oil penetrates instead of the evaporated water. Edible coatings before frying help to reduce moisture and oil transfer during frying. Hydrocolloids increase water holding capacity with trapping moisture inside and preventing the replacement of water by oil. So the amount of moisture is an important factor in determining the amount of oil absorption during frying. Therefore, increase in water loss, led to the highest amount of oil absorption in the final product [11]. The reduction in oil absorption in coated samples is related to the barrier property of the hydrocolloids of apricot gum [19].

In a similar study, Ananey-Obiri et al. [20] reduced fat-uptake to 35–60% using chicken protein coating on chicken, and García et al. [3] succeeded in reducing oil absorption by 40% using MC coating during frying.

Oil absorption and moisture loss are the two main factors in the mass transfer phenomenon during deep frying [8]. The high temperature during frying leads to the gradual evaporation of water, and according to the mass transfer mechanism, the oil is absorbed through the food [22]. In fact, there is a relationship between oil absorption and moisture content of samples during frying. The characteristics of coatings in terms of oil absorption depend on the amount of moisture, low permeability to moisture, and thermal gel formation with crosslinking [23]. There are many examples of reduced oil absorption by using coatings or pastes. For example, Akdeniz et al. [10] studied the effect of hydrophobic propyl cellulose, guar, and xanthan gum on the quality of fried carrot slices.

Furthermore, the use of guar gum is reported to decrease the oil content of fried sev by 9% [24] and fried papad by 16% [25]. Thus, the reduction of oil uptake by the

Table 1: Effect of coating with apricot gum on moisture content of zucchini cuttings during 30 days.

Treatment	Raw Storage time (days) 1	15	30	Fried Storage time (days) 1	15	30
Control	90.05 ± 1.62[a]	80.52 ± 0.65[de]	70.74 ± 0.95[hi]	85.38 ± 1.27[b]	78.03 ± 1.45[ef]	67.82 ± 1.09[i]
S8	90.22 ± 1.5[a]	83.63 ± 1.23[bcd]	75.54 ± 0.78[fg]	88.95 ± 0.98[a]	81.54 ± 0.86[cd]	74.02 ± 1.43[gh]
S10	90.72 ± 0.59[a]	84.04 ± 1.54[bc]	76.81 ± 0.69[fg]	89.05 ± 1.12[a]	82.32 ± 0.92[bcd]	75.56 ± 0.44[fg]
S12	91.25 ± 0.47[a]	85.560.97[b]	77.45 ± 1.68[ef]	89.54 ± 1.22[a]	83.66 ± 1.08[bcd]	76.83 ± 0.71[fg]

S0 (control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

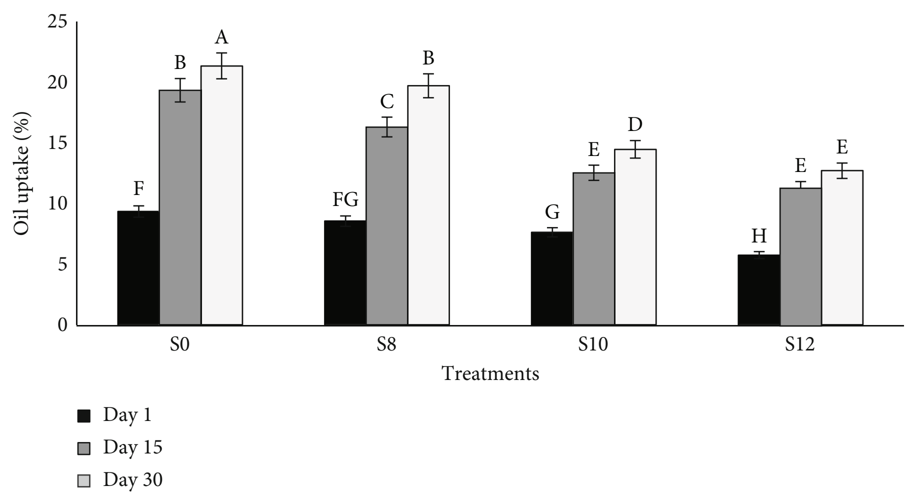

Figure 1: Effect of coating with apricot gum on oil content of zucchini cuttings during 30 days. S0 (control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

hydrocolloids depends on several factors, including the type of food matrix. Susanne and Gauri [26] showed that the use of hydrocolloids such as cellulose, pectin, and whey protein isolate reduced the absorption of oil in fried cereal products. Parimala and Sudha [27] reported that the sample containing guar gum had the highest moisture content and the lowest oil absorption.

Several studies have shown that many long-chain polymeric hydrochlorides, especially cellulosic derivatives, form gels that can be used in the frying process to reduce fat absorption. Garcia et al. [3] used methylcellulose and hydroxylpropyl methylcellulose to potato slices coating to reduce the oil uptake during frying. Coating with methylcellulose was more effective in reducing oil absorption than hydroxylpropyl methylcellulose. Coated potato with protein had the lowest fat absorption [27]. Oil absorption mainly occurs during the post frying or cooling period [28].

3.3. Frying Yield. Figure 2 showed the concentration of apricot gum had a significant effect ($P < 0.05$) on the frying yield of zucchini cuttings. So the maximum amount of frying yield of slices was observed with a significant difference ($P < 0.05$) in coated sample with 12% gum (S12) and control samples (S0) had the low frying efficiency. The results also showed that the oil uptake of coated and uncoated zucchini cuttings decreases with time.

By increasing the apricot gum concentration, the yield of frying increased, due to the barrier effects of the coating. Edible coatings form a hydrophilic layer during frying, which prevents water loss and oil penetration. In this process, due to the occurrence of heat transfer phenomena from oil to food, as well as the mass transfer between oil and food, several physical and chemical changes occur, such as water loss, migration of soluble substances, oil penetration, and mechanical deformation such as shrinkage, expansion, matrix changes, and crust formation [29]. According to the results, it can be said that by coating the zucchini, the weight of the product is more, which is due to the ability of apricot gum to water retention of the product. Due to the barrier properties of hydrocolloids and preventing of water loss, the final weight of the product will be higher in comparison with noncoated samples. These results are in agreement with the results of Daraei et al. [8] and Karimi and Kenari [30].

3.4. Coating Pick-up. The concentration of apricot gum had a significant effect on the coating pick-up ($P < 0.05$). So the maximum coating pick-up of zucchini cuttings with a significant difference was observed in coated sample with 12% gum (S12).

Coating pick-up is related to high-moisture content values [10]. Increasing the concentration of apricot gum generally increases the coating pick-up, due to the high

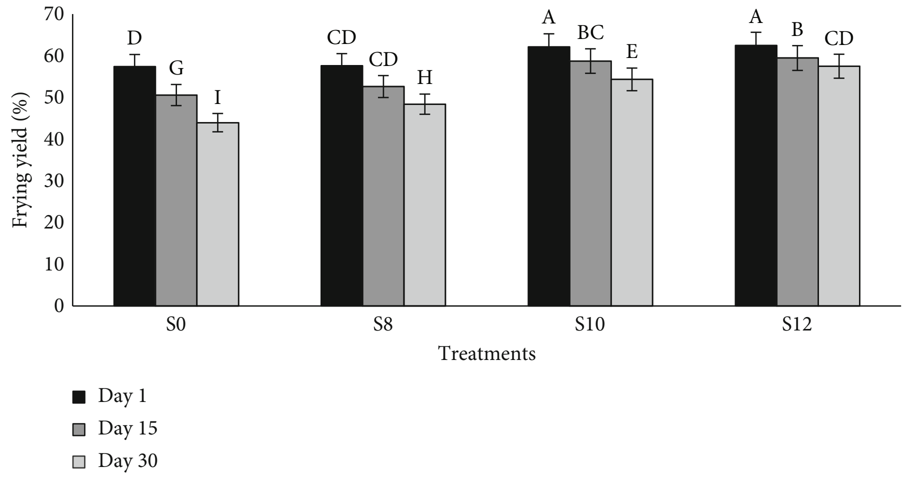

Figure 2: Effect of coating with apricot gum on frying yield of zucchini cuttings during 30 days. S0 (control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

Table 2: Effect of coating with apricot gum on ΔE of zucchini cuttings during 30 days.

Treatment	Raw Storage time (days)			Fried Storage time (days)		
	1	15	30	1	15	30
S0	0.00 ± 0.00^{n}	34.09 ± 1.12^{c}	44.97 ± 0.47^{a}	0.00 ± 0.00^{n}	27.57 ± 0.33^{e}	41.54 ± 0.22^{b}
S8	6.76 ± 0.21^{m}	24.94 ± 0.82^{fg}	33.34 ± 0.21^{c}	6.01 ± 0.16^{m}	20.37 ± 0.41^{i}	30.29 ± 1.05^{d}
S10	7.86 ± 0.15^{m}	13.23 ± 0.22^{kl}	26.41 ± 0.74^{ef}	7.33 ± 0.11^{m}	16.02 ± 0.15^{j}	24.43 ± 0.28^{fg}
S12	8.10 ± 0.08^{m}	10.90 ± 0.18^{l}	23.77 ± 0.17^{gh}	7.42 ± 0.21^{m}	15.48 ± 0.11^{jk}	21.35 ± 0.88^{hi}

S0 (control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

strength of gum gel formation [8]. Similar results were obtained by Baixauli et al. [31] for dextrin at concentrations of 1.5, 4.5, and 7.5%.

3.5. Color Measurement. As can be seen from Table 2, raw zucchini cuttings had higher ΔE values in comparison with fried slices. The concentration of apricot gum had a significant effect on ΔE ($P < 0.05$). So the maximum ΔE values belonged to control samples and the coated samples had low ΔE values. The results also showed that ΔE values of coated and uncoated zucchini cuttings increase with time.

Significantly, ΔE values were in coated samples, is probably related to the reduced amount of oil uptake during the frying process [32]. Edible coating can help to improve the appearance in maintaining the structure and color of fruits and vegetables. The higher ΔE in uncoated samples were associated with browning reactions, oxidation, etc.

In general, enzymatic browning and nonenzymatic browning, including Millard, can be mentioned as effective factors in changing the color of fruits and vegetables during storage and processing. The high temperature and low moisture content of the samples play an essential role in the Maillard reaction [11]. Edible coatings can delay the progress of the enzymatic browning reaction by reducing oxygen contact [11].

3.6. Shrinkage Measurements. Table 3 showed that raw zucchini cuttings had higher shrinkage in comparison with fried slices. The concentration of apricot gum had a significant effect on shrinkage ($P < 0.05$). So the maximum shrinkage of zucchini cuttings belonged to control samples and the coated samples had minimal shrinkage. The results also showed that the shrinkage of coated and uncoated zucchini cuttings increases with time.

Most foods, with high moisture content, will shrink during frying. Coatings due to their barrier effects, maintain more moisture content, and reduces shrinkage of samples [33–35]. This result agrees with the effect of frying on potato shrinkage reported previously [34]. Rahman [36] reported that shrinkage is dependent on initial the moisture content, composition, and size of food.

3.7. Vitamin C Content. The raw zucchini cuttings had higher vitamin C content in comparison with fried slices (Table 4). The concentration of apricot gum had a significant effect on the vitamin C content of zucchini cuttings after frying ($P < 0.05$). So the maximum amount of vitamin C in zucchini cuttings was observed with a significant difference ($P < 0.05$) in coated sample with 12% gum (S12) and control samples (S0) had the lowest vitamin C levels after deep frying. The results also showed that vitamin C content

Table 3: Effect of coating with apricot gum on shrinkage of zucchini cuttings during 30 days.

Treatment	Raw Storage time (days) 1	15	30	Fried Storage time (days) 1	15	30
S0	0.00 ± 0.00^{k}	37.27 ± 0.56^{bcd}	43.49 ± 0.32^{a}	20.35 ± 0.33^{hi}	30.19 ± 0.31^{e}	38.72 ± 0.43^{bc}
S8	0.00 ± 0.00^{k}	35.56 ± 0.15^{cd}	40.31 ± 0.52^{ab}	17.41 ± 0.12^{i}	29.02 ± 0.12^{e}	34.21 ± 0.14^{d}
S10	0.00 ± 0.00^{k}	24.75 ± 0.45^{fg}	37.87 ± 0.47^{ef}	13.06 ± 0.58^{j}	23.27 ± 0.15^{gh}	29.24 ± 0.29^{e}
S12	0.00 ± 0.00^{k}	23.52 ± 0.11^{gh}	27.34 ± 0.62^{ef}	12.90 ± 0.42^{j}	21.37 ± 0.28^{gh}	24.35 ± 0.74^{fg}

S0 (Control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

Table 4: Effect of coating with apricot gum on vitamin C content of zucchini cuttings during 30 days.

Treatment	Raw Storage time (days) 1	15	30	Fried Storage time (days) 1	15	30
S0	26.22 ± 0.74^{a}	15.55 ± 0.91^{fg}	7.41 ± 0.33^{j}	20.06 ± 0.22^{cde}	15.02 ± 0.19^{gh}	7.04 ± 0.12^{j}
S8	26.92 ± 0.62^{a}	17.13 ± 0.84^{efg}	9.21 ± 0.42^{ij}	20.18 ± 0.18^{bcd}	15.84 ± 0.25^{fg}	8.51 ± 0.32^{j}
S10	27.04 ± 0.48^{a}	21.82 ± 1.05^{b}	12.32 ± 0.95^{hi}	20.53 ± 0.78^{bcd}	17.47 ± 0.21^{def}	12.32 ± 0.58^{hi}
S12	27.33 ± 0.55^{a}	22.41 ± 0.71^{b}	16.42 ± 0.49^{fg}	20.76 ± 0.48^{bc}	18.53 ± 0.38^{cde}	14.78 ± 0.85^{gh}

S0 (Control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

of coated and uncoated zucchini cuttings decreases with time.

Ascorbic acid (vitamin C) degrades faster than other food compounds during storage and processing. Decreasing vitamin C in the control sample could be due to the oxidation of ascorbic acid by oxidizing ascorbic acid. Moreover, increased pH due to the enzymatic activity can destroy vitamin C. Oxygen scavenging prevent or delay oxidation of vitamin C in foods [37]. By coating, oxygen penetration is reduced, which reduces the activity of ascorbic acid oxidizing enzymes and ultimately reduces the destruction of ascorbic acid. It appears that vitamin C changes in the treated samples were less due to the control of oxygen uptake into the cell and the reduction of enzymatic activity by the coating. Adetunji et al., [37] and Atress et al., [38] reported that the most important factor in the ascorbic acid retention in coated fruits was a decrease in oxygen permeability.

3.8. Oxidation Analyses. The oxidation results for fried zucchini treated with apricot gum for 30 days are shown in Figure 3. At the beginning of the experiment (day 0), no significant difference ($P > 0.05$) was observed between the acid value in different groups (Figure 3(a)). The initial acid value was in the range of 0.08–0.09 mg KOH/g oil, which indicates the high quality of the samples. The acid value increased significantly during storage ($P < 0.05$). The acid value of the control sample (S0) was significantly higher than other samples ($P < 0.05$). At the end of the storage, the highest and lowest acid value was related to S0 and S12 treatments, respectively. The acid value did not exceed the standard limit (1–4 mg KOH/g oil) during storage [39]. Edible coatings delay the rate of oil hydrolysis and the increase of acid value [40].

At day 0 of storage, the peroxide value did not show a significant difference ($P > 0.05$) and was in the range of 1.04–1.17 meq O_2/kg oil (Figure 3(b)). The peroxide value increased until the 15th day and then decreased at the end of the storage, probably due to the decomposition of hydroperoxides and the formation of secondary oxidation compounds [41]. During the storage time, the peroxide value of the control sample was significantly higher than other samples ($P < 0.05$). At the end of the storage, the highest and lowest peroxide value was related to S0 and S12 treatments, respectively. Hydrocolloids delay the rate of oxygen penetration and the formation of hydroperoxides in the fried product and reduce the peroxide value. In other words, edible coatings prevent the contact of oxygen with the product as a barrier [9, 42]. According to the national standard of Iran, the limit of peroxide value in oil is 5 meq/kg oil [43] and in the control sample, it was higher than the standard limit at day 15. Similar results were obtained by Farhoosh and Smaeilzadeh Kenari on the rancidity of canola oil containing sesame oil and rice bran oil [44].

At day 0, no significant difference ($P > 0.05$) was observed between the anisidine values in different groups (Figure 3(c)). During the storage time, the anisidine value of the control sample was significantly higher than other samples ($P < 0.05$). At the end of the storage period, the highest and lowest anisidine value was related to S0 and S12 treatments, respectively. According to the national standard of Iran, the limit of anisidine value in oil is 10 mmol/kg [45] and in the control sample, it was higher than the standard limit at day 15.

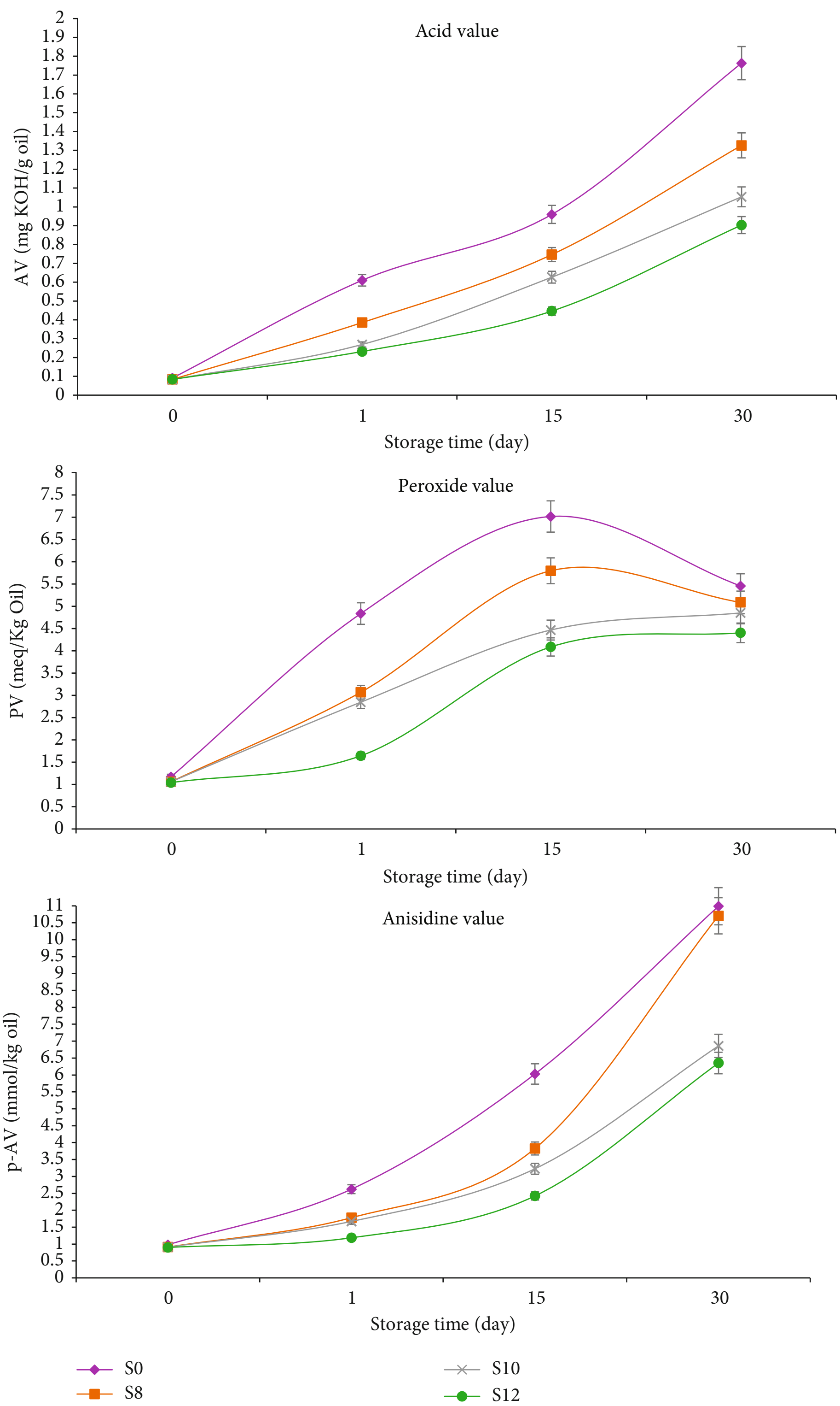

Figure 3: Oxidation parameters of fried zucchini treated with apricot gum during storage. S0 (control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum.

Similar results in reducing lipid oxidation by using hydrocolloids and edible coatings were previously reported [9, 42, 46–48].

3.9. Sensory Properties. As it can be seen from Table 5, the concentration of apricot gum had a nonsignificant effect on the sensory attributes of zucchini cuttings ($P < 0.05$).

Table 5: Effect of coating with apricot gum on overall acceptability of zucchini cuttings during 30 days.

Treatment	Raw Storage time (days)			Fried Storage time (days)		
	1	15	30	1	15	30
S0	4.38 ± 0.08^{bcd}	2.11 ± 0.03^{g}	1 ± 0.10^{h}	4.72 ± 0.08^{ab}	2.44 ± 0.12^{fg}	1.27 ± 0.08^{h}
S8	4.44 ± 0.11^{bc}	2.44 ± 0.015^{fg}	1 ± 0.12^{h}	4.72 ± 0.14^{ab}	2.61 ± 0.10^{fg}	1.38 ± 0.11^{h}
S10	4.77 ± 0.11^{ab}	3.83 ± 0.13^{e}	2.16 ± 0.04^{g}	5 ± 0.00^{a}	3.88 ± 0.06^{de}	2.72 ± 0.18^{f}
S12	5 ± 0.00^{a}	3.83 ± 0.09^{e}	2.33 ± 0.07^{fg}	5 ± 0.00^{a}	3.94 ± 0.07^{cde}	2.72 ± 0.13^{f}

S0 (Control): uncoated samples, S8, S10, and S12: coated samples with 8, 10, and 12% apricot gum. Means with similar letters are not statistically significantly different ($P < 0.05$).

Overall acceptability scores of coated samples were not similar to control ones, but the scores of the coated samples with 8% gum (S8) were the lowest and similar to the control ones after 30 days. The results also showed that the sensory properties of coated and uncoated zucchini cuttings decrease with time.

4. Conclusion

In this study, apricot gum-based edible coating at concentrations of 8, 10, and 12% was used in fried zucchini slices. The results showed that coating with apricot gum due to their barrier properties led to increase in water retention and a decrease in oil absorption. The coated samples showed low shrinkage and color changes compared with the control sample. Coating reduced primary and secondary oxidation products in fried zucchini samples. Among different samples, S12, suggested for coating and usage in industrial zucchini production. Due to the high amount of oil in fried foods and the relationship between excessive oil consumption and cardiovascular disease, the coating by apricot gum in level of 12% can be a good way to consume fried foods.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

There are no conflicts of interest.

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