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The Effect of Persian Gums and Tragacanth on Texture and Sensory Characteristics of Non-Gluten Cakes

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ABSTRACT

Background: The presence of gluten proteins in rice flour leads to some problems for patients of celiac; a digestive autoimmune disease. Consumption of a non-gluten regime can decrease the effects of this disease. The aim of this study was to produce a non-gluten cake with an appropriate quality and high nutritional value by using rice flour, quinoa flour, Persian gums, and Tragacanth. **Methods:** The effect of addition of Persian gums, Tragacanth, and a combination of both of these compounds at levels of 0.5, 1, and 1.5% on texture, color, and sensory characteristics of these cakes was evaluated in this study. **Results:** The results showed that solidity and viscosity factors were elevated by addition of gum to cake. Using of gums in cakes leads to moisture maintenance inside the cake texture and thus improves mastication property. Furthermore, the results of porosity evaluation showed that addition of Persian gums and Tragacanth decreases the size and increases the number of gas cells inside the cake texture and improves porosity. The best porosity was related to the sample containing 1.5% Persian gum and Tragacanth. The treatment that contained 0.75% Persian gum and 0.75% Tragacanth had the highest acceptability among consumers. **Conclusions:** Results showed that Persian and Tragacanth gums, whether used independently or in combination, can improve the quality and organoleptic characteristics of gluten-free cakes.

Keywords: *Non-gluten cake; Sensory characteristics; Persian gum; Gum Tragacanth*

Introduction

Celiac disease is a kind of digestive disease which damages intestinal villi and leads to failure of nutritionals absorption such as iron, calcium, fat soluble vitamins, and in some cases causes low weight, diarrhea, anemia, fatigue, stomach bloat. On the other hand, it leads to thyroid disease, cancer, bone disorders, infertility, as well as nerve and psychiatric problems (Mezaize *et al.*, 2009). Patients suffering from celiac disease cannot bear the gluten protein that exists in wheat, barley, and rye, consequently they

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have problem in consumption of foods such as cake, bread, spaghetti, etc. (Mezaize *et al.*, 2009). Rice, with very low amounts of gluten, a little sodium, protein, fat, fiber, and high amounts of digestible carbohydrates, is one of the foods which can replace wheat in non-gluten products (Turabi *et al.*, 2008).

Gluten proteins, available in flour have an important role in biking quality. Gluten protein is composed of gliadin and glutinin, which has significant effect on physical properties of batter such as elasticity, consistency, the ability of gas maintaining, and etc. The elimination of this protein results a product with brittle texture, weak color, low volume, and porosity (Gallagher *et al.*, 2004). Hence, using gluten appropriate substitutes such as hydrocolloids (Lopez *et al.*, 2004) is essential in non-gluten products' baking industries. Hydrocolloids are hydrophilic biopolymers resulting from plants, animals, microbes, and/ or synthetic materials that generally include a large number of hydroxyl groups (Guarda *et al.*, 2004). Generally, hydrochlorides are applicable for improvement of quality and viscoelastic characteristics, increasing of moisture maintaining capacity, slowing down starch alteration process, and as fat substitutes in producing nutritional products (Elke and Dal Bello, 2008).

Gums (hydrocolloids) are compounds added to nutritional products because of their role in providing jelly and consolidation properties to products (Turabi *et al.*, 2008). Persian gum is a clear gum harvested from Arjan tree (peanuts) of Rosacease family that is also called Shirazi gum and Zedu. This polysaccharide gum is water soluble with high water absorption capacity besides industrial usages. Today, Persian gum is used as a emulsion with Tragacanth and Arabic gum in pharmaceutical industry (Khalesi. H *et al.*, 2012).

Tragacanth gum is a secretory gum that has an important role in nutritional, medicinal, textile, paper, and other industrial materials. Tragacanth is a complex polysaccharide with numerous heterogeneous branches which is naturally available in slightly acidic salt of calcium, magnesium, and potassium. Tragacanth gum includes two parts: Tragacanthic acid or basourin that is insoluble in water but can distend in water and form jelly, and the other part is Tragacanth which is water soluble. Both units contain small amounts of proteins and metoxyl groups that the latter are more frequent in water soluble unit (Haj Mohammadi *et al.*, 2013).

Up to now, some studies have been conducted about use of gums, such as xanthan gum, guar gum, luckast seed gum, etc. and also use of hydrochlorides, such as sodium alginate, carginane, pectin, hydroxyl propyl methyl cellulose, etc. to prepare cakes from rice flour (Rodriguez-Garcia *et al.*, 2012, Sumnu *et al.*, 2010, Turabi *et al.*, 2008) and quinoa flour (Khalesi. H *et al.*, 2012). The results indicated improvement of cake quality. During conducted evaluations, the combination of Persian gum and Tragacanth was not used in any formulations of non-gluten cakes.

With regard to the fact that celiac patients are sensitive to gluten protein, this study tried to prepare non-gluten cakes based on rice and quinoa flour with using the combination of Persian gum and Tragacanth in its formulation. The effect of addition of different levels of these gums and their combinations on quantitative, qualitative, and sensory characteristics of products were also evaluated.

Materials and Methods

Rice flour (protein 9.3%, ash 0.9%, moisture 11.02%), quinoa flour, sugar, shortening, water, egg, salt, baking powder, Persian gum (protein 0.5%, ash 1.62%, moisture 9.4%, and carbohydrate 88.4%), as well as Tragacanth were purchased from food stores. After grinding Tragacanth laminas, Tragacanth and other powders were passed from the mesh-40 to separate big particles and impurities.

Batter preparation and cake production: The cake batter was prepared from rice flour, quinoa flour, sugar, oil, water, egg, baking powder, vanilla, and salt, all components were calculated according to the weight of rice and quinoa flour. The materials were mixed and prepared in 3 stages.

At the first stage, sugar, egg, and vanilla were mixed and at the second stage the rest of liquid materials, such as water and oil were added. At the final stage, solid materials of formula including flour, gums (each gum and their combination in 3 levels of 0.5, 1 and 1.5%) were added and mixed. Mixing was performed for 3 minutes in each stage. After preparation and mixing of the materials, the batter was filled in molds, placed in microwave and baked for 20 minutes. After baking and chilling in environment temperature, the cakes were packed for evaluation of their qualitative and quantitative properties. Treatments used in this study are shown in T**able 1**.

Table 1. The amounts of gums used in cake

Treatment's name	The concentration of added biopolymers
B	0%
0.5F	0.5% Persian gum
1.0F	1% Persian gum
1.5 F	1.5% Persian gum
0.5K	0.5% Tragacanth gum
1K	1% Tragacanth gum
1.5K	1.5% Tragacanth gum
0.5FK	0.25% Persian gum+.025% Tragacanth gum
1.0FK	0.5% persian gum+0.5% Tragacanth gum
1.5FK	0.75% persian gum+0.75% Tragacanth gum

Qualitative and quantitative examinations of non-gluten cake: Volume measurement: the definition of cake volume was performed with rapeseed movement method (Haj Mohammadi *et al.*, 2014).

Texture test: the evaluation of cake texture was conducted by texture meter apparatus and based on Gomez et al., method (2006) in time intervals of 4 hours,3 and 5 days after the production of cakes (brand CT3-1000 of Brokfield Company). The evaluation was carried out by Brokfield texture analyzer apparatus equipped with probe TA4/1000 through destroying percentage of 50%, speed of 30mm/min, and inter-cycle interval of 30 seconds. Parameters such as firmness, cohesiveness, springiness, gumminess, and chewiness were evaluated (Bourne, 1978).

The evaluation of cake shell color: the analysis of cake shell color was performed 4 hours after production in the hunter lab color-meter apparatus (Johnson brand) with definition of 3 indices L*, A*, and B*. The L* index was an indicator of sample brightness and ranged from zero (black) to 100 (white). The A* index indicated that the color of sample was similar to both green and red; it ranged from -120 (pure green) to +120 (pure red). The B* index indicates that the sample color was close to blue and yellow and ranged from -120 (pure blue) to +120 (pure yellow).

Porosity evaluation: to evaluate the rate of porosity, the center of cakes were evaluated 2 hours after production with organization method. For this purpose, a resection by dimensions of 2 × 2 cm was prepared from the center of the cake and was imaged by scanner (HP Scanject G3010) with resolution of 1200 pixels, then it was placed in Image J software. With activating the 8 bit part, gray images were created. In order to change the gray images to two-two images, the two-two part of software was activated. These images are assortments of light and dark spots, which help to calculate the ratio of light spots to dark ones as an index for estimating porosity rate of the samples. Obviously, higher ratios show that the number of chambers in the cake tissue has been higher (porosity rate). With activating analyses part of the

software, this ratio and the percentage of samples' porosity were calculated (Rodriguez-Garcia *et al.*, 2012).

Sensory evaluation: sensory evaluation was performed with 5-spot Hedonic method and by presence of 10 panelists. In these tests, factors such as color, odor, taste, and texture (oral sense) were evaluated separately for cakes containing Tragacanth, Persian gum, combination of them, and the control group. During these tests, the panelists were asked to give grade 1 to the best sample and grade 5 to the worst one. For data analyses, initially total grades related to each sample were calculated and then the presence of significant difference among them was determined by using Friedman test (Haj Mohammadi *et al.*, 2013).

Data analysis: Comparison of harvested results of all tests was performed by complete analyses of variance and tests of mean score comparisons at the probability level of 5%.

Results

Definition of special volume of cake: According to **Figure 1**, addition of gum leads volume of non-gluten cakes to increase; the most volume increasing was related to treatment containing 0.75% Persian gum and 0.75% Tragacanth (1.5FK treatment).

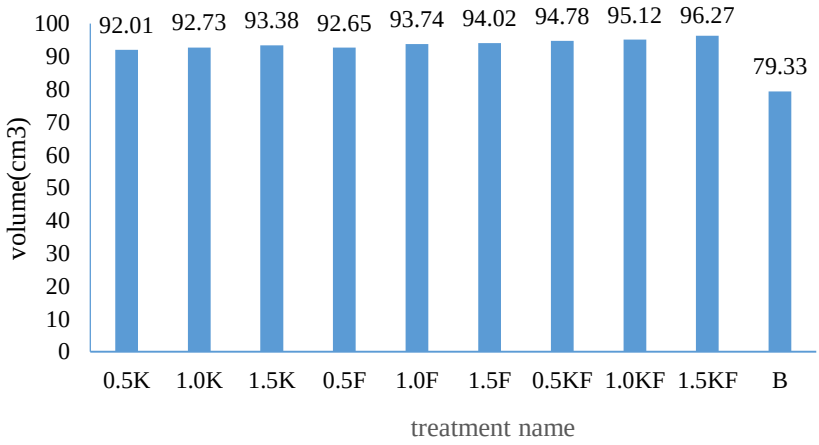

Figure 1. The volume of cake in different treatments

Cake texture: In texture test, the surface of cake samples on which TPA test was performed was 9.85. The results are reported in the **Table 2** along with standard deviation. Non-common capital letters in each column and non-capital non-common letters in each row indicates significant difference at level of $P < 0.05$ between treatments. The firmness index in the control sample had significant difference; it had an increasing trend with the increase of time. Hydrocolloids significantly increased firmness of cake core in comparison with the non-gum samples ($P < 0.05$).

Upper-case letters compare treatment to time, Lower-case letters compare a treatment to another treatment. Values with the same letters did not differ significantly ($P > 0.05$).

Cohesiveness indicates internal resistance of food structure. The evaluation of Cohesiveness index in **Table 3** showed that the cohesion of cake samples was under the effect of adding hydrocolloids. The cohesiveness inside cake texture had significant difference during times of keeping, so that it decreased with increase of the keeping duration.

Table 2. Comparison of the mean firmness of cake samples texture (gram) in different days and treatments

Treatment	First day	Third day	Fifth day
0.5F	775.17 ± 58.36 ^{Acd}	867.83 ± 47.44 ^{Ae}	930.33 ± 84.32 ^{dA}
1.0 F	703.00 ± 23.07 ^{Ade}	912.17 ± 89.76 ^{Ac}	1121.17 ± 106.88 ^{eA}
1.5 F	989.83 ± 72.88 ^{Ab}	1020.17 ± 95.87 ^{bA}	1385.17 ± 87.62 ^{abA}
0.5 K	1003.00 ± 35.19 ^{Ab}	1360.67 ± 80.75 ^{aA}	1450.5 ± 103.64 ^{abA}
1.0 K	1184.67 ± 119.35 ^{Aa}	1413.00 ± 71.52 ^{dA}	1593.67 ± 255.93 ^{Aa}
1.5 K	1029.17 ± 77.10 ^{Acde}	1150.17 ± 69.05 ^{bA}	1265.67 ± 78.98 ^{Abc}
0.5 FK	650.00 ± 76.40 ^{eA}	898.50 ± 37.69 ^{eA}	1014.00 ± 79.27 ^{Acd}
1.0 FK	1029.17 ± 63.46 ^{Ab}	1476.67 ± 72.67 ^{Ad}	1575.67 ± 127.68 ^{Aa}
1.5 FK	842.50 ± 34.54 ^{Ac}	944.50 ± 13.00 ^{eA}	945.33 ± 221.90 ^{Ad}
B	687.00 ± 64.09 ^{Cde}	714.67 ± 89.33 ^{Ad}	897.33 ± 123.73 ^{Bd}

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

Table 3. Comparison of Texture Cohesiveness mean scores (milli joule) of cake samples in different days and treatments

Treatment	First day	Third day	Fifth day
0.5F	0.62 ± 0.053^{Aabc}	0.60 ± 0.078^{Aa}	0.60 ± 0.04^{Aabc}
1.0F	0.53 ± 0.05^{eA}	0.42 ± 0.023^{Abc}	0.40 ± 0.07^{Acde}
1.5F	0.56 ± 0.01^{deA}	0.46 ± 0.045^{Ab}	0.42 ± 0.01^{Abcd}
0.5K	0.60 ± 0.006^{Abcd}	0.56 ± 0.025^{Ac}	0.54 ± 0.05^{Ade}
1.0K	0.63 ± 0.044^{Aab}	0.63 ± 0.067^{Aa}	0.56 ± 0.02^{Acde}
1.5K	0.63 ± 0.006^{abcA}	0.56 ± 0.058^{Abc}	0.52 ± 0.02^{Aba}
0.5FK	0.59 ± 0.032^{bcdeA}	0.57 ± 0.021^{Aa}	0.48 ± 0.006^{Aabcd}
1.0FK	0.67 ± 0.036^{aA}	0.61 ± 0.042^{Aa}	0.59 ± 0.006^{Aabc}
1.5FK	0.64 ± 0.023^{abA}	0.42 ± 0.017^{Abc}	0.40 ± 0.06^{Aa}
B	0.57 ± 0.026^{Acde}	0.41 ± 0.006^{Bbc}	0.38 ± 0.03^{Ade}

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

Upper-case letters compare treatment to time, Lower-case letters compare a treatment to another treatment. Values with same letters did not differ significantly ($P > 0.05$).

The evaluation of springiness was performed by punching a piece of cake with finger and its resilience to primary status. The results are shown in **Table 4**. There was no significant difference between any of treatments in days 1 to 5. With addition of hydrocolloids, the springiness showed significant alteration comparing with non-gum sample ($P < 0.05$).

Upper-case letters compare treatment to time, Lower-case letters compare a treatment to another treatment. Values with the same letters did not differ significantly ($P > 0.05$).

The results showed that gumminess of cake samples increased from day 1 to day 3, but with increase of the keeping time a significant decrease was observed in day 5 (**Table 5**).

Table 4. Comparison of mean texture springiness (millimeter) of cake samples in different days and treatments

Treatment	First day	Third day	Fifth day
0.5F	4.77 ± 0.30^{Aab}	4.58 ± 0.24^{aAbc}	4.61 ± 0.17^{Aab}
1.0F	4.29 ± 0.17^{cA}	3.66 ± 0.26^{Ae}	3.90 ± 0.15^{dA}
1.5F	4.43 ± 0.11^{bcA}	4.57 ± 0.26^{Aabc}	4.48 ± 0.09^{Aabc}
0.5K	4.40 ± 0.03^{bcA}	4.39 ± 0.14^{Aabcd}	4.25 ± 0.17^{Abcd}
1.0K	4.52 ± 0.09^{bcA}	4.39 ± 0.23^{Aabcd}	4.60 ± 0.12^{Aab}
1.5K	4.66 ± 0.09^{abcA}	4.62 ± 0.24^{abA}	4.84 ± 0.11^{Aa}
0.5FK	4.64 ± 0.11^{abcA}	4.31 ± 0.22^{Abcd}	4.59 ± 0.18^{Aab}
1.0FK	5.00 ± 0.00^{aA}	4.71 ± 0.11^{Aa}	4.49 ± 0.31^{Acab}
1.5FK	4.25 ± 0.63^{Ac}	4.26 ± 0.21^{Acd}	4.13 ± 0.57^{Acd}
B	4.61 ± 0.32^{Aabc}	4.23 ± 0.11^{Ad}	4.28 ± 0.15^{Abcd}

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

Table 5. Mean comparison of texture gumminess (gram), texture chewiness and texture stringiness of cake samples in different days and treatments

Treatment	First day	Third day	Fifth day
Texture gumminess (gram)			
0.5F	477.67 ± 28.62^{Aa}	510.57 ± 50.52^{Ae}	486.93 ± 124.74^{Ade}
1.0F	338.73 ± 26.19^{eA}	541.9 ± 24.53^{Ad}	239.77 ± 3.47^{Af}
1.5F	554.53 ± 45.48^{bA}	677.9 ± 56.89^{Abc}	507.9 ± 5015^{Aabc}
0.5K	593.3 ± 29.59^{bA}	718.17 ± 68.28^{Aa}	617.03 ± 49.89^{Abc}
1.0K	727.43 ± 34.39^{aA}	897.47 ± 65.67^{Acd}	778.67 ± 55.44^{Aab}
1.5K	443.33 ± 36.20^{cdA}	625.03 ± 54.79^{Aa}	497.57 ± 78.0^{Abc}
0.5FK	381.37 ± 25.21^{edA}	445.83 ± 38.19^{Ae}	406.93 ± 34.99^{Ade}
1.0FK	687.07 ± 35.68^{aA}	707.53 ± 39.71^{Acd}	684.13 ± 2488^{Aa}
1.5FK	176.83 ± 15.33^{fA}	206.9 ± 1966^{Aab}	771 ± 14.45^{Ad}
B	389.53 ± 35.30Bed	470.3 ± 35.31Ae	451.97 ± 27.2Be
Texture chewiness (milli joule)			
0.5F	20.76 ± 2.60^{Acd}	20.73 ± 0.74^{Ac}	21.13 ± 1.61^{Adc}
1.0F	17.43 ± 1.27^{Ae}	21.09 ± 1.95^{cA}	22.97 ± 2.04^{Ad}
1.5F	24.27 ± 2.43^{Abc}	31.23 ± 2.74^{abA}	35.45 ± 2.79^{Aabc}
0.5K	25.51 ± 1.18^{Ab}	31.30 ± 2.05^{abA}	36.46 ± 3.23^{Aabdc}
1.0K	32.26 ± 2.19^{A}	37.88 ± 2.52^{bA}	40.64 ± 3.90^{Aab}
1.5K	27.02 ± 1.66^{Ad}	37.8 ± 1.98^{aA}	39.17 ± 1.16^{Aabcd}
0.5FK	17.36 ± 1.51^{Ade}	23.36 ± 0.12^{cA}	26.86 ± 2.02^{Abcd}
1.0FK	33.70 ± 3.96^{aA}	39.6 ± 2.93^{bA}	43.51 ± 3.63^{aA}
1.5FK	25.72 ± 0.40^{bA}	27.34 ± 1.02^{Aab}	31.62 ± 2.93^{dcA}
B	17.69 ± 2.76^{deB}	17.69 ± 2.76^{deB}	18.79 ± 1.09^{Bd}
Texture stringiness (mm)			
0.5F	0.55 ± 0.10^{b}	0.63 ± 1.36^{ab}	0.56 ± 0.007^{bc}
1.0F	0.38 ± 0.247^{bcd}	0.41 ± 8.99^{a}	0.36 ± 0.29^{bc}
1.5F	0.15 ± 0.006^{ef}	0.20 ± 0.051^{b}	0.61 ± 0.509^{a}
0.5K	0.36 ± 0.070^{cd}	0.25 ± 0.06^{b}	0.41 ± 0.007^{bc}
1.0K	0.77 ± 0.177^{a}	0.88 ± 0.57^{b}	0.78 ± 0.106^{bc}

1.5K	0.87 ± 0.081^{a}	1.01 ± 0.205^{b}	0.97 ± 0.078^{b}
0.5FK	0.46 ± 0.096^{bc}	0.10 ± 0.051^{b}	0.23 ± 0.035^{c}
1.0FK	0.37 ± 0.035^{cd}	0.48 ± 0.17^{b}	0.25 ± 0.001^{bc}
1.5FK	0.27 ± 0.061^{ed}	0.42 ± 1.66^{b}	$0.04 \pm 0\ 001^{c}$
B	0.02 ± 0.005^{f}	0.018 ± 0.11^{b}	$0.04 \pm 0\ 002^{c}$

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$).

Upper-case letters compare treatment to time, Lower-case letters compare a treatment to another treatment. Values with the same letters did not differ significantly ($P > 0.05$).

The results in the **Tables 5** show that the chewiness of cake samples is directly related to cake firmness and did not have any significant alteration during the keeping period, but in control sample, it increased by increase of time from days 1 to 3. This index showed decrease by more increasing of time.

Upper-case letters compare treatment to time, Lower-case letters compare a treatment to another treatment. Values with the same letters did not differ significantly ($P > 0.05$).

According to **Table 5**, addition of Persian gums and Tragacanth led to stringiness of cake texture and the stringiest characteristics were observed in addition of 1 and 1.5% Tragacanth gum.

Color analysis: The cake color analysis was conducted in two repeats and the results are reported in the **Tables 6** along with standard deviation. Non-common characters in each column indicate the existence of significant difference in $P < 0.05$ level.

Table 6. Mean comparison of color indices L*, A* and B* at significant level of 0.05 in different treatments

Treatment	Color index		
	L*	A*	B*
0.5F	68.40 ± 0.26^{ab}	3.08 ± 1.25^{ab}	28.56 ± 0.16^{b}
1.0F	63.64 ± 1.34^{d}	9.49 ± 1.17^{a}	27.21 ± 0.23^{b}
1.5F	67.18 ± 0.81^{cb}	7.39 ± 0.66^{b}	26.45 ± 0.22^{c}
0.5K	68.49 ± 0.46^{ab}	5.39 ± 1.03^{cd}	27.36 ± 0.39^{b}
1.0K	68.04 ± 0.85^{ab}	4.9 ± 0.60^{de}	27.11 ± 0.13^{b}
1.5K	67.54 ± 0.85^{cb}	3.89 ± 0.18^{ef}	28.39 ± 0.49^{a}
0.5FK	68.15 ± 0.70^{ab}	6.43 ± 0.71^{bc}	26.41 ± 0.49^{c}
1.0FK	61.86 ± 0.98^{e}	9.43 ± 0.11^{a}	26.44 ± 0.44^{c}
1.5FK	66.24 ± 0.79^{c}	7.1 ± 0.73^{b}	27.24 ± 0.63^{b}
B	69.25 ± 0.83^{a}	6.44 ± 0.6^{bc}	25.13 ± 0.18^{d}

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

The results of variance indicated existence of significant difference of L index among treatments at significance level of 0.5. The control sample showed the highest mean L index (69.25) and the addition of gum led to decrease of this index. The lowest rate of L index (61.86) was measured by addition of 1% Persian gum and 1% Tragacanth gum.

Comparison of an index mean rate (red range) showed that treatment 2 containing 1% Persian gum, had the highest index mean rate (9.49) and treatment number 1, containing 0.5% Persian gum, had the lowest index mean rate (3.08). With elevating the amount of Persian gum in the samples, significant difference was observed for

the index from treatment 1 to 3; the highest one was seen in 1% of Persian gum, but this index decreased in lack of Persian gum and elevation of Tragacanth in the samples. In treatments with both types of gums, a pendulous status was observed in which the index rate increased initially and then decreased.

The addition of Persian gum and Tragacanth leads to increase of color factor "b" (yellow range) in cake samples in comparison with controls. The control sample had the lowest rate of b index (25.13) and the treatment containing 0.5% of Persian gum showed the highest rate of b index (28.56). There was no significant difference among 0.5F, 1.0F, 0.5K, 1.0K, 1.0FK treatments. 1.5F, 0.5FK, and 1.0FK treatments also, did not show any significant difference.

Porosity: The results in **Table 7** showed that addition of Persian gums and Tragacanth increased the porosity of cake samples comparing with the control sample. Samples containing combination of these two gums had more effective role in improvement of porosity comparing with the control sample. The addition of gum decreased the size of gas cells, increased their numbers, and led to their homogenous distribution in cake texture consequently, the porosity increased.

Table 7. Porosity rate of non-gluten cake samples in different treatments

Treatments	Number of chambers	Porosity
1.5K	371	14.06 ± 5.9
1.0K	355	9.9 ± 5.9
0.5K	295	15.13 ± 7.05
1.5F	304	13.74 ± 6.15
1.0F	273	9.65 ± 6.49
0.5F	270	14 ± 7.16
1.5FK	385	15.49 ± 6.7
1.0FK	373	14.64 ± 7.42
0.5FK	365	9.35 ± 7.42
B	231	24.59 ± 17.72

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

Sensory evaluation: Comparison of treatments in **Table 8** showed that treatment 1.5FK containing 0.75% Persian gum and Tragacanth, had the highest desirability in consumers' opinion and the control sample showed the lowest grade of total acceptability.

Discussion

Results showed that addition of Persian gums and Tragacanth to non-gluten cakes, improved the product's water holding capacity and texture parameters. Gomez indicated that there is no correlation between the cake density and special volume of cake. Actually, the final volume of cake is not often related to the primary air volume in the batter, but the capacity of gas maintenance during baking and its effect on gelatination of starch are important (Gomez *et al.*, 2007)

Haj Mohammadi added different percentages of tragacant (0, 0.1, 0.2, 0.3, 0.4, 0.6, and 0.8%) to sponge cake samples and reported that adding gum up to 0.3% leads to significant increase of cakes' volume ($P < 0.05$). But higher amounts of gum (0.4, 0.6, and 0.8%) lead the cake volume to decrease. Also, Haj Mohammadi reported that addition of betaglucan (3 and 4%) to cakes significantly increases the volume compared to non-betaglucan samples (Haj Mohammadi *et al.*, 2014).

Texture amenity increase of cakes by using gum is related to maintenance and keeping of

moisture in cake texture, but in high percentages of gum, hardness is higher than non-gum samples that is due to high viscosity in batter and creation of strong gluten plexus which consequently creates more firm texture in cake (Haj Mohammadi *et al.*, 2014).

Haji Mohammadi et al, reported that by adding Tragacanth up to 0.4%, during keeping, the sponge cake became significantly softer compared with the non-gum sample, while by more addition of Tragacanth gum up to 0.8%, the texture firmness was increased (Haj Mohammadi *et al.*, 2014).

With addition of gum to cake, the shell of cakes affects by maillard reaction and becomes darker. This reaction is affected by pH and moisture (Haj Mohammadi *et al.*, 2013). The results of Haj Mohammadi et al. study showed that with addition of betaglucan (0, 1, 2, 3, and 4%) to sponge cakes the rate of L and B factors in betaglucan samples were significantly lower than non-beta-glucan sample ($P < 0.05$). However, with elevation of betaglucan, the factor was significantly increased compared with non-betaglucan sample. The addition of gum decreased the size of gas cells, increased their numbers, and led to their homogenous distribution in cake texture so, the porosity was increased. Gambus et al., indicated that addition of xanthan gum at levels of 2 and 3% leads to creation of rather big and extensive air bubbles with non-homogenous distribution in product tissue which leads to decrease of porosity (Gambuś *et al.*, 2007).

The results of sensory evaluation showed that the gum used in cakes has an appropriate effect on final quality and desirability of the product. More desirability of samples with gum comparing with control samples, is because of gum characteristics in aroma, taste, and moisture maintenance and tenderness (Haj Mohammadi *et al.*, 2014).

Table 8. Results of sensory evaluation of non-gluten cake samples in different treatments

Treatment	Color	Odor	Taste and flavor	Texture	Total acceptation
0.5F	3.5 ± 0.84^{a}	2.7 ± 0.67^{c}	3.4 ± 0.07^{ab}	3.4 ± 0.96^{ab}	3.4 ± 0.96^{ab}
1.0F	3.6 ± 0.6^{a}	2.8 ± 0.91^{cb}	3.3 ± 1.33^{abc}	3.4 ± 0.69^{ab}	3.2 ± 0.78^{abc}
1.5F	3.3 ± 0.67^{ab}	3.3 ± 0.94^{abc}	3.9 ± 0.87^{a}	3.9 ± 0.73^{ab}	3.3 ± 0.82^{abc}
0.5K	3.2 ± 0.13^{ab}	3.6 ± 0.96^{a}	3.3 ± 0.33^{abc}	3.3 ± 0.94^{ab}	3.4 ± 0.26^{ab}
1.0K	2.6 ± 0.96^{b}	3.4 ± 0.37^{abc}	3.8 ± 0.63^{a}	3.3 ± 0.94^{ab}	3.4 ± 0.86^{ab}
1.5K	3.3 ± 0.67^{ab}	3.6 ± 0.84^{a}	2.9 ± 0.19^{bc}	3.5 ± 0.70^{ab}	3.0 ± 0.45^{bc}
0.5FK	3.3 ± 0.67^{ab}	3.6 ± 0.96^{a}	2.7 ± 0.67^{bc}	3.3 ± 0.94^{ab}	3.5 ± 0.84^{ab}
1.0FK	3.5 ± 0.38^{a}	3.4 ± 0.96^{abc}	2.5 ± 0.7^{c}	3.5 ± 0.97^{ab}	3.4 ± 0.26^{ab}
1.5FK	3.3 ± 0.94^{ab}	3.5 ± 0.84^{ab}	3.4 ± 0.17^{ab}	3.9 ± 0.87^{a}	3.8 ± 0.63^{a}
B	3.4 ± 0.96^{a}	3.0 ± 0.94^{abc}	2.7 ± 0.67^{bc}	3.5 ± 0.7^{ab}	2.6 ± 0.16^{c}

F: Persian gum, K: Tragacanth gum, FK: Persian gum+ Tragacanth gum; Values with the same letters did not differ significantly ($P > 0.05$)

Conclusions

Results showed that Persian and Tragacanth gums can independently and combinational improve the quality and organoleptic characteristics of gluten free cake. Also, application of gums for water conservation on cake texture causes the softness of cakes' texture to increase. Higher levels of gums increase the hardness of cake's texture.

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Authors' contributions

Ghasemi A wrote the manuscript. Shahedi Baghe Khandan M and Yasini Ardakani A edited

the manuscript. The authors approved the content of the manuscript, and agreed for all aspects of the work.

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Conflicts of interest

The authors declare that there is no conflict of interest in this work**.**

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