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Effects of Psyllium and Marve Seed Mucilages on Physical, Sensory and Staling Properties of Sponge Cake

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ABSTRACT

Irreversible changes in the physicochemical properties of bakery products after baking is called staling. One of the most important issues of nutritional and economic importance in the bakery industry is to delay staling. One way to postpone staling is to apply native plant and seed hydrocolloids, especially mucilages, which have high medicinal and nutritional value and low price. Therefore, in this study, the effects of different concentrations of psyllium seed mucilage (0, 0.25, 0.5, 0.75 and 1), marve mucilage (0, 0.25, 0.5, 0.75 and 1) and the combination of both kinds of mucilage (up to 1%) on the physical, sensory and staling properties of sponge cake were investigated. In general, except when 1% of mucilage was used, the overall properties of sponge cake were always improved by hydrocolloid addition. The results showed that the addition of 0.25% marve combined with 0.25% psyllium significantly (P< 0.05) enhanced properties of sponge cakes (volume, overall acceptability, hardness and moisture during storage) compared with the control sample.

Keywords: Sponge cake, Mucilage, Psyllium, Marve, Shelf life.

INTRODUCTION

Cakes because of their favourable sensory features, low cost and easy availability are often used as a substitute for their main food by people, especially children, around the world. A significant problem that limits the shelf-life of cake products is the loss of moisture and staling of cakes, which poses a challenge to its manufacturers (Gulc, 2003; Matsakidou *et al.,* 2010). Baking duration and baking temperature influence the rate of staling. Baking on gravels and higher baking temperature decreased the staling kinetic (Izadi Najafabadi *et al.,* 2015). Adding substances that have an impact on the formulas, air exposure of cake batters, and fluid batter stability can influence the quality and shelf life of baked cakes (Gomez *et al.,* 2007).

Methods of delaying staling at specific temperatures include adding additives such as hydrocolloids and gums; improving the baking quality, packaging and storage that enhance the quality of baking and storage of the product (Azizi *et al.,* 2003). Hydrocolloids/gums are used as food additives.

As a substitute for gluten (Sahraiyan *et al.,* 2014), fat replacement (Shokri Busjin, 2004), and source of fiber (Apling *et al.,* 1978), hydrocolloids are added to food products. In bakery products, additional effects of hydrocolloids include increasing the retention of moisture, delaying starch retrogradation (Davidou *et al.,* 1996) and enhancing the product's overall quality and shelf life (Gomez *et al.,* 2007). The widespread use of hydrocolloids in food products has created the need to search for new natural hydrocolloids with desirable characteristics and suitable

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pricing, which can be used instead of commercial gums. It is, therefore, important to extract mucilages from novel sources in order to assess their functional properties and explore the possibility of utilizing them.

Marve or wild sage seed (*S. macrosiphon*) is a small rounded seed, which readily swells in water to produce mucilage (Razavi *et al.*, 2010). A mechanical filtering centrifugal system can be used to quantitatively extract mucilage with water. The Sage Seed Gum (SSG) powder attained at optimal conditions include 6.72% moisture, 0.85% lipid, 8.17% ash, 2.84% protein, 1.67% crude fiber and 79.75% carbohydrate (Bostan *et al.*, 2010).

The plant genus Plantago has more than 200 species. Its seeds are used to obtain Psyllium. Psyllium husk is the main product separated from the seed. Psyllium seed coat is then used to produce mucilage by mechanical milling. Characterized as a fibrous hydrophilic substance, mucilage forms a clear and colourless gel. Psyllium, which is an excellent dietary source of both soluble and insoluble fractions (Bijkerk *et al.*, 2004) contains around 80% soluble fiber. Its average composition includes 23% arabinose, 75% xylose (molar basis) and traces of other sugars. Containing both (1→4) and β-(1→3) glycosidic linkages within its xylan backbone (Fischer *et al.*, 2004), this highly branched acidic arabinoxylan polysaccharide features approximately 35% worth of non-reducing terminal residues, as a medicinally active gel, forming natural polysaccharide dietary fiber. Psyllium has been successfully used for the treatment of diabetes, high cholesterol and obesity in children, and remediation of constipation, diarrhoea, inflammatory bowel diseases and ulcerative colitis (Singh, 2007).

To the best of our knowledge, no study has provided insight into the application of this novel hydrocolloid to bakery products. Therefore, the aim of this study was to evaluate the anti-staling effects of two mucilages extracted from native seeds namely, 'Psyllium', 'Marve', and a combination of both mucilages.

MATERIALS AND METHODS

Materials

From a local market, baking powder, refined sugar, semi-solid oil, wheat flour, whey powder, vanilla, milk powder and fresh whole eggs were purchased. From a medicinal herb store, psyllium and marve seeds were collected. Wheat flour utilized, containing 14.44±0.63% moisture, 8.28±0.03% protein (N×5.7), 26±0.88% gluten and 0.445±0.03% ash, all determined in accordance with the Approved Methods of the AACC (2000).

Extraction of Psyllium and Marve seed Mucilages

Bostan *et al.* (2010) examined the effect of temperature (25-80˚C), water to seed ratio (25:1-85:1) and pH (3-9) on the yield, apparent viscosity and emulsion stability index of marve mucilage. The optimum conditions were found at 25˚C, for a water-to-seed ratio of 51:1, and pH of 5.5.

Extraction of the psyllium seed gum was determined using the reform method employed by Askari *et al.* (2008). Optimum operating conditions were found to be an extraction temperature of 25˚C and water/seed of 30:1. Separation of the mucilage from the seed was generally performed using a centrifuge. The centrifuge was running at approximately 1,500 rpm. The precipitates were collected, dispersed in deionized water and dried overnight in a vacuum oven.

Cake Preparation

Cake samples were made of oil (57%), refined sugar (72%), eggs (72%), flour (100%), baking powder (1.34%), milk powder (2%), vanilla (0.5%), whey powder (4%) and water (25%) based on the weight of the cake flour. Flour was replaced with mucilages at different levels. Psyllium seed mucilage (0.25, 0.5, 0.75 and 1), marve mucilage (0.25, 0.5, 0.75 and 1) and the combination of both mucilages up to 1% were added to the formulation in order to attain sponge cake. A control cake lacking mucilage was also baked. To prepare the cake batter, sugar and oil were stirred for 10 minutes. Then, eggs in the third stages were added and then mixed for 2 minutes. The powder materials (milk powder, whey protein, baking powder and flour) were also added. Mucilages were added to the formulation. Vanilla was then added. The batter was mixed for one minute. Water was added at the end. The batter was mixed for one minute. All cakes were produced under equal conditions. 1,500 g of cake batter was prepared. 40 g of cake batter was then poured into each 4×5×8 centimetre metallic, lard-coated pan, and was baked for 20–25 minutes at 180–190˚C. Heat-sealing packaging was used to package the cakes in polyethylene, and they were stored at room temperature between each assessment.

Physiochemical Evaluation

Based on the number of AACC standards (2000), the moisture (44-15), protein (46-13), wet gluten (38-11) and ash (08-01) were measured. Specific gravity was evaluated by dividing the weight of a standard measure of the batter by the weight of an equal volume of water. The cake volume was determined through seed displacement (Lin *et al.*, 2003). The ratio of the weight to volume is known as the apparent density (Kocer *et al.*, 2007). The AACC (2000) method 10-91 was used to measure symmetry. Using the proposed reform method of Hess *et al.* (1983) and a texture analyser (Instron, Model 1140, UK) the texture of the cakes was evaluated after removing the crust from the samples. A compression probe was used. Instron is equipped with a load cell (5 N) and cylindrical probe with a diameter of 24 mm. The force needed for 40% compression was documented under the following conditions: 50 mm min^{-1} probe speed, 1 inch sample thickness, and 5–50 N of force exerted by the load cell device. According to F_{max}, the maximum compressive force exerted on the sample was reported. The hardness unit is based on Newton. By averaging four readings, the reported values were determined. The moisture and hardness of the samples were evaluated at 1, 7 and 14 days after cooking in order to evaluate the interactions between different percentages of mucilages and storage time on the produced cakes. Cakes during storage were kept in polyethylene packaging.

Sensory Evaluation

The cakes that had mucilages were compared with the control cake regarding sensory acceptability and preference. Using a verbal hedonic scale featuring five points (1: Disliked extremely; 5: Liked extremely) according to the AACC (2000) method 10-90 with modifications by Ronda *et al.* (2005) and Lee *et al.* (2008), the acceptability of the softness and hardness, porosity, color of crust and crumb, flavor, and the dry or doughy cake texture during chewing were evaluated. The effect of time on the texture and quality of samples was determined by a total of 10 consumers chosen from amongst the university professors, students and staff, and each evaluated 10 samples at 1, 7 and 14 days post-baking. In separate booths and under white light, sensory analysis was performed at a temperature of 22˚C. The cakes were placed in plastic packages that had hypothetical codes. The following equation was used to calculate the final score:

Final score= Total experience/Total coefficients

Statistical Analysis

A one-way analysis of variance was attained by processing the data with the Minitab Analysis System, and the existence of significant differences ($P< 0.05$) between mean values was tested by using Šidák's multiple range test. All processes were repeated three times.

RESULTS AND DISCUSSION

Effect of Mucilages on Batter Gravity

Figure 1 depicts the effects of mucilages upon the cake batters' specific gravities. The presence of mucilages has always significantly ($P< 0.05$) changed specific gravities of cake batter compared to the control sample with the exception of samples containing 0.75% psyllium and 0.5% marve. The highest batter of cake specific gravity was 1.120 and was obtained at sample with 0.75% psyllium+0.25% marve, while the lowest specific gravity was 1.03 and belonged to the sample with 0.25% psyllium+0.25% marve. Increases in specific gravity can be directly related to the decreases in the air volume incorporated in the batter. This fact could be explained by the increase in viscosity caused by hydrocolloids (Gomez *et al.,* 2007). Air bubbles that enter the batter during mixing negatively affect its specific gravity (Baeva *et al.,* 2000). Therefore, the decrease in the volume of air incorporated into the batter can directly explain these increases in specific gravities. As it is related to the final texture and volume of the cakes, the trapped air in the batter is the determining factor for specific gravity (Campbell and Mougeot, 1999).

Effect of Mucilages on Volume, Apparent Density and Symmetry

The results depicted in Table 1 indicated that higher volumes were obtained with the combination of both mucilages (about 0.25%). Additionally, when 1% of psyllium mucilage was added, an increase in a cake's apparent density was observed. A wide variety of factors affect cake volume and density, including the air bubbles trapped in the batter during mixing, and the batter specific gravity. An inverse relationship exists between volume and specific gravity (Desrochers *et al.,* 2004). The increase seen in batter specific gravity is due to the influence of mucilage on cake volumes, and slows down the rate of gas diffusion, allowing the retention of gas during the first step of baking. Furthermore, the addition of hydrocolloid increased water absorption because of the hydrogen bonding interaction between the hydroxyl groups of water and those of the polysaccharide macromolecules

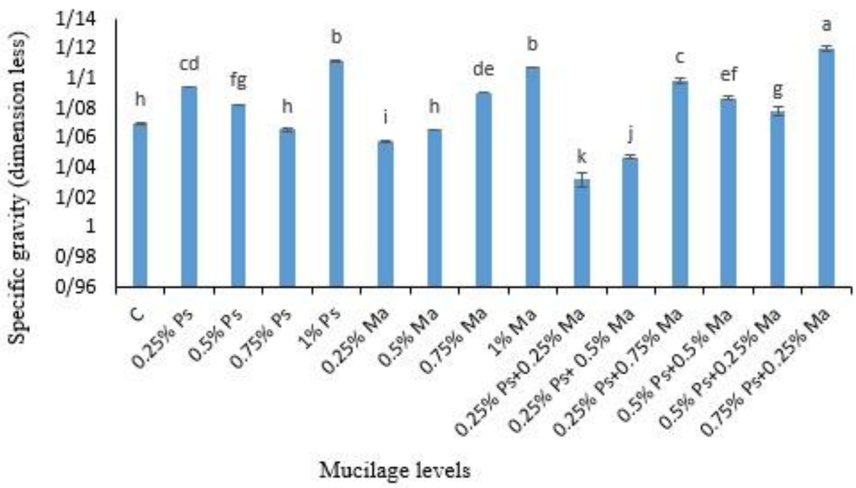

Figure 1. Specific gravity of sponge cake batter containing control sample (C) and different levels of Psyllium (Ps), Marve (Ma) and Psyllium/Marve mucilages.

Table 1. Physical properties of sponge cakes manufactured with and without (control) mucilages. [a]

Physical properties of sponge cakes			Mucilage levels (%)
Symmetry (cm)	Apparent density (g/cm^3)	Volume (cm^3)	
11.667±1.528[a]	0.431±0.016[cde]	77.33±3.79[bcdef]	Control
8.333±1.155[abcd]	0.475±0.002[abc]	75.67±2.08[cdef]	0.25% Psyllium
8.67±2.08[ab]	0.447±0.030[abcde]	77.67±2.52[bcde]	0. 5% Psyllium
10.667±0.577[ab]	0.419±0.005[de]	85±3.61[abc]	0.75% Psyllium
5.667±1.528[a]	0.495±0.018[a]	68±3.61[fg]	1% Psyllium
10±1.73[abc]	0.417±0.005[de]	80.67±2.08[abcde]	0.25% Marve
8.333±1.528[abcd]	0.446±0.029[abcde]	80±4[bcde]	0.5% Marve
7.333±1.155[bcde]	0.476±0.002[abc]	72.667±1.52[efg]	0.75% Marve
4±1[e]	0.493±0.015[ab]	64.67±3.51[g]	1% Marve
11±1.73[ab]	0.402±0.007[e]	90±3[a]	0.25% Psyllium+0.25% Marve
10.333±0.577[abc]	0.414±0.015[de]	85.67±2.08[ab]	0.25% Psyllium+0.5% Marve
6.667±0.577[cde]	0.458±0.023[abcd]	71.67±3.06[efg]	0.25% Psyllium+0.75% Marve
7.667±0.577[bcde]	0.439±0.018[bcde]	75.33±2.52[def]	0.5% Psyllium+0.5% Marve
9.667±0.577[abc]	0.411±0.009[abcde]	83±3[efg]	0.5% Psyllium+0.25% Marve
4.333±0.577[e]	0.454±0.024[de]	72±3[abcd]	0.75% Psyllium+0.25% Marve

[a] Values are the average of triplicates±standard deviation. For each characteristic, data followed by different letters are significantly (P< 0.05) different.

present in the mucilage (Chaplin, 2003; Dikeman and Fahey, 2006; Rosell *et al.*, 2001). If the water absorption increases dramatically, it would result in a batter of extremely high viscosity, in which air bubbles cannot be sufficiently trapped. An enhancement of batter viscosity could therefore decrease cake volume and hinder expansion. Generally, with an increase in mucilage percentage, the cake volume was reduced while its apparent density increased. Gomez *et al.* (2007) found that the cake volume increased when hydrocolloid was added. HajMohammadi *et al.* (2014), ShokriBusjin *et al.* (2004) and Sowmya *et al.* (2009) obtained results in agreement with the present study. Ayoubi *et al.* (2008) showed that the addition of guar and xanthan gums to the cake significantly reduced sample apparent density.

Evaluations with regard to symmetry conveyed that the addition of different percentages of mucilages significantly (P< 0.05) decreased cake symmetry. A reduction in cake symmetry from 11.667 cm to 4.1 cm was observed when flour was supplemented with 1% marve. Symmetry in the cake could mainly be due to good dispersion of the cake ingredients (baking powder) during the preparation of the batter, and also due to the regular and uniform distribution of air bubbles, which cause the dispersal of the gas achieved from improvers. With the increase in the amount of mucilage, viscosity increased excessively and reduced uniform distribution of air bubbles. Such a lowering of the symmetry index indicated that cake containing mucilage had a flatter surface. This coincides with its lower central height**.** Therefore, cakes with higher volume showed higher central height and at the same time a higher symmetry index. Guar gum cakes showed a lower symmetry index than control (Gomez *et al.*, 2007). Also, the addition of up to 0.5% basil seed mucilage significantly (p<0.05) decreased cake symmetry compared to the control sample (Peighambardoust *et al.*, 2016).

Effect of Mucilages on Water Retention during and after Baking

As portrayed in Table 2, one day after baking, the samples featuring 0.75% psyllium, 0.25% and 0.5% marve and 0.25% psyllium with 0.25% marve had the highest

Table 2. Moisture values of fresh and 14 days stored sponge cakes manufactured with and without (control) mucilages.[a]

Time (Day)			
14	7	1	Mucilage levels (%)
$14.022+0.283^{gB}$	$15.075+0.09^{gB}$	$18.674+0.759^{defA}$	Control
$16.824+0.741^{defA}$	$17.819+0.97^{defA}$	$18.633+0.828^{defA}$	0.25% Psyllium
$17.681+0.408^{bcdB}$	$17.6+0.366^{efB}$	$19.432+0.691^{cdefA}$	0. 5% Psyllium
$18.355+0.344^{abcB}$	$18.915+0.602^{bcdB}$	$20.904+0.072^{abA}$	0.75% Psyllium
$16.27+0.252^{fB}$	$17.507+0.3^{efAB}$	$18.54+0.055^{defA}$	1% Psyllium
$18.651+0.216^{abB}$	$19.985+0.646^{abAB}$	$20.864+0.123^{abA}$	0.25% Marve
$18.856+0.09^{aB}$	$20.309+0.175^{aAB}$	$21.265+0.173^{aA}$	0.5% Marve
$16.474+0.03^{efB}$	$16.796+0.05^{fB}$	$18.213+0.495^{fA}$	0.75% Marve
$16.27+0.252^{fB}$	$17.94+0.227^{defAB}$	$18.513+0.015^{defA}$	1% Marve
$18.067+0.351^{abcB}$	$19.573+0.412^{abcAB}$	$20.586+0.376^{abcA}$	0.25% Psyllium+0.25% Marve
$17.35+0.278^{cdeB}$	$18.5+0.361^{cdeAB}$	$19.543+0.289^{cdeA}$	0.25% Psyllium+0.5% Marve
$16.79+0.245^{defB}$	$17.447+0.142^{efAB}$	$18.410+0.201^{efA}$	0.25% Psyllium+0.75% Marve
$16.9+0.3^{defB}$	$17.6+0.2^{efAB}$	$18.733+0.208^{defA}$	0.5% Psyllium+0.5% Marve
$16.377+0.304^{efC}$	$18.035+0.233^{defB}$	$19.787+0.207^{bcdA}$	0.5% Psyllium+0.25% Marve
$16.37+0.234^{efB}$	$18.023+0.24^{defA}$	$18.633+0.065^{defA}$	0.75% Psyllium+0.25% Marve

[a] Values are the average of triplicates±standard deviation of the mean. Different small and capital letters represent significant differences (P< 0.05) in treatments and during storage, respectively.

contents of moisture. The lowest amount of moisture was observed in control sample 7 and 14 days after baking. The samples that had incorporated within them 0.5%, 0.75% marve and 0.25% marve with 0.25% psyllium had the maximum percentages of moisture, though the difference between them was not significant (P< 0.05). An increase in the absorption of water is caused by the interaction between the hydroxyl groups of water and those of the polysaccharide macromolecules present in the mucilages (Chaplin, 2003; Dikeman and Fahey, 2006; Rosell *et al.*, 2001). Arabinose and xylose molecules create the hydrogen bonds in the mucilages (Temudo *et al.*, 2008). The hydrophilic feature of mucilage causes interaction between flour and water and increases water retention during cooking and storage, resulting in amylopectin recrystallization. Gomez *et al.* (2007), Sidhu and Bawa (2002), Shalini and Laxmi (2007) obtained similar results with different gums.

Influence of Mucilages on Sponge Cake Texture

During 1, 7 and 14 days post-baking, textural analysis revealed (Table 3) that the softest and hardest samples were those that featured 0.25% psyllium+0.25% marve and 1% psyllium respectively. The hardness of the samples increased during maintenance. This increase was higher in the control sample and sample containing 1% psyllium mucilage. It was reported that the gums prevent the binding chains of amylose, resulting in the weakening of the structure of the starch by Biliaderis *et al.* (1997) who explained the different effects of hydrocolloids on bakery products, causing decreases in firmness. Additionally, gums prevent starch granules from swelling. However, the hydrogen bonding between the hydroxyl groups of water and those of the gum (Chaplin, 2003; Dikeman and Fahey, 2006; Rosell *et al.*, 2001) can cause moisture retention and a delay in staling (Fik and Surowka, 2002; Hug-Iten *et al.*, 2003; Sharadanant and Khan, 2003). According to Davidou *et al.* (1996), the addition of HPMC causes prevention of interaction between the polymers of starch, and also protein with starch, by the chains of the gum, resulting in the softening of the product texture. Ayoubi *et al.* (2008) improved the texture of products with the addition of guar gum and xanthan. The high percentage of mucilages hardens the cake due to excessive viscosity in the batter.

Table 3. Texture parameters of fresh and 14 days stored sponge cakes manufactured with and without (control) mucilages.[a]

Time (Day)			
14	7	1	Mucilage levels (%)
0.264+0.003 cdA	0.247+0.003 bAB	0.212+0.002 cB	Control
0.324+0.004 bA	0.236+0.056 bcB	0.170+0.007 deC	0.25% Psyllium
0.191+0.006 gA	0.177+0.003 deAB	0.145+0.001 fB	0. 5% Psyllium
0.161+0.002 hiA	0.146+0.003 efB	0.122+0.001 gB	0.75% Psyllium
0.370+0.002 aA	0.360+0.002 aAB	0.336+0.003 B	1% Psyllium
0.151+0.002 ijA	0.136+0.003 efAB	0.112+0.001 ghiB	0.25% Marve
0.181+0.006 gA	0.167+0.003 defAB	0.135+0.001 fB	0.5% Marve
0.224+0.004 fA	0.196+0.007 cdAB	0.160+0.007 eB	0.75% Marve
0.270+0.002 cA	0.260+0.002 bAB	0.234+0.002 bB	1% Marve
0.142+0.001 jA	0.126+0.002 fAB	0.103+0.002 iB	0.25% Psyllium+0.25% Marve
0.148+0.002 jA	0.132+0.001 efAB	0.109+0.002 ihB	0.25% Psyllium+0.5% Marve
0.254+0.001 dA	0.228+0.003 bcAB	0.175+0.002 dC	0.25% Psyllium+0.75% Marve
0.239+0.002 eA	0.215+0.003 bcdAB	0.164+0.001 eC	0.5% Psyllium+0.5% Marve
0.162+0.003 hA	0.144+0.001 efAB	0.120+0.002 ghB	0.5% Psyllium+0.25% Marve
0.258+0.002 dA	0.247+0.002 bAB	0.224+0.003 bB	0.75% Psyllium+0.25% Marve

[a] Values are the average of triplicates±standard deviation of the mean. Different small and capital letters represent significant differences (P<0.05) in treatments and during storage, respectively.

Table 4. Crumb colour characteristics of sponge cakes manufactured with and without (control) mucilages.[a]

Colour factor			
*b**	*a **	*L**	Mucilage levels (%)
22.264+0.010 a	2.047+0.001 a	41.12+1.122 b	Control
25.324+0.014 a	1.536+0.026 a	45.70+1.227 ab	0.25% Psyllium
26.191+0.016 a	1. 474+0.013 a	48.35+1.001 ab	0. 5% Psyllium
32.161+0.022 a	1.146+0.023 a	51.12+1.051 ab	0.75% Psyllium
23.940+0.012 a	1.060+0.014 a	43.26+2.004 ab	1% Psyllium
21.151+0.023 a	1.336+0.012 a	44.11+1.401 ab	0.25% Marve
28.181+0.021 a	1.267+0.015 a	56.30+2.071 a	0.5% Marve
35.224+0.032 a	1.096+0.017 a	46.23+1.347 ab	0.75% Marve
26.270+0.035 a	1.060+0.022 a	43.23+1.242 ab	1% Marve
29.142+0.014 a	1.826+0.032 a	49.84+2.042 ab	0.25% Psyllium+0.25% Marve
27.148+0.026 a	1.632+0.011 a	49.00+1.132 ab	0.25% Psyllium+0.5% Marve
25.254+0.018 a	1.428+0.012 a	44.17+2.142 ab	0.25% Psyllium+0.75% Marve
24.239+0.014 a	1.415+0.001 a	43.64+1.361 ab	0.5% Psyllium+0.5% Marve
26.162+0.025 a	1.344+0.011 a	47.13+2.135 ab	0.5% Psyllium+0.25% Marve
26.258+0.041 a	1.147+0.013 a	45.64+1.713 ab	0.75% Psyllium+0.25% Marve

[a] Values are the average of triplicates±standard deviation. For each characteristic, data followed by different letters are significantly (P< 0.05) different.

similar results were obtained by Hajmohammadi *et al.* (2014).

Effect of Mucilages on Colour Properties

The lowest *L** value was 41.12 and was obtained at control sample, while the highest *L** value was 56.30 and belonged to the sample with 0.5% marve (Table4). The difference between them was significant (P< 0.05). According to Lazaridou (2007) increasing *L** value was due to retention of moisture by the gums. Retention of moisture during the baking process reduced the level of crust changes in bakery products. The Lightening of cake was due to changes of crust. Uniform crust more than non-uniform crust enhanced L^* value. Sadeghnia *et al.* (2011) and Sahraiyan *et al.* (2014) obtained results in agreement with the present study.

Effect of Mucilages on Sensory Evaluation

Based on the overall acceptability of the product one day after baking (Table 5), it can be stated that hydrocolloid addition, with the exception of 1% of each of the mucilages or compound of mucilages up to 1%, led to a greater appreciation by the panelists of sponge cake than of the control cake. The chewiness, flavour, softness/hardness and overall acceptability were evaluated for staling during storage (7 and 14 days after baking). In general, the highest overall sensory score was obtained when 0.25% marve+0.25% psyllium, 0.25 and 0.5% marve were used, while there was no significant difference between them ($P< 0.05$). According to Bench (2007) increasing acceptance is due to retention of moisture, softness and flavour by the gums. Similar results were obtained for the incorporation of hydrocolloids in products by HajMohammadi *et al.* (2014) and Sowmya *et al.* (2009).

CONCLUSIONS

The highest and lowest specific gravity was related to samples containing 0.75% psyllium+0.25% marve and 0.25% psyllium+0.25% psyllium respectively. The higher volume and lower apparent density were obtained about 0.25% with the combination of both mucilages. The addition of different percentage of mucilages decreased cake symmetry. The softest and hardest samples were those featuring 0.25% psyllium+0.25% marve and 1% psyllium respectively. During maintenance, the control sample had the lowest moisture. Presence of mucilage improved panellist's overall sensory score, especially when 0.25% marve, 0.5% marve, and 0.25% marve and 0.25% psyllium were used.

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Table 5. Overall acceptability of fresh and 14 days stored sponge cakes manufactured with and without (control) mucilages.[a]

Time (Day)			
14	7	1	Mucilage levels (%)
$2.958+0.361^{efB}$	$3.292+0.191^{cdB}$	$4.125+0.109^{cdeA}$	Control
$2.958+0.191^{efB}$	$3.541+0.144^{bcdB}$	$4.191+0.87^{bcdeA}$	0.25% Psyllium
$3.125+0.125^{defB}$	$3.625+0.125^{abcdB}$	$4.408+0.238^{abcdA}$	0. 5% Psyllium
$3.458+0.144^{cdB}$	$3.916+0.07^{abcdB}$	$4.591+0.123^{abcA}$	0.75% Psyllium
$2.833+0.144^{fB}$	$3.292+0.191^{cdB}$	$3.933+0.137^{deA}$	1% Psyllium
$3.873+0.125^{abcB}$	$4.040+0.06^{abcAB}$	$4.516+0.076^{abcdA}$	0.25% Marve
$3.996+0.125^{abB}$	$4.357+0.206^{aAB}$	$4.856+0.051^{aA}$	0.5% Marve
$3.357+0.206^{deB}$	$3.873+0.125^{abcdAB}$	$4.207+0.261^{bcdeA}$	0.75% Marve
$2.873+0.125^{fB}$	$3.19+0.233^{dAB}$	$3.75+0.25^{eA}$	1% Marve
$4.08+0.07^{aB}$	$4.25+0.433^{abAB}$	$4.766+0.152^{abA}$	0.25% Psyllium+0.25% Marve
$3.583+0.07^{bcdB}$	$3.833+0.191^{abcdB}$	$4.633+0.202^{abcA}$	0.25% Psyllium+0.5% Marve
$2.916+0.07^{efB}$	$3.167+0.289^{dB}$	$3.967+0.401^{deA}$	0.25% Psyllium+0.75% Marve
$2.958+0.07^{efB}$	$3.5+0.5^{bcdAB}$	$4.08+0.06^{cdeA}$	0.5% Psyllium+0.5% Marve
$3.466+0.028^{cdB}$	$3.833+0.289^{abcdAB}$	$4.157+0.178^{cdeA}$	0.5% Psyllium+0.25% Marve
$2.956+0.07^{efB}$	$3.23+0.191^{dB}$	$3.916+0.144^{deA}$	0.75% Psyllium+0.25% Marve

[a] Values are the average of triplicates±standard deviation of the mean. Different small and capital letters represent significant differences ($P< 0.05$) in treatments and during storage, respectively.

REFERENCES

1. AACC. 2000. *Approved methods of the American Association of Cereal Chemists*. 10th Edition,: American Association of Cereal Chemists, Inc., St. Paul, MN.
2. Apling, E. E., Khen, P. and Ellis, P. R. 1978. Guar/Wheat Bread for Therapeutic Use. *Cereal Food. World*, **23:** 640-644.
3. Askari, H., Farahnaky, A., Aminlari, M., Majzoobi, M. and Mesbahi, G. H. 2008. Extraction of Mucilage Gum (*Plantago ovata L.*) and the Study of Its Rheological Properties. *Proceedings of the Eighteen National Congress on Food Technology*, Mashhad, Iran. (in Persian)
4. Ayoubi, A., Najafi, M. and Karimi, M. 2008. The Effects of Adding Whey Protein Concentrates (WPC) and Guar and Xanthan Gums on Quality and Physicochemical Properties of Cake. *Iranian Food Sci. Technol. Res. J*., **4**(**2**)**:** 33-46. (in Persian)
5. Azizi, M.H., Rajabzadeh, N. and Riahi, E. 2003. Effect of Mono-Diglyceride and Lecithin on Dough Rheological Characteristics and Quality of Flat Bread. Lebensm. *Wiss. U. Technology (LWT)*, **36:** 189-193.
6. Baeva, M. R., Panchev, I. N. and Terzieva, V. V. 2000. Comparative Study of Texture of Normal and Energy Reduced Sponge Cakes. *Die Nahrung*, **44:** 242-246.
7. Bench, A. 2007. Water Binders for Better Body: Improving Texture and Stability with Natural Hydrocolloids. *Food Beverage Asia*, 32-3
8. Bijkerk, C. J., Muris, J. W. M., Knottnerus, J. A., Hoes, A. W. and DE WIT, N. J. 2004. Systematic Review: The Role of Different Types of Fiber in the Treatment of Irritable Bowel Syndrome. *Alimentary Pharm. Ther*., **19:** 245-251.
9. Biliaderis, C. G., Arvanitoyannis, I., Izydroczyk, M. S. and Prokopowich, D. J. 1997. Effect of Hydrocolloids on Gelatinization and Structure Formation in Concentrated Waxy Maize and Wheat Starch Gels. *Starch/Staerke*, **49:** 278-283.
10. Bostan, A., Razavi, S. M. A. and *Farhoosh, R. 2010.* Optimization of Hydrocolloid Extraction from Wild Sage Seed *(Salvia macrosiphon*) Using Response Surface Methodology. *Int. J. Food Prop.*, **13**(**6**)**:** 1380-1392.
11. Campbell, G. M. and Mougeot, E. 1999. Creation and Characterization of Aerated Food Products. *Trend. Food Sci. Technol*., **10:** 283-296.
12. Chaplin, M. F. 2003. Fiber and Water Binding. *Proceed. Nutr. Soc.*, **62:** 223-227.
13. Davidou, S., Le Meste, M., Debever, E. and Bakaert, D. 1996. A Contribution to the Study of Saling of White Bread: Effect of Water and Hydrocolloid. *Food Hydrocol.*, **10:** 375-383.
14. Desrochers, J. L., Seitz, K. D., Walker, C. E., Wrigley, C. and Colin, W. 2004. *Cakes, Chemistry of Manufacture.* Encyclopedia of Grain Science, Elsevier, PP. 129-133.
15. Dikeman, C. L. and Fahey J. R. G. C. 2006. Viscosity as Related to Dietary Fber: A Review. *Crit. Rev. Food Sci. Nutr.*, **46:** 649-663.
16. Fik, M. and Surowka, K. 2002. Effect of Prebaking and Frozen Storage on the Sensory Quality and Instrumental Texture of Bread. *J. Sci. Food Agri.*, **82:** 1268-1275.
17. Fischer, M. H., Yu, N., Gray, G. R., Ralph, J., Anderson, L. and Marletta, J. A. 2004. The Gel Forming Polysaccharide of Psyllium Husk (*Plantago ovata* Forsk). *Carbohydr. Res.*, **339:** 2009-2017.
18. Gomez, M., Ronda, F., Caballero, P. A., Blanco, C. A. and Rosell, C. M. 2007. Functionality of Different Hydrocolloids on the Quality and Shelf-life of Yellow Layer Cakes. *Food Hydrocol.*, **21:** 167-173.
19. Gulc, I., Oktay, M., Recci, E. and Kufrev, R. 2003. Screening of Antimicrobial and Antioxidant Activities Anise Seed Extracts. *Food Chem*., **83:** 371-382.
20. Hajmohammadi, A., Keramat, J., Hojjatoleslami, M. and Molavi, H. 2014. Evaluation Effect of Tragacanth Gum on Quality Properties of Sponge Cake. *Iran. J. Food Sci. Technol.*, **42**(**11**)**:** 1-8. (in Persian)
21. Hess, A. and Setser, C. S. 1983. Alternative Systems for Sweetening Layer Cake Using Aspartame with and without Fructose. *Cereal Chem.*, **60:** 337-341.
22. Hug-Iten, S., Escher, F. and Conde-Petit, B. 2003. Staling of Bread: Role of Amylose and Amylopectin and Influence of Starch-Degrading Enzymes. *Cereal Chem.*, **80:** 654-661.
23. Kocer, D., Hicsasmaz, Z., Bayindirli, A. and Katnas, S. A. 2007. Bubble and Pore Formation of the High-Ratio Cake

Formulation with Polydextrose as a Sugar- and Fat-Replacer. *J. Food Eng.*, **78:** 953-964.

24. Lazaridou, A., Duta, D., Pagageorgiou, M., Belc, N. and Biliaderis, C. G. 2007. Effects of Hydrocolloids on Dough Rheology and Bread Quality Parameters in Gluten–Free Formulations. *J. Food Eng.*, **79:** 1033-1047.
25. Lee, C.C., Wang H. F. and Lin S. D. 2008. Effect of Isomaltooligosaccharide Syrup on Quality Characteristics of Sponge Cake. *Cereal Chem.*, **85:** 515-521.
26. Lin, S. D., Hwang, C. F. and Yeh, C. H. 2003. Physical and Sensory Characteristics of Chiffon Cake Prepared with Erythritol as Replacement for Sucrose. *J. Food Sci.*, **68:** 2107-2110.
27. Matsakidou, A., Blekas, G. and Paraskevopoulou, A. 2010. Aroma and Physical Characteristics of Cakes Prepared by Replacing Margarine with Extra Virgin Olive Oil. *LWT - Food Sci. Technol.*, **43:** 949-957.
28. Izadi Najafabadi, L., Hamdami, N., Le-Bail, A., Monteau, J. Y. and Keramat, J. 2015. Impact of Baking Bed and Baking Temperature on Staling of Sangak Bread. *J. Agr. Sci. Tech.*, **17:** 375-386.
29. Peighambardoust, S. H., Homayouni_Rad, A., Beikzadeh, S. and Javarai Asghari-Abadi, M. 2016. Effect of Basil Seed Mucilage on Physical, Sensory and Staling Properties of Sponge Cake. *Iranian J. Biosys. Eng*. **47**(**1**)**:** 1-9. (in Persian)
30. Razavi, S. M. A., Bostan, A. and Rahbari, R. 2010. Computer Image Analysis and Physic-Mechanical Properties of Wild Sage Seed (*Salvia macrosiphon*). *Int. J. Food Prop.*, **13**(**2**)**:** 308-316.
31. Ronda, F., Gamez, M., Blanko, C. A. and Caballero, P. A. 2005. Effects of Polyols and Nondigestible Oligosaccharides on the Quality of Sugar-Free Sponge Cakes. *Food Chem.*, **90:** 549-555
32. Rosell, C. M., Rojas J. A., Benedito D. E. and Barberr, C. 2001. Influence of Hydrocolloids on Dough Rheology and Bread Quality. *Food Hydrocol.*, **15,** 75-81.
33. Sadeghnia, N., Azizi, M. H. and Seyedin, M. 2011. Formulation and Production Gluten Free Flat Bread by Xanthan and CMC. MSc. Thesis, Department of Food Science and Technology, Islamic Azad University. (in Persian)
34. Sahraiyan, B., Karimi, M., Habibi Najafi, M. B., Hadad Khodaparast, M. H., Ghiafeh Davoodi, M., Sheikholeslami, Z. and Naghipour, F. 2014. The Effect of Balangu Shirazi (*Lallemantiaroyleana*) Gum on Quantitative and Qualitative of Surghum Gluten Free Bread. *Iranian J. Food Sci. Technol.*, **42**(**11**)**:** 129-139. (in Persian)
35. Shalini, K. G. and Laxmi, A. 2007. Influence of Additives on Rheological Characteristics of Whole-Wheat Dough and Quality of Chapati (Indian Unleavened Flat Bread). Part I-Hydrocolloids. *Food Hydrocol.*, **21:** 110-117.
36. Sharadanant, R. and Khan, K. 2003. Effect of Hydrophilic Gums on the Quality of Frozen Dough. II. Bread Characteristics. *Cereal Chem.*, **80:** 773-780.
37. Shokri Busjin, Z. 2004. Evaluation of Relationship between Structure, Operational and Rheological Properties of Tragacanth Gum and Comparison with Arabic Gum and It's Utilization in a Cake. MSc. Thesis, University of Technology, Isfahan. (in Persian)
38. Sidhu, J. P. S. and Bawa, A. S. 2002. Dough Characteristics and Baking Studies of Wheat Flour Fortified with Xanthan Gum. *Int. J. Food Prop.*, **5:** 1-11.
39. Singh, B. 2007. Psyllium as Therapeutic and Drug Delivery Agent. *Int. J. Pharm.*, **334:** 1-14.
40. Sowmya, M., Jeyarani, T., Jyotsna, R. and Indrani, D. 2009. Effect of Replacement of Fat with Sesame Oil and Additives on Rheological, Microstructural, Quality Characteristics and Fatty Acid Profile of Cakes. *Food Hydrocol.*, **23:** 1827-1836.
41. Temudo, M. S., Nunes, M. C., Batista, A. P., Carvalheiro, F., Esteves, M. P. and Raymundo, A. 2008. Physicochemical Characterization of Psyllium Fibre. In: “Gums and Stabilisers for the Food Industry”. (Eds.): Williams, P. A. and Phillips, G. O. R. Soc. Chem., PP. 572-577.

بررسی اثر افزودن موسیلاژهای اسفرزه و مرو بر ویژگیهای فیزیکی، بیاتی و حسی کیک اسفنجی

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چکیده

محصولات صنایع نانوایی پس از طی فرآیند پخت، دستخوش تغییرات فیزیکوشیمیایی مختلفی می شوند که در مفهوم کلی آنرا بیاتی می‌نامند. به تاخیر انداختن بیاتی یکی از مسائل مهم صنایع پخت بوده و از جنبه تغذیه‌ای و اقتصادی حائز اهمیت می‌باشد. یکی از راههای به تعویق انداختن بیاتی، استفاده از هیدروکلوئیدها به ویژه موسیلاژ گیاهان و دانه‌های بومی است که از نظر داشتن خواص دارویی، تغذیه‌ای و ارزان قیمت بودن حائز اهمیت هستند. از این‌رو در این مطالعه به تاثیر درصدهای مختلف موسیلاژ دانه اسفرزه (۰، ۰/۲۵، ۰/۵، ۰/۷۵ و ۱ درصد)، موسیلاژ دانه مرو (۰، ۰/۲۵، ۰/۵، ۰/۷۵ و ۱ درصد) و ترکیبی از هر دو موسیلاژ تا حداکثر یک درصد بر ویژگی‌های فیزیکی، حسی و بیاتی نمونه‌های کیک پرداخته شد. نتایج حاکی از این بود که با افزودن موسیلاژها ویژگی‌های کیفی کیک اسفنجی پیشرفت می‌کند بجز وقتیکه غلظت حداکثر یک درصد موسیلاژها افزوده شد. افزودن موسیلاژها به صورت ترکیبی از ۰/۲۵ درصد موسیلاژ اسفرزه با ۰/۲۵ درصد موسیلاژ مرو باعث پیشرفت ویژگی‌های (حجم، پذیرش کلی، بافت و رطوبت در طول نگهداری) نمونه‌ها نسبت به نمونه کنترل شد.