Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

Rheological batter and textural characteristics of gluten-free sponge cake containing pumpkin powder

Mohammad Mansour Samie [1], Aryou Emamifar [2]*, Fakhreddin Salehi[3]

1- M.Sc Student of Food Sciences and Technology, Department of Food Science and Technology, Bu-Ali Sina University, Hamedan, Iran.
2- Associated professor, Department of Food Science and Technology, Bu-Ali Sina University, Hamedan, Iran
3- Associate Professor, Department of Food Science and Technology, Bu-Ali Sina University, Hamedan, Iran

ABSTRACT

The objective of this study was to investigate the effect of replacing of rice flour with different ratios (0, 10, 20, and 20% w/w) of pumpkin powder on the rheology of batter and textural characteristics of gluten free rice cake. A factorial experiment with a completely randomized design with three replications was used for data analysis. The use of pumpkin powder in rice cake formulations significantly improved rheology of batter and textural characteristics of the samples ($p< 0.05$). By increasing the replacement level of rice flour with pumpkin powder to 30%, viscosity (from 682.66 to 3518.44 cp), hardness (from 21.11 to 53.97 g), cohesiveness (from 0.83 to 0.94), and springiness (from 9.74 to 13.49 mm) of batter cake improved significantly, but the adhesiveness (3.15 mJ) of batter increased compared to control (1.08 mJ) ($p <0.05$). However, the incorporation of pumpkin powder in the sample formulations up to 30%, increased the hardness (from 456.17 to 800.11 g), cohesiveness (from 0.56 to 0.67), springiness (from 8.68 to 11.43 mm), and chewiness (from 2231 to 6148 g) of the final cakes. Addition of pumpkin powder (up to 30%) in gluten free rice cake formulation caused the significant increasing of the total color differences (ΔE), browning index, and saturation index (chroma) in the cakes compared to control and moreover, increased the hue angle to 90^{o}which indicated an increase in the yellowness of the samples containing higher the replacement level of rice flour with pumpkin powder.

ARTICLE INFO

Article History:

Received: 2023/5/15
Accepted: 2023/8/12

Keywords:

Cake Batter,
Pumpkin,
Rheology,
Texture.

DOI :10.22034/FSCT.20.142.68
DOR:20.1001.1.20088787.1402.20.142.5.5

*Corresponding Author E-Mail:
a.emamifar@basu.ac.ir

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

1- Introduction

Celiac disease is an autoimmune systemic disorder and an inflammatory disease of the gastrointestinal tract that appears due to the contact of gluten with the cells of the small intestine with symptoms such as diarrhea, lack of growth, fatigue and anemia. Therefore, today, the demand for gluten-free products has increased from celiac patients[1]. The use of high-consumption bakery products in today's societies, including all kinds of cakes, is not possible in celiac societies due to the gluten in their formulation, which creates part of the structure of the final product.[2]. Rice, corn and potato flours are suitable substitutes for wheat flour in the production of gluten-free bakery products, which are sometimes used in combination [3]. Pumpkin with scientific name (*Musk squash*L.) belongs to the gourd family, it is a dicotyledonous vegetable with annual fruiting [4]. This useful fruit is rich in carotenoids (2-10 mg per 100 grams of fruit), vitamin C (9-10 mg per 100 grams of fruit) and vitaminAND (1.03 to 1.06 milligrams per 100 grams of fruit).Pumpkin is a rich source of various types of fiber, which, by being present in food formulations, increases the ability to absorb water and oil, and also has a direct effect on improving the health of the digestive system [5, 6].The addition of beneficial food compounds in bakery products has an effect on the rheological characteristics of the dough, the texture and sensory characteristics of the final product.[7]. Labsi et al. (2011) announced that the presence of soluble and insoluble fibers in the sponge cake formulation caused the softness and hardness of the final product, respectively [8]. Cake, similar to other bakery products, is a product with a porous texture, which is produced by increasing the temperature of the dough emulsion in the baking process. During the baking process, the moist air bubbles in the cake texture are fixed in the form of tiny pores in the cake texture [9]. Examining the rheological characteristics of the dough of cereal products such as cake has a determining role on the volume, texture and porosity of the final product [10]. The combination of pumpkin flour with other flours in the production of bakery products has a direct effect on the rheology of the dough and the textural characteristics of the final product due to the difference in the physicochemical characteristics of both types of flour [11].The studies conducted by Kondo et al. (2012) on the effect of adding pumpkin powder and guar gum on the rheological properties of dough showed that adding pumpkin powder to wheat flour decreased water absorption and increased the index of tolerance to mixing and dough resistance [12]. Part of the qualitative evaluation of cake dough structure is done with the help of rheological tests such as viscosity and viscoelastic characteristics of the dough [13]. The way of penetration, amount and duration of air bubble stability in the structure of protein and starch have a direct effect on the rheology of the cake dough and the texture structure of the final product [14].The evaluation of the rheological characteristics of cake dough is used in determining factors such as the intensity of product process factors, the choice of flour type and the amount of replacement of substitute flour with basic flour in cake production, the amount of replacement of sweeteners instead of sugar in cake formulation, as well as the type and method of dough aeration.[15]. Meza et al. (2011) investigated the rheology of cake

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

dough and stated that although the type of formulation and the amounts of its components are effective in determining the viscoelastic characteristics of the dough of all types of cakes, the dough of most cakes has a rheological behavior of the thinning type.[16]. The texture profile analysis test is one of the cake texture measurement methods that almost mimics the oral characteristics of the cake and corresponds to the consumer's feeling in the degree of firmness, chewing power, or elasticity of the cake texture.[17]. Examining the cake dough rheology and achieving the desired cake dough formulation not only improves the flowability of the dough, but also leads to the production of a product with a favorable and customer-friendly texture quality.The purpose of this research was to investigate the effects of different amounts of pumpkin powder as a substitute for rice flour on the rheological characteristics of the dough and the texture changes of gluten-free cakes based on rice flour.

2- Materials and methods

1-2- raw materials

Rice flour (moisture 61.8%, protein 49.8% and ash 0.89%) was obtained from Javed Fuman Company. Pumpkin flour (moisture 10.28%, protein 14.76%, ash 59.7% and crude fiber 10.1%) was obtained from Soghat Kavir Kermanshah Company and stored in polyethylene bags under vacuum at 20- °C was kept. Sugar (Kamka Company), sunflower liquid oil (Laden Company), eggs (Talaung Company) and baking powder and vanilla (Polar Company) used in the formulation of gluten-free cakes were obtained from a reputable store in the city.

2-2- Methods

1-2-2- Preparation of dough and cake production

Gluten-free rice cake (control sample) based on 100 grams of rice flour using rice flour (100 grams), sugar (100 grams), eggs (100 grams), water (100 grams), baking powder (4.8 grams) and vanilla (2.8 grams) was prepared. The ingredients used in the preparation of the cake were mixed and prepared in several stages. In the first step, sugar and eggs were mixed for 4 minutes, then baking powder and vanilla were added and mixed with other ingredients for 2 minutes. In the third step, other dry ingredients such as rice and wheat flour (depending on the type of cake) and pumpkin flour were sifted and added to the formulation and mixed well for 4 minutes. The obtained dough was filled in paper cups (with a volume of 30 ml) and placed in steel trays for the baking stage. During the cake baking stage, the cups containing the dough are placed in the electric oven (FI5 851 P IX, Italy) preheated at a temperature of 180 degrees Celsius and the cake was baked for 35 minutes. After cooling at room temperature, the necessary evaluations were done on the produced cakes [18]. The final product was produced and evaluated by replacing rice flour with 0, 10, 20 and 30% of pumpkin flour (weight-weight ratio) compared to the control sample.

2-2-2- Evaluation of dough viscosity

Viscosity of different dough formulations with Brookfield viscometer (Brookfield, RV2T, USA) and was measured using spindle number 5, at a cutting speed of 10 rpm, at a temperature of 25 degrees Celsius and in three repetitions.[19].

3-2-2- Dough texture profile evaluation

The dough was placed at ambient temperature for one hour before the test, and its texture was measured by back extrusion method with a texture tester(Brookfield - CT310K, USA) evaluated. The samples were filled up to a height of 3 cm in test cylinders (diameter 40 mm and height 50 mm). The change of penetration force of cylindrical smooth probe (diameter 25.4 mm) was evaluated over time with a constant reciprocating speed of 1 mm/s and two reciprocations. By using the force-time

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

curve (in grams of force per second), textural characteristics including firmness, consistency, stretchability, stickiness, gumminess, and chewability were determined [20].

4-2-2- Evaluation of cake texture profile

Texture cake using a texture measuring device (Brookfield -CT310K, USA) evaluated. 2 hours after baking, the samples were cut into rectangular cube pieces with dimensions of 2 by a sharp knife×2×2 cm were cut. The change of the compression force of the cylindrical probe with a diameter of 3.6 cm was evaluated over time with a constant reciprocating speed of 1 mm/s and two reciprocating cycles. The speed of the force before, during and after the test was 2, 1 and 2 mm/s respectively. By using the force-time curve (in grams per second), textural properties including firmness, cohesion, stretchability, adhesion, chewability, and gumminess were measured [20].

2-2-5- Cake color evaluation

The image processing method was used to evaluate the color of the cake. First, 25 mm slices were prepared from the brain of the samples and then with the help of a scanner (HP, Japan) were photographed with a resolution of 300 pixels. By activating the color space of the section (Plugins), space (LAB(active and color indicators)L) ،(a) And (b) were determined. Other color indicators include general color change ($\Delta E = \sqrt{(L_2 - L_1)^2 + (a_2 - a_1)^2 + (b_2 - b_1)^2}$), Hue angle ($Hue = \frac{b}{a}$), saturation ($Chroma = \sqrt{a^2 + b^2}$) and browning index ($x = \frac{a+1.75\,L}{5.645\,L+a-3.012\,b}, BI = \frac{[100 \times (x-0.31)]}{0.17}$) were calculated according to the main color indicators [21].

2-3- Statistical analysis

This research was conducted based on the factorial method and according to a completely random statistical design by replacing pumpkin powder with rice flour (at four levels of zero, 10, 20 and 30% pumpkin powder) weight-weight based on rice flour and in three replications. Data analysis with statistical software (SPSS) and the comparison of means was done based on Duncan's multi-range test at a significance level of 5%.

3. Results and Discussion

3-1- Paste viscosity

The changes in dough viscosity by replacing rice flour with different amounts of pumpkin powder are shown in Figure 1. The results of comparing the averages showed that by replacing the pumpkin powder, the viscosity of the dough increased significantly (0.05p<). The increase in viscosity can be related to the presence of abundant amounts of fiber and hydrophilic compounds containing hydroxyl groups in the structure of pumpkin powder. Maleki Eski et al. (2017) investigated the replacement of wheat flour with pumpkin powder in the production of sponge cake and concluded that the presence of abundant amounts of fiber and hydrophilic compounds with hydroxyl groups in the structure of pumpkin powder has a significant effect on increasing the viscosity of the resulting dough, which was consistent with the results of this research. [22]. Salehi et al. (2018) stated that with the increase of hydrophilic compounds such as soy protein isolate powder and basil seed gum in rice cake formulation, the dough viscosity increases [23]. Ganjiwatan and Hosseini Qaboos (2020) classified cake batter containing 10% pumpkin powder replaced with wheat flour in the group of non-Newtonian fluids dependent on shear and time [24].

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

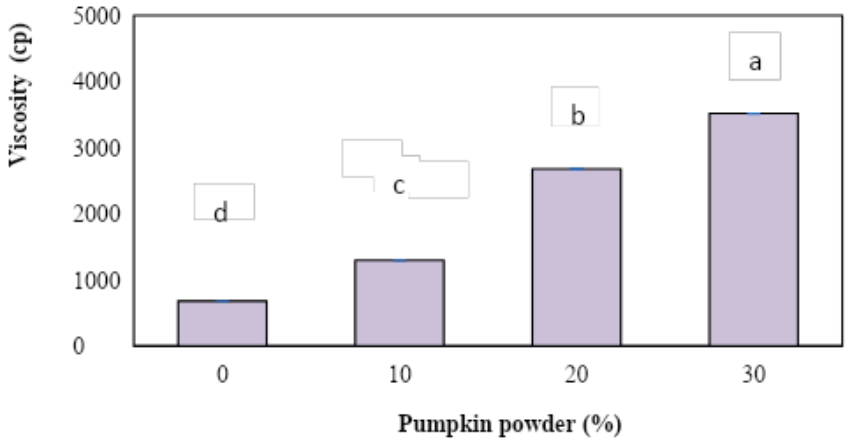


Fig 1. The effect of replacing rice flour with varying levels of pumpkin powder on the apparent viscosity of cake batter samples. Different letters are significantly different (p<0.05)

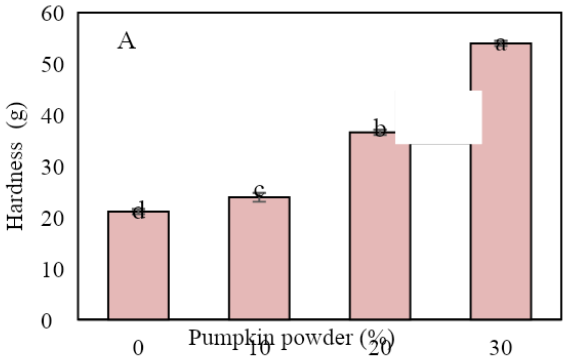
2-3- Dough back extrusion test results

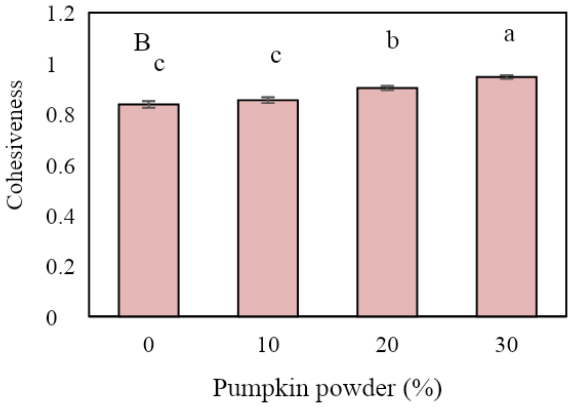
Evaluating the texture profile of the dough is the examination of the texture variables of the dough during force application. The stiffness variable is the maximum force used in the first pressing period and is the strength or strength of the dough. According to Figure 2, by increasing the ratio of replacing rice flour with pumpkin powder, the firmness of the produced cake dough increased significantly (05/0p<). The increase in consistency and firmness of the dough can be related to the increase in the amount of protein and fiber in the dough formulation containing pumpkin powder compared to the control sample. Moore et al. (2004) increased the dough stiffness of gluten-free products by adding protein compounds [25]. Siarani et al. (2010) also increased the strength and stiffness of the dough by adding soy powder as a protein source in the formulation of gluten-free dough, which was consistent with the results of this research [26]. According to Figure 2, by increasing the ratio of replacing rice flour with pumpkin powder to 30%, the consistency of the dough increased significantly (0.05).p<). The consistency of the dough shows the resistance and the degree of the dough's disintegration during the application of force. This indicator plays an important role in increasing the volume of the final product and maintaining air bubbles during dough mixing. The increase in consistency of the dough can be attributed to the increase in the amount of fiber and protein in the formulation of doughs containing higher amounts of substitution (30%) with pumpkin powder. Ayado et al. (2018) reported that increasing the consistency of cake dough is related to increasing the amount of fiber and protein in the dough formulation and finally increasing the absorption of free water in the dough formulation [27]. Martinez et al. (2014) reported that increasing the presence of fiber in the dough formulation increases the strength and cohesiveness of the dough due to the formation of a strong structure with starch granules in the dough.28]. Singh et al. (2016) stated that the addition of carrot puree to gluten-free cake dough increases the cohesiveness and strength of the dough by reducing free water in the formulation and facilitating the movement of particles in the dough texture.29]. Increasing the level of replacing rice flour with pumpkin powder in

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

the cake formulation up to 30%, has a significant effect on the elasticity of the dough (0.05p<) added (Figure 2). The increase in the elasticity of the dough can be related to the increase in the amount of protein and fiber and as a result, the reduction of free water in the dough tissue. Ayado et al. (2018) announced the increase in elastic modulus and stretchability of gluten-free cake dough using soluble fibers in the formulation [27]. In the dough of products containing two or more types of flour, the temperature of gelation is increased and therefore enough time is provided for the presence and expansion of air bubbles in the dough texture during the baking process, and as a result of the increase in volume and porosity of the final product, the texture of the product will be more elastic.[30]. Kondo et al. (2014) showed that replacing pumpkin powder with wheat flour in the sponge cake formulation by developing the interaction of pumpkin protein and fiber with other components of the dough formulation, increased the elasticity of the dough.Gives[12]. According to Figure 2, adding up to 30% of pumpkin powder to the dough formulation, the stickiness increased significantly (0.05p<). The increase in dough stickiness can be related to the increase in the viscosity of the dough containing pumpkin powder (Figure 1). [22]. An excessive increase in viscosity increases the stickiness of the dough by preventing the dispersion and uniformity of air bubbles in the dough texture and ultimately the bubbles joining together [31]. The characteristics of chewing power and gumminess are also dependent on the degree of stiffness and cohesion of the dough and indicate the amount of energy required to destroy the dough tissue [20]. According to figure 2By increasing the replacement rate of rice flour with pumpkin powder up to 30%, two properties of chewing power and gumminess increased significantly (0.05).p<).





[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

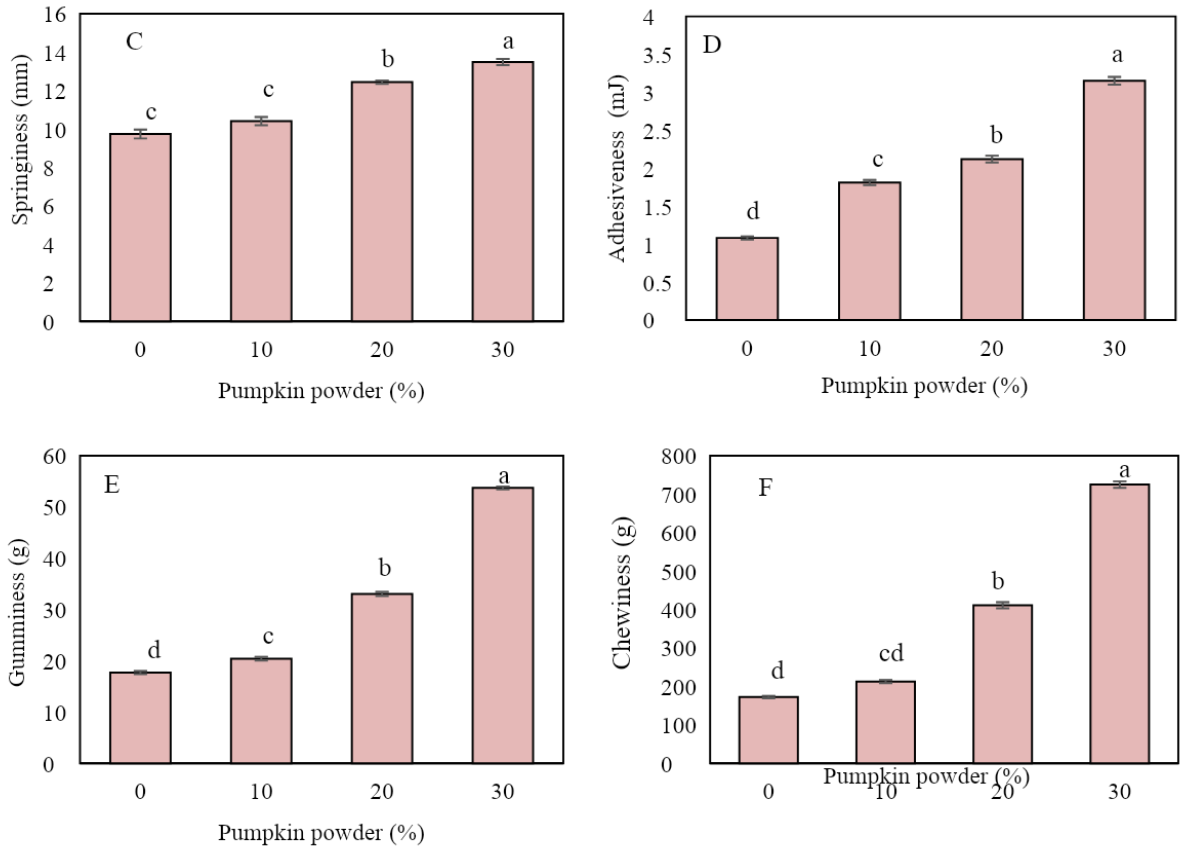


Fig 2. The effect of replacing rice flour with varying levels of pumpkin powder on the Hardness (A), Cohesiveness (B), Springiness (C), Adhesiveness (D), Gumminess (E), and Chewiness (F) of cake batter samples. Different letters are significantly different ($p < 0.05$).

3-3- Evaluation of cake texture profile

According to the results of comparing the average stiffness of the cakes in Figure 3, with the increase in the ratio of replacing rice flour with powderSquash Up to 30% in the formulation, the hardness of the samples showed a significant increase (0.05).p<). The highest hardness in samples containing 30% powderSquash (1437.66 grams) was measured compared to the control sample (1044.33 grams). The increase in the stiffness of the cake texture by replacing rice flour with pumpkin powder can be attributed to the increase in the amount of dough fiber and simple sugar compounds in the dough formulation [32]. Padalino et al. (2013) reported that by adding the powder of some vegetables such as pumpkin powder, spinach or eggplant to food formulations, the resistance to breakage and hardness of the products increases, which was consistent with the results of this research.[33]. Mir Hosseini et al. (2015) reported that by adding pumpkin powder to the formulation of gluten-free pasta, the firmness of the product increased significantly due to the increase in the water absorption capacity of the dough.34]. The continuity of the cake shows the degree of resistance to its disintegration during a mechanical action such as chewing or squeezing [20]. The results of the comparison of the consistency averages in Figure 3 showed that by increasing the amount of pumpkin powder to 10% in the formulation, the consistency of the samples did not change significantly.(05/0p<). The highest tissue cohesion was observed in the samples

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

containing 30% pumpkin powder (0.672) compared to the control sample (0.563).05/0p<). Dabash et al. (2017) showed that the addition of pumpkin powder up to 10% did not change the consistency of gluten-free rice breads, which was consistent with the results of this study [35]. The increase in the protein content of formulations containing pumpkin powder is one of the possible reasons for the increase in tissue consistency of the samples. Hosseini Qaboos et al. (2018) improved the consistency of the cake texture by using pumpkin powder in the sponge cake formulation [5]. Goularte et al.'s research (2012) showed the improvement of the consistency of gluten-free rice cake texture due to the increase in the protein content of the product by adding bean powder to the dough formulation, which was consistent with the results of this research [36]. Saeedi et al. (2018) stated that increasing the texture of gluten-free rice cake containing pomegranate seed powder increased the fiber and protein content of the formulation [37]. The results of the comparison of the elasticity averages in Figure 3 showed that by increasing the amount of pumpkin powder up to 10% in the dough formulation, the consistency of the samples did not change significantly.(05/0p<). The highest elasticity was observed in the samples containing 30% of pumpkin powder (11.672 mm) compared to the control sample (8.68 mm).05/0p<). Ashourmohammadi and Hosseiniqabus (2018) also reported an increase in the stretchability of ice cream samples containing pumpkin powder, an increase in the amount of pectin caused by pumpkin powder in the formulation [38]. The increase in the elasticity of the texture of cakes containing pumpkin powder is also related to the increase in the protein content of the product, which improves the elasticity of the product texture. Goularte et al. (2012) reported that increasing the protein content of gluten-free rice cake formulation due to the addition of lentil, bean and chickpea flour caused an increase in elasticity.The final product was in accordance with the results of this research [35]. According to Figure 3, replacing up to 10% of rice flour with pumpkin powder did not have a significant effect on the stickiness of the final product (0.05).p<). By increasing the replacement of pumpkin powder to more than 10%, the stickiness of the final product showed a significant increase (0.05p<). Mirhosseini et al. (2015) reported that by replacing wheat flour with pumpkin powder in the pasta dough formulation, the stickiness of the final product increased due to the change in starch gelatinization conditions in the formulation, which was consistent with the results of this research.[34]. The reports of Indranti et al. (2021) also showed an increase in stickiness in noodle texture with the addition of pumpkin powder due to the increase in water absorption capacity in the dough formulation [39]. The results of Figure 3 showed that by increasing the amount of replacing rice flour with pumpkin powder up to 30%, the gumminess and chewing power of the final product increased significantly compared to the control (0.05).p<). In general, gumminess (the product of stiffness multiplied by the degree of cohesion) and chewing power (the product of gumminess multiplied by the elasticity) are a function of the degree of hardness, elasticity and cohesiveness of the product [20]. Therefore, according to the increase of the mentioned factors that have been described before, the trend of significant increase in the quantitative values of the two factors of gumminess and chewing power of cakes containing pumpkin powder was not far from expected (0.05).p<). Hosseiniqabus et al. (2018) also reported that the two characteristics of chewability and gumminess of cakes containing pumpkin

powder increased significantly compared to the control [5]. Majzoubi et al. (2014) reported an increase in the gummy process by adding soy protein isolate in the sponge cake formulation due to the increase in the protein content of the formulation [40].

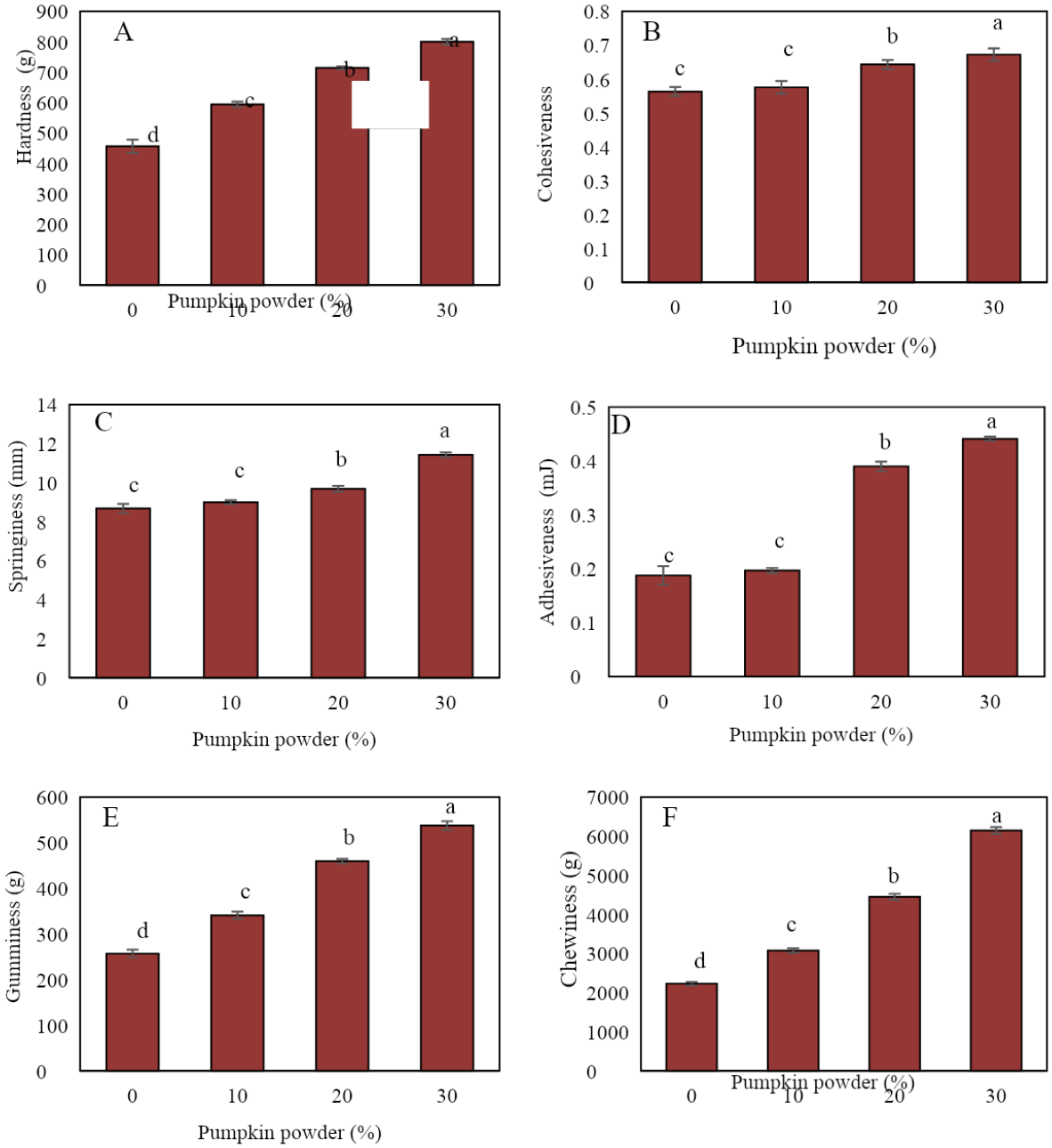


Fig 3. The effect of replacing rice flour with varying levels of pumpkin powder on the Hardness (A), Cohesiveness (B), Springiness (C), Adhesiveness (D), Gumminess (E), and Chewiness (F) of cake samples. Different letters are significantly different ($p < 0.05$).

[DOR: 20.1001.1.20088787.1402.20.142.5.5]
[DOI: 10.22034/FSCT.20.142.68]

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

4-3- Evaluation of the color of the cake

According to the results of Figure 4, the replacement of rice flour with pumpkin powder in the sponge cake formulation increased the overall color change, browning, hue angle and saturation of the product by 30% compared to the control sample (0.05)p<). The overall color change indicates the color change of the product after adding pumpkin powder compared to the control sample. If this value is greater than 3, the color change is visible to humans [41]. the most Overall color change (21/62=ANDD) was obtained in cakes with the highest level of pumpkin powder substitution (30%) compared to the control sample, which was consistent with the results of Si et al. (2007) regarding the increase in darkness of breads containing pumpkin powder [42]. The browning index is another color parameter that indicates the amount of enzymatic and non-enzymatic browning reactions during the cake baking process. The most browning (168/62=WITH A) in the samples containing 30% pumpkin powder compared to the rice control sample (46.33=WITH A) was observed (0.05p<). Zamordi et al. (2019) explained the reason for the dark color of cakes containing pumpkin powderThey attributed the non-enzymatic browning and caramelization reactions to increasing the amount of reducing sugars in pumpkin powder [43]. With the increase in the replacement ratio of rice flour with pumpkin powder, the Hue angle index in the product has a significant increase trend (0.05p<) showed that the Hue angle increased from 42.78 degrees in the control sample to 59.3 degrees in the samples containing 30% pumpkin powder, which indicated the color change towards yellow. This result was consistent with the observations of Maleki Eski et al. (2017) regarding the increase in the intensity of the yellow color component in cakes containing pumpkin powder.[22]. Jalali et al. (2018) investigated the enrichment of sponge cake containing pumpkin powder and announced that adding up to 10% of pumpkin powder increased its yellowness due to the increase in beta-carotene of the product [44].The chroma index shows the degree of saturation and color intensity of the samples. By increasing the ratio of replacing rice flour with pumpkin powder (30%), the color intensity of the samples increased significantly (0.05).p<). The highest color intensity (35.16) was obtained in cakes formulated with the highest level of pumpkin powder substitution (30%) compared to the control sample (17.01). The increase in the chroma index was directly related to the increase in the replacement ratio of pumpkin powder with rice flour. This increase can be related to the increase in the amount of beta-carotene in the final product and as a result the increase in the intensity of the yellow color[44].

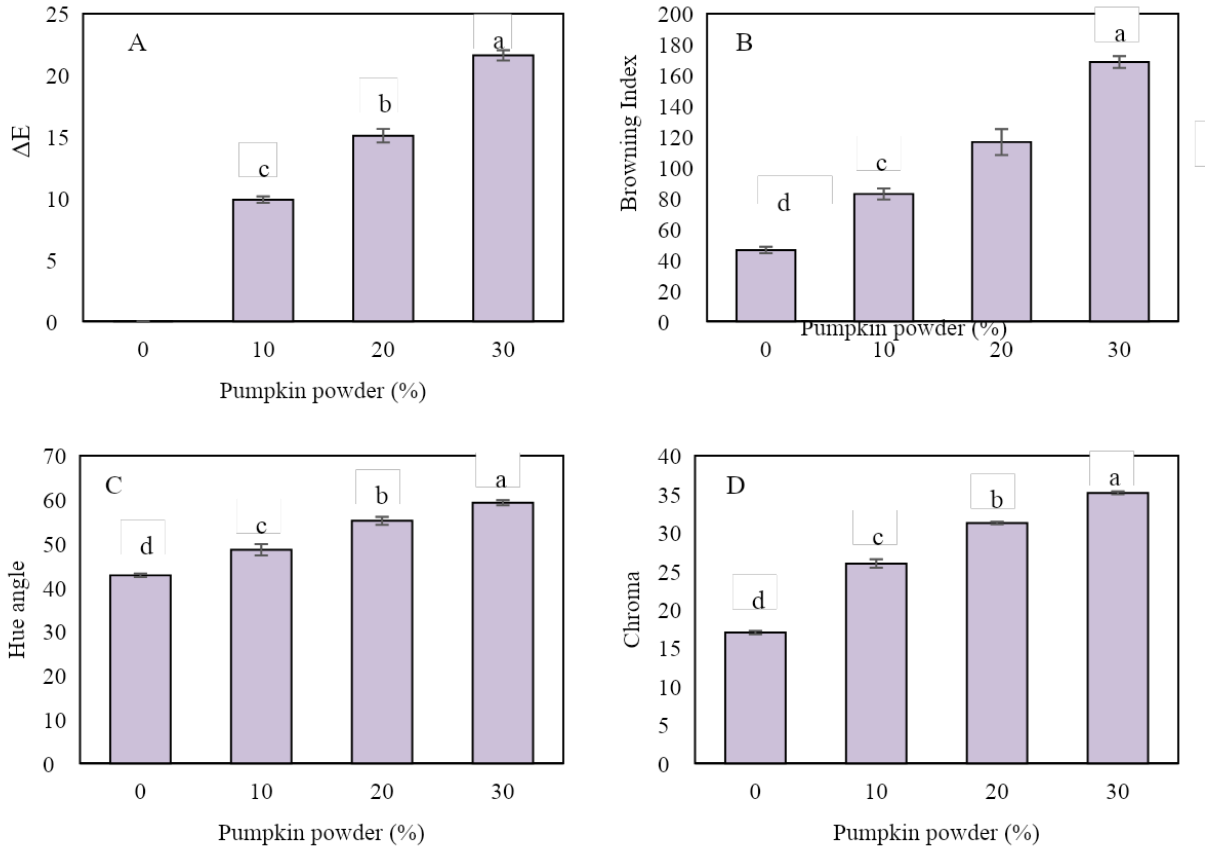


Fig 4. The effect of replacing rice flour with varying levels of pumpkin powder on the Total color differences (ΔE) (A), Browning Index (B), Hue angle (C), and Chroma (D) of cake samples. Different letters are significantly different ($p<0.05$).

4 - Conclusion

In this research, the rheological characteristics of the dough and texture of gluten-free sponge cake with different levels of replacing rice flour with pumpkin powder were evaluated as improving the texture and color of gluten-free cakes based on rice flour. Replacing rice flour with pumpkin powder in the production of gluten-free cakes, in addition to improving the rheological characteristics of the dough, also significantly improved the texture of the final product compared to the control samples (0.05).p<). The use of pumpkin powder in cake formulation is significant (0.05p<) increased the strength, consistency and elasticity of the dough texture compared to the control sample, which had a favorable effect on the texture characteristics of the final product. The high level of protein and fiber of pumpkin powder significantly improved the dough strength and texture structure of gluten-free cakes based on rice flour (0.05).p<). By increasing the ratio of replacing rice flour with pumpkin powder, the resulting dough became more sticky, which of course caused an increase in the amount of stickiness in the final product after baking. Due to the white color of rice flour, with the addition of pumpkin powder in the formulation of gluten-free cakes based on rice flour, a significant color change was observed in the samples compared to the control (0.05).p<). According to the increase of hue angle, this color change tended towards yellow, which was consistent with the increase of carotenoids in pumpkin powder with higher replacement values (up to 30%). The

[DOR: 20.1001.1.20088787.1402.20.142.5.5]
[DOI: 10.22034/FSCT.20.142.68]

texture evaluation of dough and cakes containing pumpkin powder showed that replacing rice flour with pumpkin powder for the production of sponge cake has a favorable effect on improving the texture quality of the final product.

5- Resources

[1] Xu, J., Zhang, Y., Wang, W., & Li, Y. (2020). Advanced properties of gluten-free cookies, cakes, and crackers: A review. *Trends in Food Science & Technology*, 103: 200–213.

[2] Poursafar, L., Peighambardoust, S. H., Alizadeh Shalchi, L., ShakuoieBonab, E., &Rafat, S. A. (2012). Effect of the temperature and time of flour heat treatment on thequality characteristics of sponge cake. *Food Processing and Preservation Journal*, 2 (4): 87-104[in Persian].

[3] Yanpi, M., Aalami, M., Mohammadzadeh, J., Sadeghi, A. R., &Kashiri, M. (2018). Effects of the addition of white maize flour and xanthan gum on physical and sensory properties of gluten-free rice cake.

[4]El Khatib, S., & Muhieddine, M. (2020). Nutritional profile and medicinal properties of pumpkin fruit pulp. The Health Benefits of Foods-Current Knowledge and Further Development, 1-20.

[5]Hosseini Ghaboos, S.H. & Ardabili, S.M. & Kashaninejad, M. (2018). Physio-chemical, textural and sensory evaluation of sponge cake supplemented with pumpkin flour. *International Food Research Journal*, 25 (2), 854-860.

[6] Davodi, Z., Shahidi, M, &Kadivar, M. (2013). Effect of pumpkin powder on rheological properties of dough and physical properties of Tafton bread. *21th National Congress of Food Science and Technology*, Shiraze, 1-6.

[7] Dhingra D., Michael, M., Rajput, H., &Patil, R.T. (2011). Dietary fiber in foods: a review. *Journal of Food Science and Technology*, 49, 255-266.

[8] Lebesi, D. M., Tzia, C. (2011). Effect of the addition of different dietary fiber and edible cereal bran sources on the baking and sensory characteristics of cupcakes. *Food and Bioprocess Technology*, 4, 710-722.

[9] Bárbara, E., Meza, A.K.S., Chesterton, Verdini, R. A., Rubiolo, A. C., Sadd, P.A., Moggridge, G. D. & Wilson, D.I. (2011). Rheological characterization of cake batters generated by planetary mixing: Comparison between untreated and heat-treated wheat flours. *Journal of Food Engineering*, 104 (4), 592-602.

[10] Mokhtari, Z., Ziaiifar, A. M., Aalami, M., Kashaninejad, M., & Aghajanzadeh, S. (2019). Physicochemical and rheological properties of dough from a corn flour and inulin. *Journal of Food Science and Technology (Iran)*, 15 (84), 23-38 [in Persian].

[11] Wang, J., Rossel, C.M., & Benedito de Barber, C. (2002). Effect of addition of different fibers on wheat dough performance and bread quality. *Food Chemistry*, 79, 221–226.

[12] Kundu, H., Grewal, R. B., Goyal, A., Upadhyay, N., & Prakash, S. (2014). Effect of incorporation of pumpkin (*Cucurbita moshchata*) powder and guar gum on the rheological properties of wheat flour. *Journal of Food Science and Technology*, 51(10), 2600–2607.

[13] Turabi, E., Sumnu, G., & Sahin, S. (2008). Rheological properties and quality of rice cakes formulated with different gums and an emulsifier blend. *Food Hydrocolloids*, 22, 305–312.

[14] Lopes-Da-Silva, J.A., Santos, D.M.J., Freitas, A., Brites, C., & Gil, A.M. (2007). Rheologicaland nuclear magnetic resonance (NMR) study of the hydration and heating of undeveloped wheat doughs. *Journal of Agriculture and Food Chemistry*, 55, 5636–5644.

[15] Christaki, M., Verboven, P., Van Dyck, T., Nicolaï, B., Goos, P., & Claes, J. (2017). The predictive power of batter rheological properties on cake quality - The effect of pregelatinized flour, leavening acid type and mixing time. *Journal of Cereal Science*,77, 219-227.

[16] Meza, B., Chesterton, A., Verdini, R., Rubiolo, A., Sadd, P., Moggridge, G., & Wilson, D. (2011). Rheological characterization of cake batters generated by planetary mixing: comparison between untreated and heat- treated wheat flours. *Journal of Food Engineering*, 104, 592-602.

[17] Fiszman, S. M., Salvador, A., &Varela, P. (2005). Methodological developments in bread staling assessment: application to enzyme-supplemented brown pan bread. *European Food Research and Technology*, 221, 616-623.

[18] Emamifar, A., Zanganeh, Z., Latifian, M., & Arbab, Z. (2020). Physicochemical, textural and sensory properties of containing jujube cake. Journal of Food Science and Technology (Iran), 17 (103), 33-46 [in Persian].

[19] Salehi, F., Amin Ekhlas, S., Pavee, S., & Zandi, F. (2018). Effect of balangu seed gum on rheological, physical and sensory properties of gluten free rice cake. Journal of Food Technology and Nutrition,15 (4), 61-68 [in Persian].

[20] Abbaszadeh, F., Alami, M., Sadeghi Mahoonak, A., & Kashaninejad, M. (2017). Influence of sweet almond protein concentrate and xanthan gum on physic-chemical and textural properties of dough and rice cakes. *Innovative Food Technologies*, 4 (3), 107-118.

[21] Bagheri, H., Kashaninejad, M., Ziaiifar, A. M., & Alami, M. (2016). Evaluation of color parameters, moisture content and energy consumption during roasting of peanut kernels using hot air method. *Innovative Food Technologies*, 3 (3), 59-71.

[22] Maleki aski, K., Mirzaee, H., & Fadavi, A. (2017). Using of pumpkin powder in cake producing and evaluation some physicochemical and microbial properties of cake containing pumpkin powder. *Journal of Food Science and Technology (Iran)*, 61 (13), 183-193 [in Persian].

[23] Salehi, F., Amin Ekhlas, S, & Souri, F. (2018). Investigation of the batter characteristic and sponge cake properties containing soy protein isolate and basil seed gum. *Journal of Food Science and Technology (Iran)*, 14 (70), 323-315 [in Persian].

[24] Ganji Vatan, B, & Hosseini Qaboos, S.H. (2020). The effect of balango seed gum on improving the physicochemical, textural and sensory properties of sponge

[DOR: 20.1001.1.20088787.1402.20.142.5.5]

[DOI: 10.22034/FSCT.20.142.68]

cake enriched with pumpkin powder. *Journal of Food Technology and Nutrition*, 17(67), 81-92 [in Persian].
[25] Moore, M. M., Schober, T. J., Dockery, P., &Arendt,E. K. (2004). Textural comparisons of gluten-free andwheat-based doughs, batters, and breads. *Cereal Chemistry*,81(5), 567–575.
[26] Sciarini, L.S., Ribotta, P. D., Leó, A. E., Pérez, & G. T. (2010). Influence of gluten-free flours and their mixtures on batter properties and bread quality. *Food and Bioprocess Technology*, 3(4), 577-585.
[27] Aydogdu, A., Sumnu, G., &Sahin, S. (2018). Effects of addition of different fibers on rheological characteristics of cake batter and quality of cakes. *Food Science and Technology*, 55(2): 667–677.
[28] Martınez, M.M., Dıaz, A., & Gomez, M. (2014). Effect of differentmicrostructural features of soluble and insoluble fibres ongluten-free dough rheology and bread-making. *Journal of Food Engineering*, 142, 49–56.
[29] Singh, J.P., Kaur, A., & Singh, N. (2016). Development of eggless gluten freerice muffins utilizing black carrot dietary fiber concentrate and xanthan gum. *Journal of Food Science and Technology*, 53,1269–1278.
[30] Herranz, B., Cuesta, F. J., Canet, W., & Alvarez, M. D. (2017). A comparison of gluten wheat flour functionality versus gluten-free chickpea flour, and their mixtures, in the oscillatory, transient, and steady rheological properties of muffin batters. Nova Science Publishers, 1-44.
[31] Balagi, S., Sheikhaleslami, Z., & Asetiri, S. H. (2017). Improving the qualitative, rheological and sensory properties of oil cake by adding puree and concentrate Raisins. *Journal of Innovation in Food Science and Technology*, 2 (32), 12-26 [in Persian].
[32] Sabanis, D, Lebesi, D, Tzia, C. (2009). Effect of dietary fiber enrichment on selected properties of gluten-free bread. *LWT. Food Science and Technology*, 42,1380 – 1389.
[33] Padalino, L., Mastromatteo, M., Lecce, L., Cozzolini, F., & Del Nobile, M. A. (2013).Manufacture and characterization of gluten-free spaghetti enriched withvegetable flour. *Journal of Cereal Science*, 57, 333-342.
[34] Mirhosseini, H., Abdul Rashid, N. F., Tabatabaee Amid, B., Cheong, K.W., Kazemi, M., & Zulkurnain, M. (2015). Effect of partial replacement of corn flour with durian seed flour and pumpkin flour on cooking yield, texture properties, and sensory attributes of gluten free pasta. *LWT - Food Science and Technology*, 63 (1), 184-190.
[35] Dabash, V., Burešová, I., Tokár, M., Zacharová, M., & Gál, R. (2017). The effect of added pumpkin flour on sensory and textural quality of rice bread.*Journal of Microbiology, Biotechnology and Food Science*, 6 (6), 1269-1271.
[36] Gularte, M.A., de la Hera, E., Gómez, M., &Rosell, C.M. (2012). Effect of different fibers on batter and gluten-free layer cake properties. *LWT. Food Science and Technology*, 48,209–214.
[37] Saeidi, Z, Nasehi,B., & Jooyandeh, H. (2018). Optimization of gluten-free cake formulation enriched with pomegranate seed powder and transglutaminase enzyme.Journal of Food Science and Technology, 55(8), 3110–3118.
[38] Ashurmohammadi, M., & Hosseini Ghaboos, H. (2018). Evaluation of ice cream enriching with pumpkin flour and investigating of physiochemical properties. *Journal of Innovation in Food Science and Technology*, 10 (3), 57-71 [in Persian].
[39] Indrianti, N. N., Sholichah, E., & Afifah, N. (2021). Pumpkin flour effects on antioxidant activity, texture, and sensory attributes of flat tubers noodle. *IOP Conference Series: Materials Science and Engineering*, 1011 (2021) 012007.
[40] Majzoobi, M., Ghiasi, F., Habibi, M., Hedayati, S.,Farahnaky, A. (2014). Influence of soy protein isolateon the quality of batter and sponge cake. *Journal of Food Processing and Preservation*, 38(3), 1164-1170.
[41] Baixauli, R., Salvador, A. & Fiszman, S. M. Textural and color changes during storage and sensory shelf life of muffins containing resistant starch. *European Food Research and Technology*, 226, 523–530.
[42] See, E. F., Wan, N. W. A. & Noor, A. A. (2007). Physic-chemical and sensory evaluation of breads supplemented with pumpkin flour. *ASEAN Food Journal*, 14(2): 123-130.
[43] Zomorodi, S., Heidari, R., & Behnam, S. (2019). The effect of pumpkin powder on the quality properties of gluten-free sponge cake prepared with corn flour. *Food Engineering Research*, 18 (67), 1-14 [in Persian].
[44] Jalali, S., Jalali, H., & Hosseini Ghaboos, S. H. (2018). Effect of pumpkin powder and malt on physicochemical, textural and sensory properties of sponge cake. *Iranian Food Science and Technology Research Journal, 14(*4), 451-460 [in Persian].

مجله علوم و صنایع غذایی ایران

سایت مجله: www.fsct.modares.ac.ir

مقاله علمی_پژوهشی

ویژگی‌های رئولوژیکی خمیر و بافت کیک اسفنجی بدون گلوتن حاوی پودر کدوحلوایی

محمد منصور سمیع[۱]، آریو امامی‌فر[۲]* و فخرالدین صالحی[۳]

۱- دانشجوی کارشناسی ارشد فناوری مواد غذایی، دانشگاه بوعلی سینا، همدان

۲- دانشیار گروه صنایع غذایی، دانشکده صنایع غذایی، دانشگاه بوعلی سینا، همدان

۳- دانشیار گروه علوم و صنایع غذایی، دانشگاه بوعلی سینا، همدان، ایران

اطلاعات مقاله

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۲/۲/۲۵

تاریخ پذیرش: ۱۴۰۲/۵/۲۱

کلمات کلیدی:

خمیر کیک،

کدوحلوایی،

رئولوژی،

بافت

DOI: 10.22034/FSCT.20.142. 68

DOR:20.1001.1.20088787.1402.20.142.5.5

* مسئول مکاتبات:

a.emamifar@basu.ac.ir

چکیده

هدف از این مطالعه بررسی تأثیر سطوح مختلف جایگزینی (۰، ۱۰، ۲۰ و ۳۰ درصد وزنی- وزنی) آرد برنج با پودر کدوحلوایی بر ویژگی‌های رئولوژیکی خمیر و بافت کیک اسفنجی بدون گلوتن بر پایه آرد برنج بود. تجزیه‌وتحلیل داده‌ها بر اساس آزمایش فاکتوریل در قالب طرح آماری کاملاً تصادفی و در سه تکرار انجام شد. استفاده از پودر کدوحلوایی در فرمولاسیون کیک‌های بدون گلوتن بر پایه آرد برنج ویژگی‌های رئولوژیکی خمیر و بافتی نمونه‌ها را به شکل معنی‌داری بهبود بخشید ($p<۰/۰۵$). با افزایش نسبت جایگزینی آرد برنج با پودر کدوحلوایی تا ۳۰ درصد، ویسکوزیته (از ۶۸۲/۶۶ تا ۳۵۱۸/۴۴ سانتی پواز)، سفتی (از ۲۱/۱۱ تا ۵۳/۹۷ گرم)، انسجام (از ۰/۸۳ تا ۰/۹۴) و کشش‌پذیری (از ۹/۷۴ تا ۱۳/۴۹ میلی‌متر) خمیر به‌صورت معنی‌داری بهبود یافت؛ اما چسبندگی خمیر (۳/۱۵ میلی ژول) در مقایسه با نمونه شاهد (۱/۰۸ میلی ژول) افزایش یافت ($p<۰/۰۵$). همچنین افزودن پودر کدوحلوایی تا ۳۰ درصد در فرمولاسیون نمونه‌ها، سبب افزایش سفتی (از ۴۵۶/۱۷ تا ۸۰۰/۱۱ گرم)، انسجام (از ۰/۵۶ تا ۰/۶۷)، کشش‌پذیری (از ۸/۶۸ تا ۱۱/۴۳ میلی‌متر) و قابلیت جویدن (از ۲۲۳۱ تا ۶۱۴۸ گرم) کیک‌های تولیدی شد ($p<۰/۰۵$). افزایش اختلاط پودر کدوحلوایی در فرمولاسیون کیک (تا ۳۰ درصد)، افزایش معنی‌داری در تغییرات کلی رنگ (EΔ)، شاخص قهوه‌ای شدن و اشباعیت رنگ (کروما) کیک‌های تولیدی در مقایسه با نمونه‌های شاهد ایجاد کرد و همچنین سبب افزایش زاویه هیو به سمت ۹۰ درجه گردید که نشان دهنده افزایش شدت رنگ زرد در نمونه‌های حاوی مقادیر بیشتر پودر کدوحلوایی بود ($p<۰/۰۵$).