Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

Application of principal component analysis (PCA) method to study the qualitative and quantitative parameters of muffin with reduced sugar containing maltodextrin and traditional ghavoot

Zolfaghari, N. [1*], Ataye Salehi, E. [2], Sheikholeslami, Z. [3]

1. Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran.
2. Department of Food Science and Technology, Quchan Branch, Islamic Azad University, Quchan, Iran.
3. Agricultural Engineering Research Department, Khorasan Razavi Agricultural and Natural Resources Research and Education Center, AREEO, Mashhad, Iran.

ARTICLE INFO

Article History:

Received 2022/ 11/ 10
Accepted 2022/ 12/ 15

Keywords:

Reduced sugar,
Principal component analysis method,
Ghavoot,
Maltodextrin,
Muffin.

DOI: 10.22034/FSCT.19.132.211
DOR: 20.1001.1.20088787.1401.19.132.16.9

*Corresponding Author E-Mail:
zolfaghari.n.59@gmail.com

ABSTRACT

In this study, the principal component analysis method was used to evaluate the relationships between quantitative and qualitative parameters of muffin with reduced sugar. The principal component analysis (PCA) method is a useful tool for interpreting and finding relationships in a set of parameters with various dimensions and characteristics in each observation. This tool provides useful help in increasing the interpretability of data and multidimensional visualization of the relationship between them. In order to replace sugar, a formulation based on three levels of maltodextrin (0, 25 and 50%) and four levels of ghavoot (0, 3, 6 and 10%) was used in a completely random design.Based on the study of the principal component analysis plot, it was determined that the relationships between the studied parameters are influenced by changes in the sugar substitute formulation. Based on this, new relationships between the studied parameters on muffins are formed by changing the level and type of sugar substitute composition. The evaluation of the change in the relationship between the parameters under the influence of the replacement of maltodextrin and ghavoot in the muffin formulation with reduced sugar shows the changes made in the structural substrates and the influence of a set of parameters on each other under the applied treatment.The results of this research show the efficiency and importance of using data mining methods to create an understanding of the relationships between quantitative and qualitative parameters of baking products with changes in formulation.

[DOR: 20.1001.1.20088787.1401.19.132.16.9]

[DOI: 10.22034/FSCT.19.132.211]

1. Introduction

After bread, cake is one of the most consumed and important products in the baking industry [1]. Sugar in the cake formulation has different roles, including helping to form the cake structure, volume, porosity, improving the storage quality, the color of the inner texture and the cake shell, increasing the half-life and maintaining moisture [2]. The demand for producing low-calorie foods with less sugar is due to the association of sugar with some health problems such as blood pressure, cardiovascular diseases, tooth decay, obesity and diabetes [3]. Maltodextrin nH2O (C6H10O5) as one of the sugar substitutes, is a polymer of saccharides without sweet taste, whose dextrose equivalent is less than 20 and includes a mixture of compounds with a molecular weight between polysaccharides and oligosaccharides, which are white powders or Thick syrups are available. [4]. On the other hand, due to the society's need for food containing beneficial compounds and enriched with minerals, vitamins, fiber, etc., the enrichment of the products of the Bakht industry (the dominant force of the society) has received much attention from the researchers of the food industry. Qavot is one of the nutritious compounds whose use in traditional medicine of Kerman has a long history [5] and despite its widespread use in Iran, it has not been studied scientifically and it seems that the introduction of this nutritious product Independently or its use in other food products abroad has been shortened. Depending on the type of formulation, Qawot may be from grinding 1 to 40 components, including some plant seeds, nuts and medicinal herbs. be produced with a certain amount of sugar [6]. As stated earlier, sugar as the main component of cake formulation, in addition to the role of sweetening and creating desirable organoleptic properties, has a fundamental role in creating the structure and quantitative and qualitative characteristics of the product. Therefore, replacing a part of sugar with other substitute compounds causes a change in the structural dimensions and characteristics of the final product. On this basis, the study of the changes made as a result of replacing sugar with a mixture of maltodextrin and Qavoot, reveals favorable information about the substrates and the relationship between the parameters for a better understanding of the changes made in the system.

Principal Component Analysis (PCA)[1]It is a useful tool for interpreting and finding relationships in sets of parameters with various dimensions and characteristics in each observation. This tool provides useful help in increasing the interpretability of data and multi-dimensional visualization of the relationship between them. In other words, PCA is a statistical technique to reduce the dimensions of the data set. This is done by linearly transforming the data into a new coordinate system in which the changes in the data can be reduced to a smaller dimension than the original data. described In many studies, the first two principal components are used to plot data in two dimensions and visually identify clusters of data points close to each other. [7]. The first component[2] The variable derived from the main variables is the one with the most explanatory variance, and the second principal component explains the most variance in what remains after removing the effect of the first component. PCA is mostly used when many variables are highly correlated with each other. And it is desirable that their number be reduced to an independent set to extract the relationship between their sub-layers in order to reach an interpretation of the changes made in the system [8].

According to the mentioned cases, the aim of this research is to evaluate the changes between the studied parameters in muffins (density, consistency and viscosity of dough and moisture, porosity, specific volume, color and sensory characteristics) and the relationship between the studied characteristics using It is a method of principal component analysis. It should be noted that in this research zero, 25 and 50% of sugar was replaced with a mixture of maltodextrin (zero, 25 and 50% based on the weight of sugar) and Qawot (zero, 3, 6 and 9% based on the weight of flour).

2- Materials and methods

2-1- Materials

1. Principle component analysis
2. Firstcomponent

[DOR: 20.1001.1.20088787.1401.19.132.16.9]

[DOI: 10.22034/FSCT.19.132.211]

Wheat flour with 11.7% protein, 0.61% ash, 12.87% moisture, 35.12% wet gluten and 33.09% dry gluten was prepared from Qods Razavi factory and stored in a dry and cool warehouse. Also, other materials including chemicals from Merck (Germany), sugar, salt, liquid vegetable oil and baking powder were purchased from a confectionery store. Fresh eggs will be prepared one day before the production of muffins and placed in the refrigerator at a temperature of 4 degrees Celsius. Maltodextrin from Osina Chemical Company and seeds, nuts and medicinal plants for the preparation of Qavot were also obtained from a reputable perfumery in Mashhad.

2-2-Preparation of reinforcement

First, nuts, seeds and medicinal plants were separated from all foreign substances and washed. After drying, roasting was done. Next, based on the Qawot formulation mentioned below, a certain proportion of nuts, seeds and medicinal plants were mixed with some sugar and then ground. Grinding was done to pass 35 mesh. It should be noted that cardamom, black pepper, ginger and cinnamon were not roasted and were added raw. But the roasting of purslane seeds, flax seeds, barley, hemp, lettuce seeds, coriander seeds, sunflower seeds, black seeds, poppy seeds and coffee was done. The prepared qavut was kept in a glass package in the freezer at -20 degrees Celsius until use. The formulation of the traditional full qavut of Kerman included the following ingredients;

50% sugar, barley, purslane, flax, poppy and hemp seeds (38.6% each), lettuce, coriander, sesame, sunflower seeds (19.3% each), black seeds and coffee (27% each) 1.1 percent), Mordaneh (1.25 percent), Rupas (0.63 percent), cardamom (0.32 percent), Jedva (0.3 percent), black peppercorns (0.2 percent), and ginger and cinnamon (0.05 percent of each). It should be noted that the aforementioned formulation was in accordance with the formulation of Akhwan (2015) [9].

2-3-preparation of muffins

In order to produce muffins, first the raw materials include plain flour (100 grams), sugar (72 grams), liquid oil (57 grams), eggs (72 grams), powdered milk (2 grams), table salt (1 gram), Vanilla (0.5 g), baking powder (1.34 g) and water (as needed) were weighed. It should be noted that other raw materials were based on the percentage of flour weight. To prepare muffins, in the first step, oil and powdered sugar were mixed together and stirred by an electric mixer (Electra EK-230M, Japan) at a speed of 128 rpm for 6 minutes until a light cream with air bubbles was created. Eggs were added to the creamy mixture in four stages. At the end, water was added and a uniform mixture was created. Next, the prepared mixture was poured into muffin capsules and placed in a laboratory oven with hot air (Zucchelli Forni, Italy) at a temperature of 180 degrees Celsius for 30 minutes. Then the baked cakes were cooled at room temperature and stored in polyethylene packages for testing. The formulation of muffin production was based on the method of Najafi and Salehifar (2016) with some changes [10]. The treatments of this research were according to Table 1.

Table 1 Treatments

Treatments	Sugar (gr)	Maltodextrin (gr)	Ghavoot (gr)
1 (Conrol)	75	0	0
2	56.25	18.75	3
3	56.25	18.75	6
4	56.25	18.75	9
5	37.5	37.5	3
6	37.5	37.5	6
7	37.5	37.5	9

2-4- Dough density

To measure this quantity, a similar volume of cake dough and double distilled water was weighed at the same temperature. By dividing the weight of the cake dough by the weight of double distilled water, the specific weight of the cake dough was calculated [11].

2-5-Dough consistency

Bostwick consistency meter (China) was used to measure this quantity. This machine has a rectangular cube or semi-cylindrical chamber with two small and large houses, the dough was poured into the small house, and after releasing the blade between the two houses, the path traveled by the dough in a certain time is read and the photo of the distance traveled It was reported by Khemer as the consistency [12].

6-2-viscosity

Muffin dough viscosity using a Brookfield rotary viscometer (Brookfield, model RVDV-ц+pro, USA) at a shear speed equal to S^{-1}60 was measured at a temperature of 25°C using spindle number S07 [10].

6-2-muffin moisture

AACC standard, 2000 No. 16-44 was used to perform this test. For this purpose, the samples were placed in an oven (Jeto Tech brand, model OF-O2G, made in South Korea) at a temperature of 100-105 degrees Celsius within 2 hours after baking [13].

2-7-size for muffins

To measure the specific volume, the volume replacement method with rapeseed was used according to the AACC standard, 2000 No. 10-72. For this purpose, at a time interval of 2 hours and one week after baking, a 2 x 2 cm piece was prepared from the geometric center of the muffin and its specific volume was determined by dividing the volume by the weight [13].

2-8-Muffin porosity

Image processing technique was used to evaluate the porosity of the muffin core within 2 hours after baking. For this purpose, a 2 x 2 cm section of the brain was imaged with a scanner (model: HP Scanjet G3010) with a resolution of 300 pixels. The prepared image was obtained by Image J software and the porosity percentage of the samples was measured [14].

2-9- Muffin crust color

Analyzing the color of the cake crust at a time interval of 2 hours after baking, by determining three L indices* ،a*and b*took place For this purpose, first a slice of 2x2 cm was prepared from the cake shell and it was photographed with a scanner (model: HP Scanjet G3010) with a resolution of 300 pixels. Then, the images were obtained by Image J software. By activating the LAB space in the Plugins section, the above indices were calculated [15].

2-10-muffin texture

The evaluation of the cake texture was done in a time interval of 2 hours and one week after baking, using a QTS texture tester, model CNS Farnell, UK, made in England. The maximum force required to penetrate a probe with a cylindrical end (2 cm in diameter and 2.3 cm in height) at a speed of 60 mm/min from the center of the muffin was calculated as a hardness index. The starting point and target point were 0.05 N and 25 mm, respectively [16].

2-11-muffin sensory test

For this purpose, 10 referees were selected according to the triangular test and the method of Gasolausing (1984) [17]. Then, the sensory characteristics of the muffin were evaluated in terms of form and shape, upper surface characteristics, lower surface characteristics, porosity, firmness and softness of the texture, chewability, and smell and taste. The attribute evaluation coefficient was from very bad (1) to very good (5) and based on 5-point hedonic [18, 19]. The examined features had a ranking coefficient of 4, 2, 1, 2, 2, 3 and 3, respectively. Finally, the overall acceptance score (quality number) was calculated based on the following relationship.

$$Q = \frac{\Sigma(P \times G)}{\Sigma P}$$

Q = overall score (muffin quality number), P = attribute rank coefficient and G = attribute evaluation coefficient.

12-2- Data analysis

The design of the treatments to replace sugar in the formulation based on the use of three levels of maltodextrin (zero, 25 and 50%) and four levels of strength (zero, 3, 6 and 10%) was done in the form of a completely randomized simple design with 3 replications. The principal component analysis method was used using Minitab 17 software based on the first and second components as 2 components including the most explanatory variances to analyze the relationships between parameters under the influence of the use of sugar substitute compounds.

3. Results and Discussion

[DOR: 20.1001.1.20088787.1401.19.132.16.9]

[DOI: 10.22034/FSCT.19.132.211]

3-1- The relationship between the quantitative and qualitative parameters of the muffin sample without replacement

The relationships between the measurement parameters in the control sample can be seen in the principal component analysis space in Figure 1. Based on the results, the high correlation between the studied parameters on the control sample has been placed in 3 groups. Based on this, moisture, consistency, skin color and viscosity have shown the highest correlation in the first category. The high correlation between the mentioned parameters indicated the dependence of the three consistency parameters, shell color and viscosity with the moisture parameter. The browning of the cake crust is due to the Maillard reaction and the interaction between reducing sugars and the amino group of proteins and the caramelization of sucrose (interaction between sugars), which is caused by exposure to high baking temperatures [20]. The process of converting sucrose into reducing monosaccharides takes place in the baking process and by reducing the moisture content of the sample. Hence, the correlation of color to moisture can be understood. Viscosity is defined as an indicator of the resistance of fluid layers to displacement. On the other hand, consistency is defined as an index of mass resistance to deformation and displacement. These two parameters are defined directly under the influence of humidity as parameters affecting the colloidal structure of the muffin and the formation of the base structure. In the second category, the highest correlation between stiffness and porosity parameters was observed. Porosity is introduced as indicators of holes formed in the structure during the baking period. On the other hand, stiffness was evaluated as the structure's resistance to fracture. These two parameters are indicators of structure formation. Among the examined parameters, the overall acceptance of the control sample showed the highest correlation with the specific volume parameter. The specific volume is evaluated as an indicator of the expansion of the structure and including the appearance characteristics of the baking products. Therefore, the obtained relationship between the specific volume and the overall acceptance of the witness sample is significant from both structural and sensory dimensions.

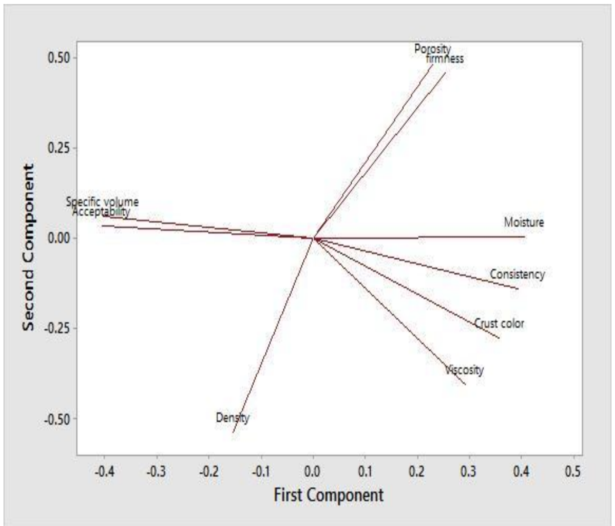

Fig 1 visualization of relationship between the parameters in the PCA plot.

2-3-Relationship between quantitative and qualitative parameters of muffin under the influence of replacing sugar with maltodextrin and strength

Figure 2 shows the relationships between the studied parameters on muffins with the replacement of 25% maltodextrin and 3% kavoot. As the results show, the studied parameters were affected by the replacement of sugar in the formulation. On this basis, the formation of highly correlated interfaces between moisture parameters, density, specific volume, viscosity, porosity and overall acceptance was observed. Among the aforementioned parameters, 3 parameters of humidity, density and specific volume had a higher correlation than the other 3 parameters. Based on the obtained results, it can be stated that the presence of maltodextrin and Qavoot in the muffin formulation has the greatest effect on the parameters with indicators of network structure development characteristics. On the other hand, the results showed that consistency and firmness parameters were independent from other parameters in muffins. The role of sugar as the main component of muffin formulation, in addition to influencing the sensory properties of

[DOR: 20.1001.1.20088787.1401.19.132.16.9]

[DOI: 10.22034/FSCT.19.132.211]

the product, plays a significant role in the development and formation of the structure. In addition to the effect of sugar on air entering the cake dough during the mixing period, this substance plays a major role in the dispersion of air particles entering the dough during the baking period [21]. Therefore, the higher influence of the structural parameters can be interpreted by the substitution at the sugar level. In a study, Kohsari et al. (2018) investigated the effect of replacing sugar with stevia and adding chia seed flour and pea protein isolate on the qualitative and rheological characteristics of gluten-free muffins prepared from rice flour. These researchers stated that the addition of chia seed flour to the formulation has the greatest effect on the structural parameters of the muffin. On this basis, it was reported that the addition of this compound increased the strength of the structure by affecting the viscosity and consistency of the dough [22].

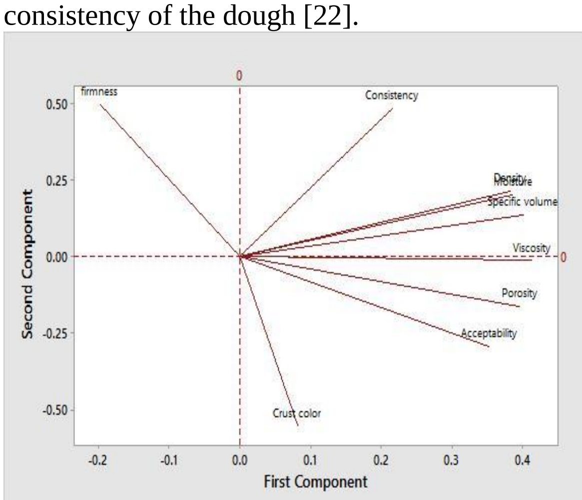

Fig 2 visualization of relationship between the parameters in the PCA plot with sugar substitution (25% Maltodextrin- 3% Ghavoot)

Figure 3 shows the relationship between the studied parameters on a muffin sample with a substitution level of 25% maltodextrin and 6% kavut. The relationships formed between the studied parameters showed the correlation between the 3 parameters of viscosity, humidity and specific volume. On the other hand, the density, porosity and color of the crust show the greatest influence on each other in the principal component analysis space. Also, the overall acceptance score showed a relationship with the hardness of the samples. By increasing the strength level to 6% compared to the sample with 3% strength level, the formation of interfaces between porosity and density parameters with shell color was observed. Based on the obtained results, it seems that the increase in the strength level with the increase of insoluble dry matter in the muffin formula has affected the microstructure and size distribution of the cavity particles. Therefore, in addition to the formation of the relationship between the structural characteristics, the effectiveness of the general acceptance of the stiffness parameter can also be understood. Increasing the level of strength in the formulation as a result of interaction with the protein network causes a change in the viscoelastic properties and as a result, a reduction in the gas holding capacity. Reducing the expansion of the dough and preventing the expansion of air bubbles inside the structure will affect the resulting structure and make the final product stiff. Similar results were reported by Kohsari et al. (2018) regarding the addition of chia seed flour to muffins [22].

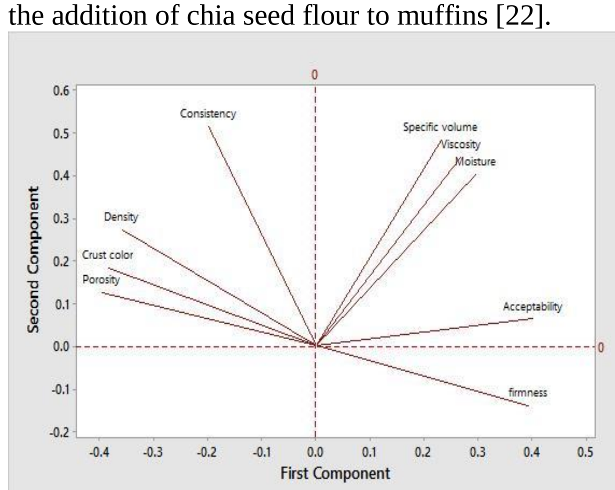

Fig 3 visualization of relationship between the parameters in the PCA plot with sugar substitution (25% Maltodextrin- 6% Ghavoot)

Figure 4 shows the relationship between the studied parameters in the sample containing 25% maltodextrin and 10% Qavoot. The results of this section indicated the formation of a relationship between the parameters of viscosity, porosity and density with each other, along with the effectiveness of the overall acceptance of the viscosity parameter compared to other parameters. On the other hand, in the study of the principal component analysis space, high intensity relationships between the consistency parameter and specific volume were observed

[DOR: 20.1001.1.20088787.1401.19.132.16.9]
[DOI: 10.22034/FSCT.19.132.211]

with the increase in the substitution level of the strength. The high influence of specific volume and consistency parameters on each other can be related to the role of strength size as a combination of insoluble dietary fibers. In a study, Martins et al. (2014) evaluated the effect of particle size of insoluble dietary fibers on bread structure. Based on the results reported by these researchers, the size and type of edible insoluble fiber particles showed the greatest impact on the structure in the parameters of specific volume and hardness of bread [23].

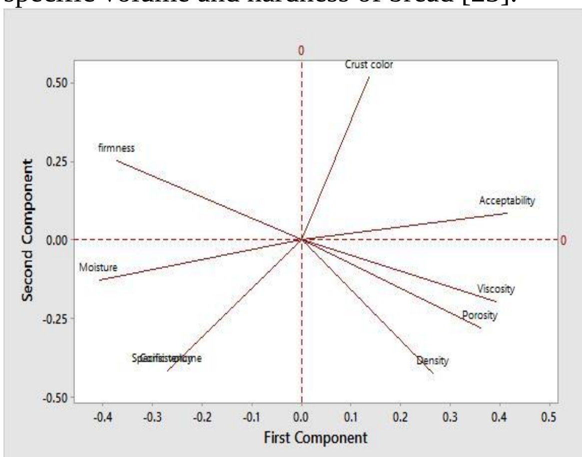

Fig 4 visualization of relationship between the parameters in the PCA plot with sugar substitution (25% Maltodextrin- 10% Ghavoot)

Figure 5 shows the relationships between the studied parameters on muffins containing 50% maltodextrin and 3% Qavoot. As the results show, there were high correlations between parameters of moisture, consistency, firmness and overall acceptance. On the other hand, it was observed to create links between the parameters of skin color, viscosity and density. Increasing the level of maltodextrin by affecting the viscosity of the dough reduces the entry and distribution of air bubbles in the muffin. Therefore, the formation of a dense structure causes a negative effect on the specific volume. Similar results were reported by Junadishan and Bojang (2014) as a result of replacing sugar with maltodextrin in the formulation of a native Malaysian cake. Based on the findings of these researchers, increasing the level of maltodextrin in the cake formulation caused a negative effect on the viscosity and, as a result, reduced the specific volume of the production samples [24].

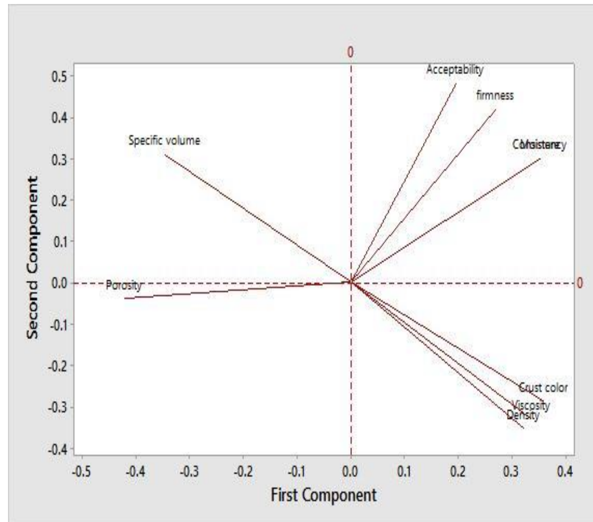

Fig 5 visualization of relationship between the parameters in the PCA plot with sugar substitution (50% Maltodextrin- 3% Ghavoot)

Figure 6 shows the relationships between the parameters of the sample containing 50% maltodextrin and 6% strength. The location of the studied parameters in the principal component analysis space shows that high correlations have been formed between the shell color, density and stiffness parameters. A pattern similar to the relationships mentioned in the principal component analysis results of the sample containing 50% maltodextrin and 3% strength was also observed (Figure 5). In addition to the relationships mentioned, by increasing the strength level to 6% at a constant level of maltodextrin (50%), a relationship with high correlation between the viscosity parameter and specific volume has been established. Viscosity, as an index of the resistance of fluid layers to displacement, shows the strength of intermolecular connections in the microstructure. As a combination of soluble and insoluble fibers, along with maltodextrin, as a high molecular weight polysaccharide, Qavot has the ability to absorb water and form a gel and film in the structure of muffin dough starches. Therefore, inter-colloidal interactions in the structure increase the structural cohesion and subsequently affect the specific volume parameter as an indicator of network expansion capability.

[DOR: 20.1001.1.20088787.1401.19.132.16.9]

[DOI: 10.22034/FSCT.19.132.211]

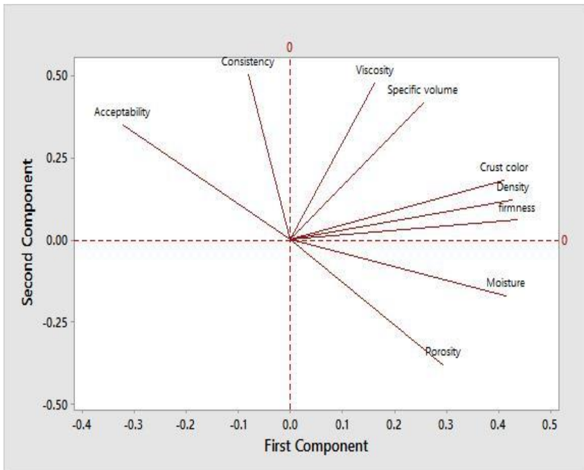

Fig 6 visualization of relationship between the parameters in the PCA plot with sugar substitution (50% Maltodextrin-6% Ghavoot)

Figure 7 shows the relationship between the parameters of the muffin with the highest level of maltodextrin (50%) and strength (10%). As the principal component analysis shows, consistent relationships between the parameters of porosity, consistency, specific volume and overall acceptance have appeared in this sample.

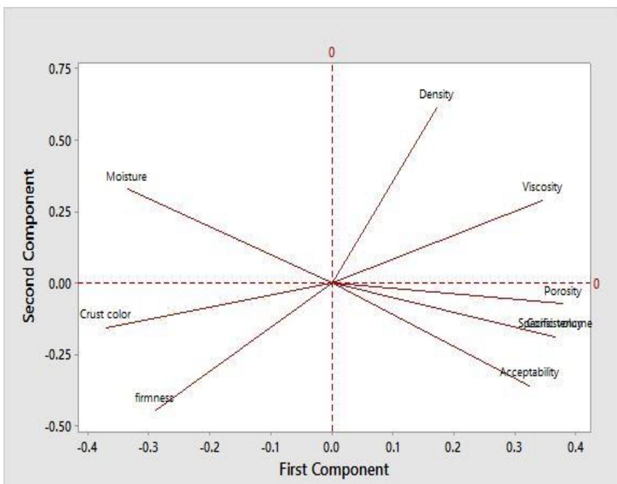

Fig 7 visualization of relationship between the parameters in the PCA plot with sugar substitution (50% Maltodextrin-10% Ghavoot)

Meanwhile, the parameters of specific volume and consistency show a higher correlation. This can be found in the increase in structural strength as a result of increasing the water absorption of dough by soluble and insoluble fibers. On this basis, increasing the strength of the structure and subsequently preventing the expansion of the network causes a negative effect on the specific volume. In the research conducted by Saedi et al. (2018), the effect of adding dried pieces of pineapple fruit on the quality characteristics of muffins was investigated. Based on the results reported by these researchers, increasing the percentage of fruit substitution in the muffin formulation led to an increase in crude fiber and as a result, a decrease in specific volume [25].

4- Conclusion

Principal component analysis was used as a useful tool to study sets of quantitative and qualitative parameters of muffin with reduced sugar. The obtained results showed that the relationships created between the parameters were influenced by the change in the level and type of sugar substitute in the formulation. Also, the findings of this research show the efficiency and importance of using data mining methods to create knowledge of the substrates of relationships between quantitative and qualitative parameters of baking products with changes in formulation.

5-Resources

[1] Cauvain, S.P. & Young, L.S. (2006). Ingredients andtheir influences. In: Baked product: Science, Technologyand Practice, p. 72, Blackwell Publishing, Oxford. UK.

[2] Esteller, M.S., Yoshimoto, R.M.D.O., Amaral, R.L. and Lannes, S.C.D.S., 2004. Sugar effect on bakery products. Food Science and Technology, 24, pp.602-607.

[3] Misra, Varucha, A. K. Shrivastava, S. P. Shukla, and Mohammad Israil Ansari. "Effect of sugar intake towards human health." Saudi Journal of Medicine 1, no. 2 (2016): 29-36.

[4] Lakshminarayan, S.M., Rathinam, V. and KrishnaRau, L., 2006. Effect of maltodextrin and emulsifiers on the viscosity of cake batter and on the quality of cakes. Journal of the Science of Food and Agriculture, 86(5), pp.706-712.

[5] Naghibi, B., Sheibani, V., Bagherinia, M., Dehghan-nudeh, G. and Sharififar, F. (2011). Anti anxiety effect of Ghavoot: a traditional nutrient preparation. Int J Biol Chem Sci. 5: 322-326.

[6] Meamarbashi, A. and Manzari Tavakoli, A. (2014). Ergogenic effect of a traditional natural powder: Ghavoot. J diet suppl. 11(3): 241-247.

[7] Jolliffe, I.T. and Cadima, J., 2016. Principal component analysis: a review and recent developments. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374(2065), p.20150202.

[8] Abdi, H. and Williams, L.J., 2010. Principal component analysis. Wiley interdisciplinary reviews: computational statistics, 2(4), pp.433-459.

[9] Hamidreza Akhavan. (2016). Nutritional Value, Total Phenolic Content and Antioxidant Activity of Ghavoots (traditional Souvenir of Kerman/Iran). Journal of Kerman University of Medical Sciences. 23(6): 770-782. (In Persian).

[10] Najafi, S. and Salehifar, M. (2017). Optimization of production low-calorie muffin with natural sweetener stevia and maltodextrin. Journal of Food Research, 26(4): 715-724. (In Persian).

[11] Ashwini, A., Jyotsna, R., and Indrani, D. (2009). Effect of hydrocolloids and emulsifiers on the rheological characteristic and quality of flat bread. Lebensm.Wiss.u.Technology, 36: 18-193.

[12] Ayoubi, A., Habibi Najafi, M. B. and Karimi, M. (2011). Effect of different levels of whey protein concentrate on the physicochemical and sensory properties of muffin cake. Journal of Food Science and Technology, 8(29): 1-8. (In Persian).

[13] AACC. (2000). Approved Methods of the American Association of Cereal Chemists, 10th Ed., Vol. 2. American Association of Cereal Chemists, St. Paul, MN.

[14] Bárcenas, M. E. and Rosell, C. M. (2006). Different approaches for improving the quality and extending the shelf life of the partially baked bread: Low temperatures and HPMC addition. Journal of Food Engineering, 72: 92–99.

[15] Sabbaghi, H., Ziaiifar, A., Kashaninejad, M. (2018). Fractional conversion modeling of color changes in apple during simultaneous dry-blanching and dehydration process using intermittent infrared irradiation. Iranian Food Science and Technology Research Journal, 14(2), 383-397. doi: 10.22067/ifstrj.v0i0.62293.

[16] Ronda, F., Oliete, B., Gomez, M., Caballero, P., and Pando, V. (2011). Rheological study of layer cake batters made with soybean protein isolate and different starch sources. Journal of Food Engineering, 112: 272-277.

[17] Gacula, J. R. and Singh. (1984). Statistical methods in food and consumer research. Academic press Inc. U.S.A. 360-366.

[18] Jalali, M., Sheikholeslami, Z., Elhamirad, A. H., Haddad Khodaparast, M. H. and Karimi, M. (2019). The effect of Balangu Shirazi (Lallemantia Royleana) gum on the quality of gluten-free pan bread containing pre-gelatinization simple corn flour with microeave. Carpathain Journal of Food Science and Technology, https://doi.org/10.34302/crpjfst/2019.11.2.6.

[19] Yaseen, A.A., Shouk, A.H., and Ramadan, M.T.)2010(. Corn-wheat pan bread quality as affected by hydrocolloids. Journal of American Science, 6(10): 684-690.

[20] Şen, D. and Gökmen, V., 2022. Kinetic modeling of Maillard and caramelization reactions in sucrose-rich and low moisture foods applied for roasted nuts and seeds. Food Chemistry, 395, p.133583.

[21] Stavale, M.D.O., Assunção Botelho, R.B. and Zandonadi, R.P., 2019. Apple as sugar substitute in cake. Journal of Culinary Science & Technology, 17(3), pp.224-231.

[22] Kohsari, F. Imam Juma, Z. Yarmand, M.S. The effect of replacing sugar with stevia and adding chia seed flour and pea protein isolate on the qualitative and rheological properties of gluten-free muffins made from rice flour. 2018. Biosystem Engineering of Iran (Agricultural Sciences of Iran), 50:3, 670-657 [In Persian].

[23] Martínez, M.M., Díaz, Á. and Gómez, M., 2014. Effect of different microstructural

features of soluble and insoluble fibres on gluten-free dough rheology and bread-making. Journal of Food Engineering, 142, pp.49-56.

[24] Junaidishah, N.A.M. and Bujang, A., 2018. Effect of Maltodextrin Substitution on Physicochemical and Sensorial Properties of Malay Traditional Cake 'Bahulu'. International Journal of Engineering & Technology, 7(4.14), pp.239-243.

[25] Saedi, Z. Karajian, R. Mehraban Sang Atash, M, The effect of dried pieces of pineapple fruit on the quality characteristics of muffins. 2018. Iran Food Sciences and Industries, 16:93, 109-120. (In Persian).

مجله علوم و صنایع غذایی ایران

سایت مجله: www.fsct.modares.ac.ir

مقاله علمی_پژوهشی

کاربرد روش تحلیل مؤلفه اصلی (PCA) جهت مطالعه پارامترهای کمی و کیفی مافین کم ساکارز حاوی مالتودکسترین و قاووت سنتی

نفیسه ذوالفقاری[1*]، اسماعیل عطای صالحی[2]، زهرا شیخ‌الاسلامی[3]

۱-دانش آموخته کارشناسی ارشد گروه علوم و صنایع غذایی، واحد قوچان، دانشگاه آزاد اسلامی، قوچان، ایران.

۲-دانشیار گروه علوم و صنایع غذایی، واحد قوچان، دانشگاه آزاد اسلامی، قوچان، ایران.

۳- دانشیار بخش تحقیقات فنی و مهندسی کشاورزی، مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی خراسان رضوی، سازمان تحقیقات، آموزش و ترویج کشاورزی، مشهد، ایران.

اطلاعات مقاله

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۱ /۰۸/۱۹

تاریخ پذیرش: ۱۴۰۱/۰۹/۲۴

کلمات کلیدی:

شکر کاهش‌یافته،

روش تحلیل مؤلفه اصلی،

قاووت،

مالتودکسترین،

مافین.

DOI: 10.22034/FSCT.19.132.211

DOR: 20.1001.1.20088787.1401.19.132.16.9

* مسئول مکاتبات:

zolfaghari.n.59@gmail.com

چکیده

در این مطالعه از روش تحلیل مؤلفه اصلی برای ارزیابی روابط میان پارامترهای کمی و کیفی (دانسیته، قوام، ویسکوزیته، رطوبت، حجم مخصوص، تخلخل، بافت و ویژگی‌های حسی) مافین با شکر کاهش یافته استفاده گردید. روش تحلیل مؤلفه اصلی(PCA)ابزاری سودمند برای تفسیر و یافتن ارتباط در مجموعه‌ای از پارامترها با ابعاد و ویژگی‌های متنوع در هر مشاهده است. این ابزار کمک شایانی در افزایش تفسیرپذیری داده‌ها و تجسم چند بعدی از ارتباط میان آن‌ها را فراهم می‌کند. در این پژوهش به منظور جایگزینی شکر، از فرمولاسیونی حاوی سه سطح مالتودکسترین (صفر، ۲۵ و ۵۰ درصد) و چهار سطح قاووت (صفر، ۳، ۶ و ۱۰ درصد) در قالب یک طرح ساده کاملا تصادفی استفاده شد. بر مبنای مطالعه فضای تحلیل مؤلفه اصلی مشخص گردید که روابط میان پارامترهای مورد مطالعه تحت تأثیر تغییرات در فرمولاسیون بود. به طوری که روابط جدیدی میان پارامترهای مورد مطالعه بر روی مافین مشاهده شد. ارزیابی تغییر در روابط میان پارامترها تحت تأثیر جایگزینی مالتودکسترین و قاووت در فرمولاسیون مافین با شکر کاهش یافته نشان‌دهنده تغییرات صورت گرفته در زیرلایه‌های ساختاری و تأثیرپذیری مجموعه‌ای پارامترها از یکدیگر تحت تیمارهای اعمال شده بود. نتایج حاصل از این پژوهش نشان‌دهنده کارایی و اهمیت کاربرد روش‌های مبتنی بر داده‌کاوی برای ایجاد شناخت از روابط میان پارامترهای کمی و کیفی فراورده‌های پخت با تغییر در فرمولاسیون است.