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Effect of substitution of sucrose and wheat flour with isomalt and quinoa seed flour on physicochemical, microbial, and rheological properties of low calorie cake powder

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ABSTRACT

One of the most important research areas in the production of sweet bakery products is the use of sugar substitute sweeteners and the use of other plant sources flour as a substitute for wheat flour in the production of these products. In this study, sugar and wheat flour were substituted with isomalt and quinoa seed flour in cake powder formulation at four levels (25, 50, 75 and 100%). Based on the statistical results, replacing wheat flour with quinoa flour and replacing sugar with isomalt had a significant effect on the moisture content of cake powder samples as well as viscosity and density of dough ($P < 0.05$). While sugar substitution with isomalt had no significant effect on insoluble ash content, pH and the total count of microorganisms in cake powder samples ($P > 0.05$).The results showed that replacement of wheat flour with quinoa flour reduced the moisture percent and increased ash content, pH and the total count of microorganisms of cake powder samples. Also, it increased viscosity and density of dough. The replacement of sugar with isomalt increased the moisture content and reduced the ash percentage of the cake powder sample. While the viscosity and density of the cake dough obtained from the cake powder increased. According to the considered characteristics of cake powder in this study, 25% replacement of wheat flour with quinoa flour and 25% replacement of sugar with isomalt (T1 treatment) were determined as the optimal treatment.

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1. Introduction

Beneficial food products, in addition to acting as nutrients, also affect specific biological functions, improve the overall level of health, and reduce the risk of certain diseases. Extra-beneficial food products can be a combination of food items to which healthy substances have been added or harmful compounds have been removed.1]. Faramand cake powder is a semi-finished product that consists of the main ingredients including wheat flour, sugar, baking powder and faramand additives. In this product, the mentioned ingredients are mixed with each other in the required ratio, and the consumer should mix it with water or milk, egg, butter or vegetable oil (solid or liquid) according to the manufacturer's instructions, and then cook it. Substitute for wheat flour. With the flour of other vegetable sources in the production of cake powder, it is considered as one of the most useful methods of preparing cake powder. Choosing the right source to replace wheat flour in the production of super-profitable bakery products and using the right methods to improve the quantitative and qualitative characteristics of the final product along with this replacement has always focused the minds of researchers.2]. Replacing wheat flour with flours from sources other than wheat, such as barley, rice, soy, sugar beet, chickpea, quinoa, etc., creates special nutritional and sensory properties in these products. Among the required characteristics of wheat substitute flours to create similar chemical and physical properties in bakery products after replacing flour is the tendency to have a lot of water and the presence of high amounts of fiber in them. The flour used as a substitute for wheat flour can improve the nutritional properties of these products due to their properties such as bioactive compounds (flavonoids, carotenoids, etc.), phytic acid, higher fiber content, high binding capacity to water and oil, and low energy.3]. Quinoa is a plant from the order of carnations, Taj Khorosian family and species*C. quinoa* With a scientific name*Chenopodium quinoa* is. The seeds of this plant are very digestible and a rich source of protein, fiber, copper, iron, phosphorus, magnesium, manganese, folate, thiamin, various vitamins and omega-3. The unusual and exceptional combination of protein, oil, fat, minerals, acids The fat, antioxidants and vitamins in quinoa make it a nutritious food. It is also gluten-free and is highly recommended for those on a gluten-free diet.4, 5].

Sweet bakery products based on wheat flour are among the most consumed foods in the whole world. Sucrose is one of the main ingredients in these products and contributes significantly to its energy content. High consumption of this substance is associated with problems related to diet such as obesity, blood pressure, tooth decay, diabetes and many other problems. Therefore, the need to produce low-calorie foods by reducing the amount of free sugar by using low-calorie sweeteners, such as polyols, in the formulation of these products has become evident to prevent diet-related diseases [6-8]. Low-calorie sweeteners are used as a partial substitute for sugars in food. The consumption of low-calorie sweeteners has increased in recent years among people of different age groups.9]. Sucrose, as a main ingredient in the preparation of cake powder, exerts its effect not only by providing energy and sweetness, but also by: (1) delaying and limiting the formation of the gluten network during mixing; (2) increasing the viscosity of the cake batter and improving its air holding capacity; (3) increasing the temperature and shrinking the egg protein and gelatinizing the starch; (4) It acts as the main agent of the Maillard reaction and the caramel reaction, which contributes to the color and flavor of the cake.10-12]. Although the energy content of sweet bakery products may be suitable by replacing sucrose with natural sweeteners or high-intensity artificial sweeteners, this can cause significant changes in properties such as texture, volume, color, taste, dough processing, useful life and most importantly the acceptance rate of the final product [13]. Polyols are a type of sucrose substitute that have low calories and its consumption may reduce the risk of obesity and diabetes. The use of polyols in bakery products has been studied for decades. However, the difference between the effects of sucrose and polyols on functional properties has not been conclusively clarified. In this regard, polyols are used as a suitable substitute for sucrose in sweet bakery products, along with strong sweeteners, due to properties such as not being completely absorbed by the digestive system and insulin-independent metabolism in case of absorption.13, 14]. Among polyols, isomalt is the only bulking sweetener that is exclusively derived from sucrose and includes two isomers of glucopyranosyl sorbitol and glucopyranosyl mannitol. Isomalt has a weak sweet taste and no aftertaste, and it enhances the transfer of flavor in food, the sweetening power is a function of

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its concentration, and the amount of sweetness increases with increasing concentration.15-17]. The low moisture absorption of isomalt makes the products that are exclusively or mainly based on isomalt have a long shelf life and the products produced with it have the same texture and appearance as the products produced with sucrose.15-17]. Considering the unique characteristics of quinoa seed, investigating the partial replacement of wheat flour with quinoa seed flour and also considering the adverse effects of sucrose on people's health, the use of sugar alcohol isomalt as alternative sweeteners in the formulation of cake powder, the purpose of this It is beneficial to investigate the effect of replacing sucrose and wheat flour with isomalt and quinoa seed flour on the physicochemical, microbial and rheological properties of low-calorie cake powder.

2- Materials and methods

2-1- Materials

The raw materials used in the preparation of cake powder, including wheat flour from Roshan Flour Factory in Tehran, quinoa seeds from Pakan Seed Company of Isfahan, isomaltase from Sigma Aldrich Company (USA), and other materials used in the preparation of cake were obtained from reliable domestic factories. All chemicals used in the tests were obtained from Merck (Germany). Also, Kant agar plate culture medium for microbial examination of samples was prepared from Merck (Germany).

2-2- Methods

2-2-1- Preparation of cake powder

After preparing the quinoa seed and cleaning it from foreign materials such as wood and leaves, a certain amount of quinoa seed was converted into flour by the mill and used in the preparation of low-calorie cake powder. Isomalt and quinoa flour were substituted for sugar and wheat flour at 4 levels (25, 50, 75 and 100%), respectively. Ingredients including powdered sugar, isomalt, wheat flour, quinoa flour were used based on grams per 100 grams of cake powder according to the formulations presented in table (1). Also, powdered milk (1.6% by weight), baking powder (2.6% by weight), improver (1.2% by weight), hydrogenated vegetable oil (0.7% by weight) and edible essential oil (0.1% by weight)) were used similarly in the formulation of all treatments.

Table 1 Sugar content, wheat flour, isomalt and quinoa flour in each treatment (gr/ 100 gr cake powder)

Treatment	Replacement percentage	Sugar	Isomalt	Wheat flour	Quinoa flour
Control	No replacement (Basic formula)	40	0	54	0
T_1	25% Isomalt+25%Quinoa	30	10	40/5	13/5
T_2	50% Isomalt +50%Quinoa	20	20	27	27
T_3	75% Isomalt +75%Quinoa	10	30	13/5	40/5
T_4	100% Isomalt +100%Quinoa	0	40	0	54
T_5	100% Quinoa–No isomalt	40	0	0	54
T_6	100%Isomalt- N0 Quinoa	0	40	54	0

2-2-2- Physicochemical properties of cake powder and quinoa flour

Evaluation of moisture percentage, pH and percentage of ash insoluble in acid using Iranian National Standard No. 6949, fiber content using the method presented in Iranian National Standard No. 3105, crude protein percentage using Iranian National Standard No. 2863 and evaluation of percentage Fat was measured using Iran's national standard number 2862.

2-2-3- The total number of microorganisms

To determine the total number of microorganisms, the national standard of Iran No. 3851 was used. For this purpose, first, a specific amount (gram) of cake powder was taken and mixed well with 9 times the weight of the diluent solution and the initial suspension was prepared. Decimal dilutions were made from the cake powder sample according to the national standard of Iran No. 8923. Using a sterile pipette, 1 ml of each of the prepared decimal dilutions was transferred to two separate sterile petri dishes. About 12 to 15 ml of Kant agar plate culture medium with a temperature of 44 to 47 degrees Celsius was poured into each plate. The plates were carefully mixed with the culture medium by swirling motion and placed on a horizontal, cool surface to completely solidify. The prepared plate was placed upside down in a greenhouse at a temperature of 30 degrees Celsius for 72 ± 3 hours. Then the plates with less than 300 colonies were selected for counting and the colonies were counted by colony counter.

2-2-4- Rheological evaluation of dough obtained from cake powder

Cake batter viscosity was evaluated using Brookfield viscometer and using LV spindle at a speed of 100 rpm.18]. Also, the density of the cake batter was determined according to the AACC-50-55 standard method. First, the weight of the dough was weighed in a container with a specific volume and the same volume of water was divided by the weight. Specific density was determined using equation (1).

$$SG=W_1/ IN_2$$

in equation (1)W_1 W_1 Weight, dough in a container with a certain volume andW_2 W_2 Weight is water in a container with a certain volume.

2-2-5- Sensory evaluation

Evaluation of the sensory characteristics of the cake samples, including aroma, taste, color, texture and general acceptance, was done using the hedonic method 5 with the use of 10 trained evaluators (Melgard et al. 1999).

2-2-6- Statistical design and results analysis method

Statistical analysis in this research was done using SPSS19 software. A factorial experiment was used in the form of a completely randomized block design. To check the presence of statistically significant differences between different treatments, one-way analysis of variance (ANOVA) was used, and Duncan's test was used to compare the average data at a significance level of 5%.

3- Results and discussion

3-1- Physicochemical and microbial properties of quinoa flour

Due to the existence of different varieties of quinoa, the characteristics of quinoa flour used in the preparation of cake powder have an effect on the physicochemical properties of the final product and the processing of the dough. Therefore, the physicochemical properties of the used quinoa flour were determined. In the investigation of these properties, the pH of quinoa flour is equal to 6.50±0.1, moisture 70.7±0.4, ash 3.21±0.2, protein 19.25±0.6, fiber 33.0±0.7 6 and fat equivalent to 0.13 was determined as 5.04 ± 5%. Also, the evaluation results of the total number of microorganisms in the quinoa flour sample indicated the presence of 4.42±0.05 Log CFU/g in the flour sample used.

2-3-Physicochemical properties of cake powder

The results of evaluating the moisture content of cake powder to determine the effect of replacing sugar with isomalt and wheat flour with quinoa flour on the moisture percentage of cake powder samples are presented in the graph of Figure (1). The results show a decrease in the moisture content of the cake powder sample with the simultaneous replacement of wheat flour with quinoa flour and sugar with isomalt (treatments T1 to T4). By comparing the control treatment and the treatment containing 100% isomalt and without quinoa flour (T6), we can conclude that the moisture level has increased by replacing sugar with isomalt. While comparing the control treatment and the treatment containing 100% quinoa flour and no isomalt (T5), it can be concluded that the moisture level has decreased by replacing wheat flour with quinoa flour. The reason for this is the low moisture level of quinoa seed flour (7/% 7) relative to the moisture content of wheat flour (14-15%). Also, the main reason for the very small increase in moisture content due to the use of isomalt can be the higher moisture content of isomalt compared to the sugar used in the preparation of cake powder. The low moisture content of quinoa seed flour compared to wheat flour in the research of Shehry (2016) in the use of quinoa flour for the production of bakery products [19] and Kaur in the evaluation of gluten-free bakery products using quinoa flour.20] and Wang et al. (2015) in investigating the effect of quinoa flour on the characteristics of cakes, Chinese steamed bread [21] has been reported. The results show a significant effect of replacing wheat flour with quinoa flour, replacing sugar with isomalt, and simultaneously replacing wheat flour with quinoa flour and sugar with isomalt on the moisture content of cake powder samples ($P<0.05$). Also, replacing wheat flour with quinoa flour has a greater effect on the amount of moisture change in cake powder samples than replacing sugar with isomalt.

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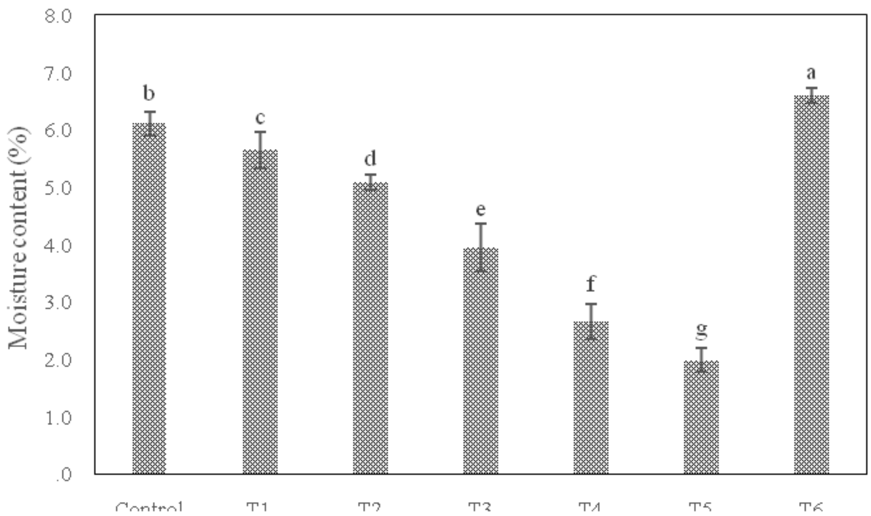

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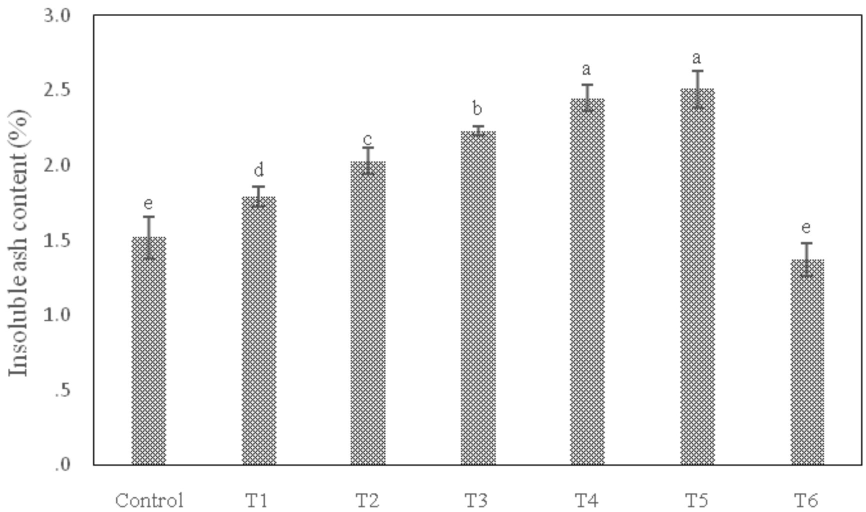
(Ism = Replacement percentage ofsugar with isomalt، q = Replacement percentage of wheat flour with quinoa flour)

letters in each treatment indicates a significant difference between the means.Different *

Fig 1 Average moisture content of cake powder samples

The results of the evaluation of ash percentage of cake powder samples obtained from different formulations are presented in the graph of Figure (2).

The results show a significant effect of replacing wheat flour with quinoa flour on the percentage of insoluble ash of cake powder samples (P<0.05), while replacing sugar with isomalt did not have a significant effect on the percentage of insoluble ash of cake powder samples (P<0.05).).



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(Ism = Replacement percentage ofsugar with isomalt، q = Replacement percentage of wheat flour with quinoa flour)

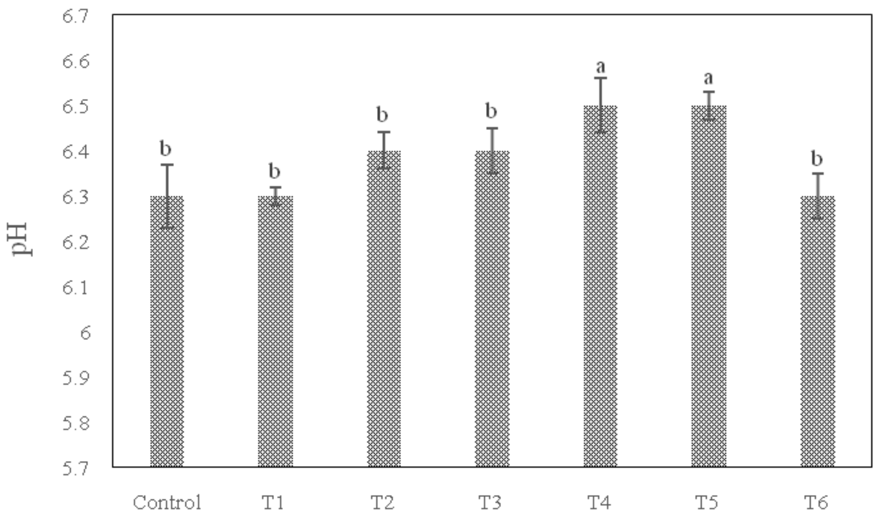
letters in each treatment indicates a significant difference between the means.Different *

Fig 2 Average acid insoluble ash content of cake powder samples

By comparing the ash percentage of the treatment containing 100% quinoa flour and without isomalt and the control treatment, we can conclude that by replacing wheat flour with quinoa flour, the ash percentage of the cake powder sample has increased. The main reason for this can be the higher ash content of quinoa flour (21%). 3) compared to wheat flour (0.38-

0.7%). Also, by comparing the control treatment and the treatment containing 100% isomalt and without quinoa flour, it can be concluded that the amount of ash did not change significantly by replacing sugar with isomalt. According to figure (2), during the simultaneous replacement of wheat flour and sugar with quinoa flour and isomalt in the cake powder formulation, an increase in the ash percentage of the cake powder samples is observed. The increasing trend of ash percentage with increasing percentage of quinoa flour in the research of Turkut et al. (2016) in the study of the effect of quinoa flour on the properties of gluten-free bread dough confirms the results of this study.22].

The results of the pH evaluation of cake powder samples obtained from different formulations are presented in the graph of Figure (3). The results showed that replacing wheat flour with quinoa flour had a significant effect on the pH of cake powder samples (P<0.05), while replacing sugar with isomalt did not have a significant effect on the pH of cake powder samples (P<0.05). According to the pH of the treatment containing 100% quinoa flour and without isomalt (T5) and the control treatment, it can be concluded that the pH of the cake powder samples has increased by replacing wheat flour with quinoa flour. Also, by comparing the control treatment and the treatment containing 100% isomalt and without quinoa flour (T6), we can conclude that there was no significant change in the pH level by replacing sugar with isomalt. The results show an increase in the pH of cake powder samples containing quinoa flour and isomalt in high concentrations of quinoa flour. By replacing wheat flour with quinoa flour, the average pH of the cake powder sample has increased from 6.31 to 6.54. The main reason for this could be the higher pH of quinoa flour (6.5) compared to wheat flour (6-6.5).



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(Ism = Replacement percentage ofsugar with isomalt ، q = Replacement percentage of wheat flour with quinoa flour)

letters in each treatment indicates a significant difference between the means.Different *

Fig 3 Average pH of cake powder samples

3-3- The total number of microorganisms

The results of the pH evaluation of cake powder samples obtained from different formulations are presented in the diagram of Figure (4). According to the results presented in the diagram of Figure (4), replacing wheat flour with quinoa flour has a significant effect on the total number of microorganisms in the samples. cake powder had (P<0.05), while replacing sugar with isomalt had no significant effect on these characteristics (P<0.05). Replacing wheat flour with quinoa flour has increased the total number of microorganisms in cake powder samples. According to the results of the examination of the total number of microorganisms in the cake powder samples, it can be concluded that the average logarithm of the number of microorganisms in the control treatments, T2 (50% replacement of sugar and wheat flour with isomalt and quinoa seed flour) and T5 (without replacing sugar with isomalt

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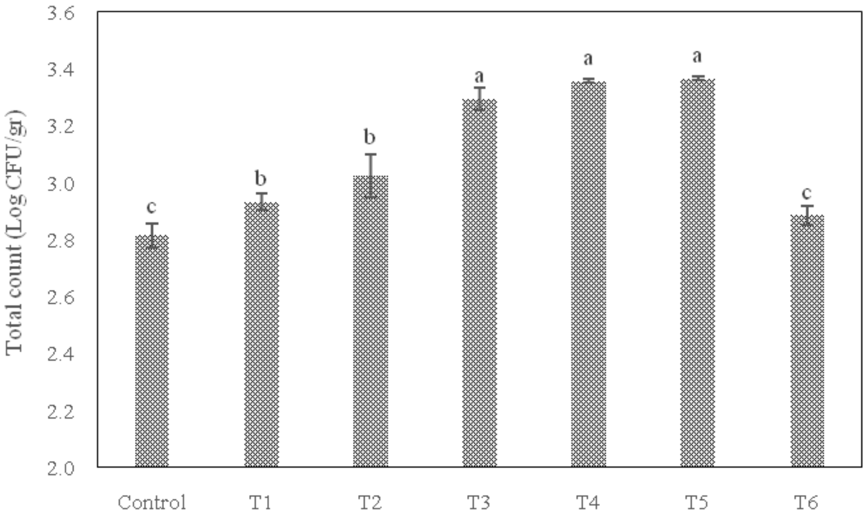
and replacing wheat flour with quinoa flour), have significant differences with each other. The average number of total microorganisms in treatments T3 (75% replacement of sugar and wheat flour with isomalt and quinoa flour), T4 and T5 are not significantly different from each other. Also, no significant difference was observed in the average total number of microorganisms in treatments T1 (25% replacement of sugar and wheat flour with isomalt and quinoa seed flour) and T2. The average number of total microorganisms in the control treatment and T6 (replacing sugar with isomalt) were also not significantly different from each other. By comparing the average total number of microorganisms in the T5 treatment and the control treatment, we can conclude that by replacing wheat flour with quinoa flour, the total number of microorganisms in the cake powder sample increased from 2.815 to 3.366 Log CFU/g. The reason for this could be the amount of microorganisms present in quinoa flour compared to wheat flour. Also, by comparing the control treatment and T6 treatment, we can conclude that by replacing sugar with isomalt, the total number of microorganisms did not change much, and there is no statistically significant difference between these two values. In other words, it can be said that the percentage of replacing wheat flour with quinoa flour had an increasing effect on the total number of microorganisms in cake powder samples.



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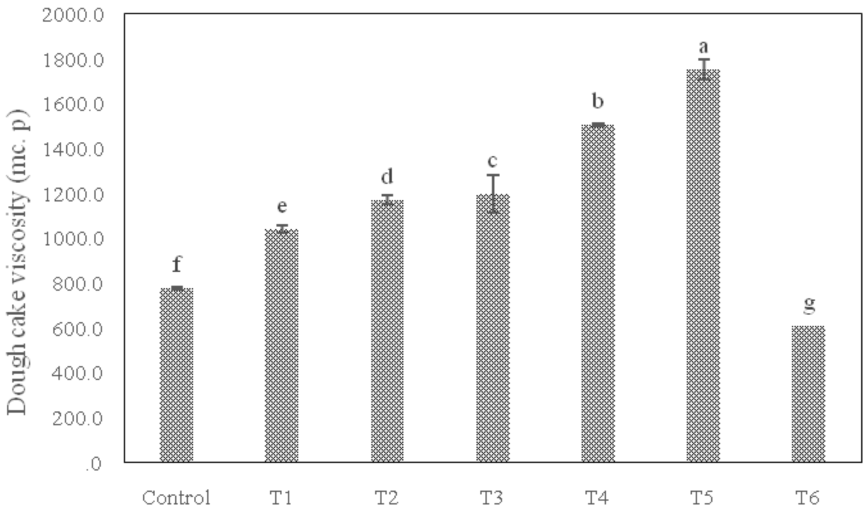
(Ism = Replacement percentage ofsugar with isomalt ، Replacement percentage of wheat flour with quinoa flour)

letters in each treatment indicates a significant difference between the means.Different *

Fig 4 Average total count of microorganisms of cake powder samples

3-4-Rheology of cake dough

The properties of cake batters prepared from different cake powder formulations including viscosity and density of the batter were evaluated. The results of dough viscosity evaluation are presented in Figure (5). According to the results presented in this figure, the replacement of wheat flour with quinoa flour, the replacement of sugar with isomalt, and the simultaneous replacement of wheat flour with quinoa flour and sugar with isomalt had a significant effect on the viscosity of the dough obtained from cake powder samples (0.05). >P). Replacing wheat flour with quinoa flour has an increasing effect and replacing sugar with isomalt has a decreasing effect on the average viscosity of the dough obtained from cake powder samples. By comparing the average viscosity of dough obtained from cake powder samples in treatment T5 (without replacing sugar with isomalt and replacing wheat flour with quinoa flour) and the control treatment, it can be concluded that by replacing wheat flour with quinoa flour, the viscosity of the dough increased from mcP 779 to 1752. Considering the increasing trend of viscosity of the treatments containing quinoa flour and isomalt (T1-T4) with increasing replacement percentage, it can be concluded that the effect of quinoa flour on the viscosity of cake powder dough is greater than the effect of isomalt on this characteristic. The main reason for the increase in dough viscosity during the replacement of wheat flour with quinoa flour is the change in the amount of gluten and the type of starch in the cake powder, which directly affect the viscosity and viscoelastic properties of the dough.23]. Also, by comparing the control treatment and the T6 treatment (full replacement of sugar with isomalt and no replacement of wheat flour), it can be concluded that by replacing sugar with isomalt, the viscosity of the dough obtained from the cake powder samples has decreased from 779 mcP to 610.33. In other words, it can be said that the percentage of replacing wheat flour with quinoa flour had an increasing effect and replacing sugar with isomalt had a decreasing effect on the average viscosity of the dough obtained from cake powder samples. Turkut et al. (2016) in the study of the effect of quinoa flour on the rheology of gluten-free bread dough showed that the viscosity of the dough increased by increasing the amount of quinoa flour.22]. Wang et al. (2015) in investigating the effect of quinoa flour on cake characteristics, Chinese steamed bread, reported an increase in hot dough viscosity with an increase in the percentage of quinoa flour.21]. Psimouli et al. (2012) in investigating the effect of sucrose substitute sweeteners on dough rheology and final cake properties from specific polyols (mannitol, maltitol, sorbitol, lactitol), fructose, oligofructose and polydextrose as sugar substitutes (with an equal amount of each) were used in the cake formulation. The results showed that by using all the alternatives except oligofructose and polydextrose, the index of the flow index in the power model has decreased. Also, the consistency coefficient in the power model has increased in all alternatives except sorbitol and oligofructose.24]. Cervera et al. (2014) in the investigation and comparison of different polyols as sucrose substitutes in muffin cookies on rheological properties showed that sorbitol, maltitol, erythritol and isomalt increased the peak viscosity of muffin dough samples.25]. The results of this research are consistent with the results of research conducted in the field of using quinoa flour and replacing sucrose.



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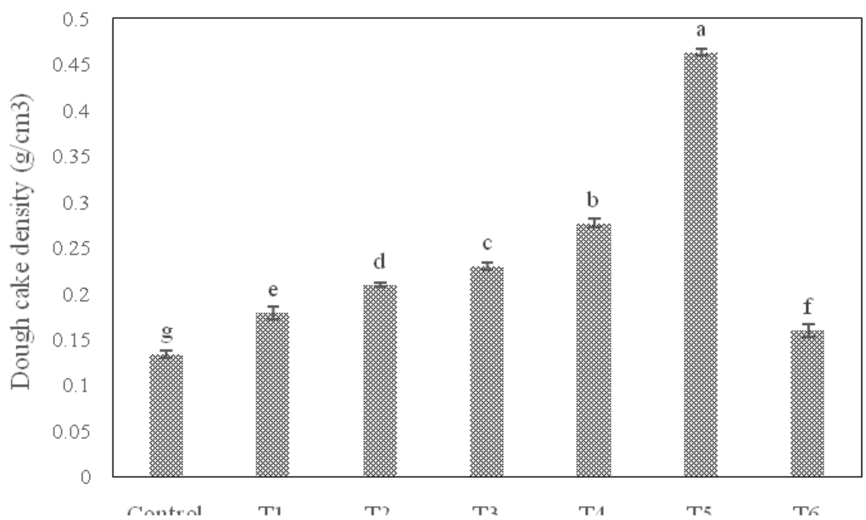
)Ism = Replacement percentage ofsugar with isomalt ، q = Replacement percentage of wheat flour with quinoa flour(
letters in each treatment indicates a significant difference between the means.Different *

Fig 5 Average viscosity of dough obtained from cake powder samples

The results of examining the density of the dough obtained from different formulations are shown in Figure (6). According to the results presented in the diagram of figure (6), replacing wheat flour with quinoa flour, replacing sugar with isomalt, and also replacing wheat flour with quinoa flour and sugar with isomalt had a significant effect on the density of the dough obtained from cake powder samples. (P<0.05). The results show the high impact of replacing wheat flour with quinoa flour on dough density compared to replacing sugar with isomalt. Replacing wheat flour with quinoa flour and replacing sugar with isomalt had an increasing effect on the average density of dough obtained from cake powder samples. By comparing the average density of dough obtained from cake powder samples in treatment T5 (without replacing sugar with isomalt and replacing wheat flour with quinoa flour) and the control treatment, we can conclude that by replacing wheat flour with quinoa flour, the density of dough increased from 0.1340 to 0.4634. grams per cubic centimeter has increased. The main reason for the increase in the density of the dough with the use of quinoa flour is the reduction of the amount of gluten in the dough and the lack of structure formation, as well as the reduction of trapping air bubbles in the dough.26]. Also, by comparing the control treatment and the T6 treatment (replacing sugar with isomalt), we can conclude that by replacing sugar with isomalt, the density of the dough obtained from the cake powder samples is from gr/cm^3 0.1340 has increased to 0.1599. In other words, it can be said that the percentage of replacing wheat flour with quinoa flour and replacing sugar with isomalt had an increasing effect on the average density of the dough obtained from cake powder samples. Research has shown that the presence of sugar in the formulation of bakery products increases the gelatinization temperature of starch, which directly affects the trapping of air bubbles and carbon dioxide, and ultimately the specific volume of bakery products.27]. Increasing the use of isomalt causes a decrease in the presence of sugar in the formulation, and as a result, the positive effect of sugar on increasing the specific volume is reduced, as a result, the specific volume of the final product is reduced. The main reason for the increase in the density of the dough during the decrease in the presence of sugar in the formulation is the positive role of sugar in trapping air bubbles and carbon dioxide.



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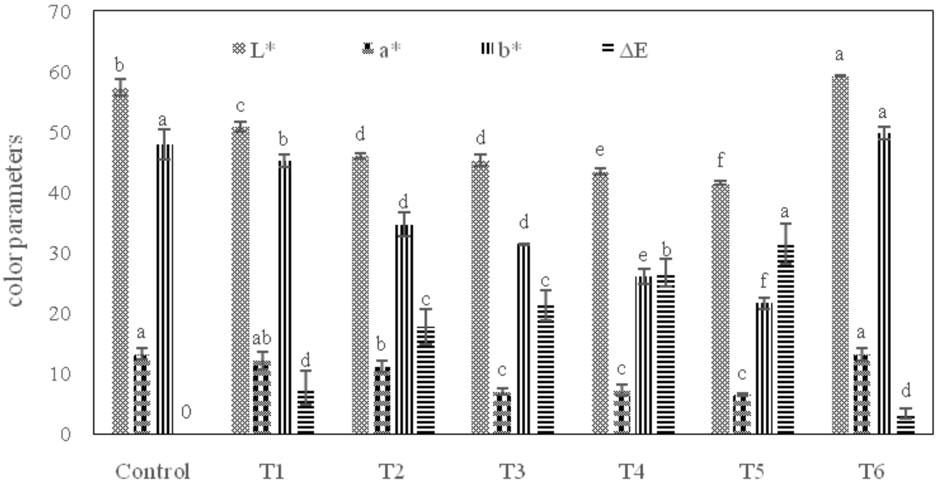
letters in each treatment indicates a significant difference between the means.Different *

Fig 6 Average density of dough obtained from cake powder samples

5-3-Evaluating the color of the cake

The results of evaluating the color parameters of the cake samples from different cake formulations to determine the effect of replacing sugar with isomalt and wheat flour with quinoa flour on the color parameters are presented in Figure (7). According to the results of statistical analysis, replacing wheat flour with quinoa flour had a significant effect on all color parameters of the cake ($P<0.05$), while replacing sugar with isomalt had a significant effect on the L* brightness parameter of the cake (<0.05). P) and the reddening parameter*a and jaundice* b were not affected by replacing sugar with isomalt ($P<0.05$). The effect of isomalt replacement on the brightness parameter L* was very insignificant compared to the replacement of quinoa flour. The results show a significant difference between the average of the L* brightness parameter in all treatments. The results show the reduction of all color parameters of the cake by replacing wheat flour with quinoa flour. The main reason for this reduction is more darkness, redness and less yellowness of quinoa flour compared to wheat flour. Comparison of color changes (ΔE) of T4 and T6 treatments shows that replacing wheat flour with quinoa flour increases ΔE. While comparing T4 and T5 treatments, it can be concluded that ΔE is reduced by replacing sugar with isomalt.



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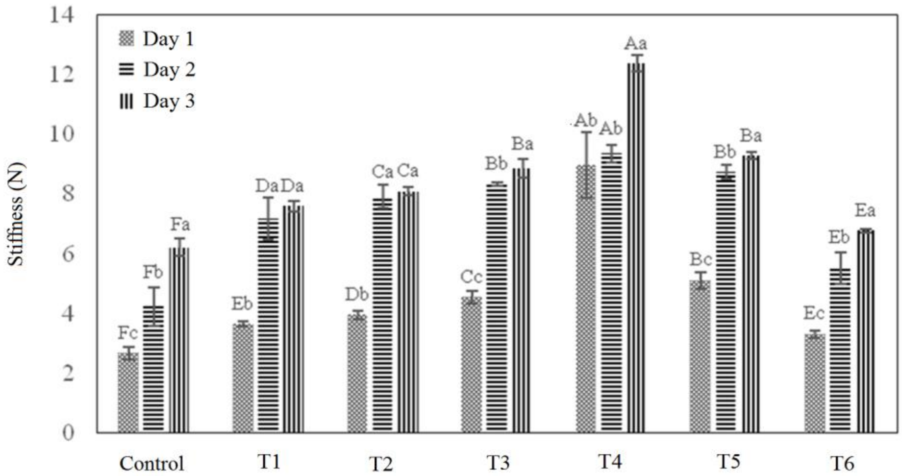
letters in each treatment indicates a significant difference between the means.Different *

Fig7 Color parameters and color change of cake samples

6-3- Cake texture

Evaluation of tissue stiffness was evaluated on the first, second and third days. The results of the evaluation of the texture of the cake samples during the storage period are presented in Figure (8).



Ism100%-q0% :T6 Ism100%-q100% :T4 Ism50%-q50% :T2 Ism0%-q0% :Control
Ism0%-q100% :T5 Ism75%-q75% :T3 Ism25%-q25% :T1

(Ism = Replacement percentage ofsugar with isomalt ، q = Replacement percentage of wheat flour with quinoa flour)

lowercase letters in each treatment indicates a significant difference between the means.Different *

capital letters in each day indicates a significant difference between the means.Different **

Fig 8 Effect of type of treatment and storage time onthe stiffness of cake samples

The results show that the type of treatment in all the examined days and the duration of storage in all the examined treatments had a significant effect on tissue stiffness ($P<0.05$). The highest tissue stiffness in each treatment is on the third day of storage. Comparison of the results on each day shows that on the first day, the highest tissue stiffness is related to the T4 treatment sample and the lowest tissue stiffness is related to the T0 control treatment. The increase in texture stiffness due to the use of isomalt and quinoa flour can be due to the decrease in specific volume and the trapping of air bubbles due to the decrease in the amount of gluten and the decrease in the formation of the three-dimensional structure in the cake with the decrease in the amount of gluten (Belido et al. 2009). Replacing sugar with isomalt has increased the firmness of the texture. The increase in the stiffness of the tissue due to the reduction of sugar can be attributed to the positive effect of the presence of sugar in the trapping of air bubbles and the softening of the dough (Noormohammadi and Prophetedoost 2015). The increase in texture firmness with the use of quinoa flour and the use of sugar substitute sweeteners in baking products has been reported in several studies (Martinez et al. 2014; Noormohammadi and Prophetedoost 2015; Turkat et al. 2016).

7-3- sensory characteristics

The sensory evaluation results of cake samples obtained from different treatments are presented in table (2). According to the results of the statistical analysis, the type of treatment had a significant effect on each of the sensory characteristics ($P<0.05$). By increasing the percentage of replacing wheat flour with quinoa flour, the sensory score of aroma and taste has decreased. So that the lowest sensory score of aroma and taste belongs to the T4 treatment sample. The results showed that replacing sugar with isomalt had no significant effect on the taste and aroma characteristics of the cake samples. The highest color score belongs to the T6 treatment sample. By replacing sugar with isomalt, the sensory color score of cake samples improved, and by replacing wheat flour with quinoa flour, the sensory color score decreased. Also, with the increase in the percentage of quinoa flour and isomalt, the texture score of the cake samples decreased. The results showed a decrease in the sensory score of overall acceptance by replacing quinoa flour and isomalt in the cake formulation. The significant effect of using quinoa flour and sugar substitute sweeteners in the formulation on the sensory characteristics of baking products including gluten-free rice cookies, cakes, biscuits and bread has been shown in several studies (Al Shahri 2016; Kodina et al. 2017; Kaer and Kaer 2017; Pavkin et al. 2015).

Table 3 Sensory characteristics of cake samples

Treatment	Score ± Standard deviation				
	Taste	Smell	Color	Texture	Acceptance
Control	3.91 ± 0.32^{a}	4.44 ± 0.19^{a}	4.09 ± 0.22^{b}	4.60 ± 0.16^{a}	4.18 ± 0.13^{a}
T1	3.71 ± 0.23^{b}	4.10 ± 0.14^{b}	3.75 ± 0.28^{c}	4.34 ± 0.21^{b}	3.91 ± 0.12^{b}
T2	3.52 ± 0.26^{c}	3.51 ± 0.33^{c}	3.43 ± 0.26^{d}	3.27 ± 0.24^{c}	3.32 ± 0.26^{d}
T3	3.11 ± 0.08^{d}	2.61 ± 0.15^{d}	$3.24\pm0.17^{It\ is}$	3.26 ± 0.23^{c}	$3.04\pm0.09^{It\ is}$
T4	$2.99\pm0.20^{It\ is}$	$2.48\pm0.16^{It\ is}$	$3.17\pm0.09^{It\ is}$	2.46 ± 0.21^{d}	2.72 ± 0.12^{f}
T5	$2.92\pm0.20^{It\ is}$	$2.46\pm0.23^{It\ is}$	3.03 ± 0.37^{f}	2.57 ± 0.2^{d}	2.71 ± 0.16^{f}
T6	4.00 ± 0.36^{a}	4.41 ± 0.31^{a}	4.42 ± 0.25^{a}	4.44 ± 0.23^{b}	3.78 ± 0.16^{c}

Different letters in each characteristic mean significant difference *

4 - Conclusion

The most important goal of this research is to improve the nutritional value and reduce the calories of cake powder as one of the widely used bakery products through replacing quinoa flour as a combination with high nutritional value with wheat flour and replacing isomalt as a low calorie sweetener with sugar in the formulation. Cake powder was made. Examining the physicochemical characteristics of cake powder samples showed that replacing wheat flour with quinoa flour decreased the moisture content of the cake powder sample, increased the ash percentage and pH of the cake powder. Also, the replacement of sugar with isomaltase increased the percentage of moisture and decreased the percentage of ash. By replacing wheat flour with quinoa flour, the total number of microorganisms in the cake powder sample increased. While replacing sugar with isomalt did not have a significant effect on the total number of microorganisms in cake powder samples. The main reason for these changes is the difference in the physicochemical properties of quinoa flour and wheat flour, as well as sugar and isomalt. By replacing wheat flour with quinoa flour, the viscosity and density of the dough increased. The main reason for the increase in the viscosity and density of the dough during the replacement of wheat flour with quinoa flour is the change in the amount of gluten, the type of starch in the cake powder, which directly affect the viscosity and viscoelastic properties of the dough. Also, by replacing sugar with isomalt, the viscosity of the dough obtained from the cake powder samples decreased and the density of the cake dough increased. Replacing sugar with isomalt improved the color of cake samples. According to the evaluation of the texture of the cake samples, with the increase in the replacement percentage of quinoa flour, the texture characteristics decreased. Also, the replacement of quinoa flour and isomalt in the cake formulation caused a decrease in sensory scores, including taste, aroma, color, texture, and overall acceptance. By examining the sensory characteristics, it can be concluded that the color and sensory characteristics of the cake samples had a significant impact on the overall acceptance of the cake samples. Therefore, according to the evaluation of the physicochemical, microbial, rheological and sensory characteristics of the cake samples, the treatment containing 25% replacement of wheat flour with quinoa flour and 25% replacement of sugar with isomalt (treatment T1) was determined as the optimal treatment.

5-Resources

[1] Modoran, C., Muste, S., Modoran, D., Frigioiu, A., Rotar, A.M., Morar, O.A., 2007. Researches regarding the improvement of bread quality using functional ingradients Journal of Agroalimentary Processes and Technologies, 2: 363-368.

[2] Dziki, D., Różyło, R., Gawlik-Dziki, U., Świeca, M., 2014. Current trends in the enhancement of antioxidant activity of wheat bread by the addition of plant materials rich in phenolic compounds. Trends in Food Science & Technology, 40(1): 48-61.

[3] Quiles, A., Campbell, G.M., Struck, S., Rohm, H., Hernando, I., 2016. Fiber from fruit pomace: A review of applications in cereal-based products. Food Reviews International: 1-20.

[4] Gálvez , A. , Miranda , M. , Vergara , J. , Uribe , E. , Puente , L. , Martinez , E.A. a review. Journal of the Science of Food and Agriculture, 90(15): 2541-2547.

[5] Pereira, E., Encina-Zelada, C., Barros, L., Gonzales-Barron, U., Cadavez, V., Ferreira, I.C., 2019. Chemical and nutritional characterization of Chenopodium quinoa Willd (quinoa) grains: A good alternative to nutritious food. Food chemistry, 280: 110-114.

[6] Brownell, K.D., Walsh, B.T., Eating disorders and obesity: A comprehensive handbook. 2017: Guilford Publications.

[7] Dwivedi, B.K., Low calorie and special dietary foods. 2018: CRC Press.

[8] Wang, Y., Van Eys, J., 1981. Nutritional significance of fructose and sugar alcohols. Annual review of nutrition, 1(1): 437-475.

[9] Figueiredo, L., Scapin, T., Fernandes, A.C., Da Costa Proença, R.P., 2018. Where are the low-calorie sweeteners? An analysis of the presence and types of low-calorie sweeteners in packaged foods sold in Brazil from food labelling. Public health nutrition, 21(3): 447-453.

[10] Foulkes, P.H., Replacement of sugar in a sugar-containing food and process. 1977, Google Patents.

[11] Marshall, R.T., Goff, H.D., Hartel, R.W., Ice cream. 2012: Springer.

[12] Wilderjans, E., Luyts, A., Brijs, K., Delcour, J.A., 2013. Ingredient functionality in batter type cake making. Trends in food science & technology, 30(1): 6-15.

[13] Hao, Y., Wang, F., Huang, W., Tang, X., Zou, Q., Li, Z., Ogawa, A., 2016. Sucrose substitution by polyols in sponge cake and their effects on the foaming andthermal properties of egg protein. Food Hydrocolloids, 57: 153-159.

[14] Livesey, G., 2003. Health potential of polyols as sugar replacers, with emphasis on low glycaemic properties. Nutrition Research Reviews, 16(2): 163-191.

[15] Nabors, L., Alternativesweeteners. 2016: CRC Press.

[16] Thiebaud, D., Jacot, E., Schmitz, H., Spengler, M., Felber, J., 1984. Comparative study of isomalt and sucrose by means of continuous indirect calorimetry. Metabolism-Clinical and Experimental, 33(9): 808-813.

[17] Zumbe, A., Lee, A., Storey, D., 2001. Polyols in confectionery: the route to sugar-free, reduced sugar and reduced calorie confectionery. British Journal of Nutrition, 85(S1): S31-S45.

[18] Salehi, F., Kashaninejad, M., Akbari, E., Sobhani, S.M., Asadi, F., 2016. Potential of sponge cake making using infrared–hot air dried carrot. Journal of texture studies, 47(1): 34-39.

[19] Al Shehry, G.A., 2016. Use of Corn and Quinoa Flour to Produce Bakery Products for Celiac disease. Advances in Environmental Biology, 10(12):237-244.

[20] Kaur, S., Development and organoleptic evaluation of gluten free bakery products using quinoa (Chenopodium quinoa) flour. 2016, Punjab Agricultural University,

Ludhiana.
[21] Wang, S., Opassathavorn, A., Zhu, F., 2015. Influence of Quinoa Flour on Quality Characteristics of Cookie, Bread and C hinese Steamed Bread. Journal of Texture Studies, 46(4): 281-292.
[22] Turkut, G.M., Cakmak, H., Kumcuoglu, S., Tavman, S., 2016. Effect of quinoa flour on gluten-free bread batter rheology and bread quality. Journal of Cereal Science, 69: 174-181.
[23] Witczak, M., Juszczak, L., Ziobro, R., Korus, J., 2012. Influence of modified starches on properties of gluten-free dough and bread. Part I: Rheological and thermal properties of gluten-free dough. Food Hydrocolloids, 28(2): 353-360.
[24] Psimouli, V., Oreopoulou, V., 2012. The effect of alternative sweeteners on batter rheology and cake properties. Journal of the Science of Food and Agriculture, 92(1): 99-105.
[25] Martínez-Cervera, S., Salvador, A., Sanz, T., 2014. Comparison of different polyols as total sucrose replacers in muffins: Thermal, rheological, texture and acceptability properties. Food Hydrocolloids, 35: 1-8.
[26] Campbell, G.M., Herrero-Sanchez, R., Payo-Rodriguez, R., Merchan, M.L., 2001. Measurement of dynamic dough density and effect of surfactants and flour type on aeration during mixing and gas retention during proofing. Cereal Chemistry, 78(3): 272-277.
[27] Nourmohammadi, E., Peighambardoust, S.H., 2015. A comprehensive study on the effect of maltitol and oligofructose as alternative sweeteners in sponge cakes. International journal of food engineering, 11(4): 557-562.

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تاثیر جایگزینی ساکارز و آرد گندم با ایزومالت و آرد دانه کینوآ بر خصوصیات فیزیکوشیمیایی، میکروبی و رئولوژیکی پودر کیک کم کالری

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چکیده

یکی از زمینه‌های تحقیقاتی بسیار مهم در تولید محصولات نانوایی شیرین استفاده از شیرین کننده‌های جایگزین شکر و بکارگیری آرد سایر منابع گیاهی به عنوان جایگزینی آرد گندم در تولیداین محصولات می‌باشد. در این تحقیق ایزومالت و آرد کینوآ در چهار سطح (۲۵، ۵۰، ۷۵ و ۱۰۰ درصد) جایگزین شکر و آرد گندم در فرمولاسیون پودر کیک شدند. براساس نتایج آماری جایگزینی آرد گندم با آرد کینوآ و جایگزینی شکر با ایزومالت تاثیر معنی‌داری بر میزان رطوبت نمونه‌های پودر کیک و همچنین ویسکوزیته و دانسیته خمیر داشت (P<۰/۰۵). در حالی که جایگزینی شکر با ایزومالت تاثیر معنی‌داری بر درصد خاکستر نامحلول،**pH**و شمار کلی میکروارگانیسم‌های نمونه‌های پودر کیک نشان نداد (P>۰/۰۵). نتایج نشان داد جایگزینی آرد گندم با آرد کینوآ سبب کاهش درصد رطوبت، پارامتر روشنایی**L***، پارامتر قرمزی**a*** و پارامتر زردی**b*** و افزایش درصد خاکستر، **pH** و شمار کل میکروارگانیسم‌های نمونه‌های پودر کیک و افزایش ویسکوزیته و دانسیته خمیرشد. همچنین جایگزینی شکر با ایزومالت سبب افزایش درصد رطوبت و افزایش پارامتر روشنایی**L***، کاهش درصد خاکستر نمونه کیک، ویسکوزیته خمیر حاصل از نمونه‌های پودر کیک و افزایش دانسیته خمیر کیک شد. ارزیابی بافت نمونه‌های کیک نشان داد که نوع تیمار در کلیه روزهای مورد بررسی (روز اول، دوم و سوم پس از پخت) و مدت زمان ذخیره سازی در کلیه تیمارهای مورد بررسی اثر معنی‌داری بر سفتی بافت داشت. نوع تیمار اثر معنی‌داری بر هر یک از ویژگی‌های حسی شامل طعم و مزه، عطر و بو، رنگ، بافت و پذیرش کلی داشت. با توجه به خصوصیات مورد بررسی در این تحقیق تیمار حاوی ۲۵ درصد جایگزینی آرد گندم با آرد کینوآ و ۲۵ درصد جایگزینی شکر با ایزومالت (تیمار**T1**) به عنوان تیمار بهینه تعیین گردید.