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The effect of different proportions of hydrocolloids and food emulsifiers on the physicochemical, textural and microbial properties of sponge cake during the storage period

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ABSTRACT

In this research, three different types of hydrocolloids (chitosan ,tragacanth, hydroxy propyl methyl cellulose) 2 % on the basis of flour weight and three different kinds of emulsifiers (lecithin, glycerol mono stearate, propylene glycol) 1 % on the basis of flour weight, were added in different proportions to sponge cake's formulation in order to assay quality indicators of cake. Bulk density, true density, aw (water activity), moisture, amylose content, texture analysis, microbial growth and colour (hue, chroma) were used as quality indices during cake's shelf life period (12 weeks). Colour, aw and firmness did not significantly affect by any of hydrocolloids and emulsifiers and they affected only by the storage time. HPMC and lecithin had the most effect on decreasing true density and bulk density respectively. Results indicated that chitosan was the most effective hydrocolloid for retention of moisture in cakes. The amylose content increased by increasing lecithin during the six weeks and PG had significant effect in last three weeks of storage time. Lecithin also significantly affected the Fmax, so the cake's with high levels of lecithin in formulation had tender crust, and hardness decreased during the first six weeks of shelf life. No microbial growth was reported in addition of different proportions of hydrocolloids and emulsifiers. Except of lecithin, two other emulsifiers had no significant effect on Chroma index in comparison with control cakes.

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1. Introduction

Cakes are the most important bakery products and their global market has an annual growth of about 1.5%. The challenges in the cake market include reducing costs and increasing shelf life and quality control [1]. The cake industry consists of mixing ingredients in the form of a dough, which has a low viscosity due to the high level of liquid phase, and this dough turns into a cake [2]. Although the method of preparing the cake has a very important effect on its quality, the role and mutual effects of its ingredients have not been fully determined. Any change in the cake formula will be very important in these effects because the cake has a lot of variety. In any case, the general formula of the cake includes flour, sugar, eggs, oil or fat, and bulking agents. The overall moisture content of this product varies from 18-28% in different types so that it is more than sweets and less than bread [3]. In industrial cakes, all the basic ingredients of the cake, including flour, sugar, baking powder, powdered milk, the number of eggs, flavorings, permitted edible colors, and in short, all the basic ingredients, even sometimes oil, are formulated in a certain ratio and provided to the home consumer. He gives to prepare fresh cake when necessary. In such cases, adding fresh milk, water, oil and eggs in a certain ratio is done by the consumer [4]. In sponge cakes, the amount of sugar, flour, and whole egg is more or less the same, because of the use of whole egg, which puffs up less compared to egg white, you should be careful to increase the volume of the cake dough. Adding cream of tartar, lemon juice, salt and sugar helps to make it spongy and stable [5]. Emulsifiers are substances that are placed in the dough between two immiscible phases, and by reducing the surface tension of the molecules of the two phases, they make it easier to mix them and form a stable emulsion. These compounds have hydrophilic and lipophilic poles. Using them reduces starch swelling, increases gelatinization temperature, improves rheological characteristics, improves texture, color, volume, and delays staleness [6]. The first emulsifiers used in the food industry were their natural types such as lipoproteins, bile salts, casein, and lecithin. Today, lecithin is used more often as a natural emulsifier, but their synthetic types, such as mono and diglycerides, have been widely used. . Helping the complexation of starch and protein, reacting with proteins. Changing the dough viscosity, aeration and foaming of the dough, changing the texture of the product, smoothing the gluten network, changing the state of the starch crystal, moisturizing, delaying staleness, and improving the palatability of the final product are among the most important roles of emulsifiers in baking products [7]. The mechanism of effect of emulsifiers in conditioning the dough and softening its texture has not been well explained, but most researchers evaluate their effect in improving the quality of baking products positively. The use of emulsifiers in baking products has become specialized, and for example monoglycerides, citric acid esters, monodiglycerides are used to stabilize dough emulsion [8]. Lecithin is very attractive as an efficient and safe emulsifier in the food industry, and its use has been common since the 1950s. Liquid lecithin is a mixture of polar phospholipids and glycerolipids with esterified fatty acids and is more saturated. The most important lecithin, which is related to soy, has a higher amount of unsaturated fatty acid and a lower amount of saturated fatty acid. The work of lecithin, like other emulsifiers, is to reduce the surface pressure between two non-homogeneous phases and prevent their separation and two-phase mixture [9]. Hydrocolloids, which are often known as gums, are hydrophilic polymers of plant, microbial, animal or synthetic origin and generally contain hydroxyl groups and in some cases polyelectrolytes and are usually naturally present in foods or added. The most important properties of hydrocolloids include creating viscosity (consistency or gel) and binding to water, but some other properties include stability of emulsions, prevention of recrystallization of ice, and organoleptic properties [10]. The characteristics of chitosan oligosaccharide, such as the degree of distillation, charge diffusion, and its chemical characteristics cause its high consumption. Unlike chitosan with high molecular weight, chitosan oligosaccharide easily enters the bloodstream in the intestine and has biological effects in organisms. Most of the accepted mechanisms have shown that oligosaccharide prevents the entry of materials into the cell by preventing the biological function of the microbe's cell wall, resulting in the death of the microbe's cell due to the lack of nutrients [11].

High-quality cakes have features such as high volume, uniform texture, crispness, shelf life, and resistance to staleness, all of which depend on the formula and aeration of the cake dough, and the final quality of the cake can be affected by the addition of ingredients that affect the properties of the cake, such as The function of hydrocolloids [12]. These polysaccharides are used in food preparation for various purposes to provide dietary fiber or contribute to certain performance properties in products. Also, they are able to improve food texture, delay starch retrogradation, and improve moisture retention. increase the final quality of products during storage. In a study that was conducted to investigate the effect of each type of hydrocolloid such as sodium alginate, carrageenan, pectin, hydroxypropyl methyl cellulose, locust bean gum, guar gum, and xanthan gum, the properties of dough include The density of the dough, the volume of the cake, the texture of the cake, including firmness, gumminess, chewiness, adhesion, continuity and elasticity of the cake and sensory evaluations were tested [13].

The use of dietary fibers has a nutritional role and is effective against cardiovascular diseases, cancer, reducing serum cholesterol and regulating blood glucose levels. Chitosan and chitosan oligomers are of interest as dietary fibers. Chitosan oligosaccharides are biologically more active than high molecular weight chitosan. And these compounds have the bioavailability of vitamins E, C, A, and B_1 ‘B_2 ‘ B_3‘B_6 ‘B_9 and B_{12} and increases riboflavins, iron, zinc and copper, and the addition of chitosan to bakery products brings a chance to combine technological properties with biological properties. Determined. Oligosaccharides of chitosan and chitosan with low molecular weight increase the rate of sterility, and chitosan with medium molecular weight increases the rate of sterility less than the two high types [14]. Aryai et al. (2015) of three microcrystalline cellulose gums[1] Hydroxypropyl methyl cellulose[2] and xanthan, two glycerol monostearate emulsifiers[3] and sodium stearyl lactylate[4]as well as whey protein isolate[5] Used as a fat substitute. reported that the addition of hydrocolloids increased the viscosity and density of the paste. Among the hydrocolloids, xanthan has the most effect, followed by microcrystalline cellulose and hydroxypropyl methyl cellulose [15]. Ahmadi et al. (2015) investigated the effect of guar gum and propylene glycol monostearate (PGME) emulsifier on the qualitative and physicochemical properties of sponge cake and guar gum at zero, 0.3 and 0.5% levels and PGME emulsifier At zero level and 0.5% were added to the sponge cake formulation. The relevant results have shown that the addition of guar gum and PGME emulsifier improves water absorption, increases porosity, and improves the texture, so that the examination of the textural properties of the cake by the texture tester revealed that the addition of gum and emulsifier reduces the hardness of the cake over time. becomes [16].

[1] Microcrystalline cellulose
[2]hydroxypropyl methylcellulose
[3]Glycerol monostearate
[4]Sodium stearoyl lactylate
[5]Whey protein isolate

Pourfarzad et al. (2012) also used the response procedure method in order to study the effect of improving gel components on the stickiness of Berber bread dough and to optimize the gel formula. Gel samples were produced by adding sodium stearoyl lactylate and propylene glycol in the range of 0 to 0.5 g/100 g. The results have shown that the addition of all three components to the gel formula has reduced the adhesion force. Although the adhesion distance increased due to the addition of all three components, but sodium stearoyl lactylate square and the interaction of dotum and propylene glycol significantly reduced it. The adhesion level was only affected by sodium stearoyl lactylate and other components had no significant effect on this index [17].

The main purpose of this research is to investigate the effect of adding three types of emulsifiers (lecithin, propylene glycol and glycerol monostearate) as substances that facilitate the mixing and stability of the dough, as well as three types of hydrocolloids (hydroxypropylene methyl cellulose, chitosan and vectera) as water retaining agents. In the cake batter, it depends on the quality indicators of the cake. This mixing is done in different ratios of each of the emulsifiers and hydrocolloids in the dough so that the optimal mixing ratio of the emulsifier and hydrocolloids is obtained in terms of checking the quality indicators during the shelf life of the cake.

1- materials and methods

2-1- Materials

Nol flour produced by Kusheh Nakhdeh flour company, liquid oil by Nazgol brand, sugar produced by Urmia sugar factory, whole eggs prepared from a poultry farm in Urmia city, invert syrup prepared by Talia company, table salt by Saba brand, vanilla powder Produced by Jivodan Company, Powdered Milk by Binarzen Company, Starch produced by Chi Chest Sanbleh Company, Glucose produced by Chi Chest Glucose, Baking Powder produced by Hermin Company, Chitosan with medium molecular weight from Pars Teb Novin Company, Ketira (Tragacanth) from Attari, Urmia City, Hydroxypropyl Methyl Cellulose was obtained from Sigma Aldrich Company, glycerol monostearate was obtained from Irxathate Company. Lecithin produced by Behpak Company, propylene glycol produced by SKC Company in Korea, amylase enzyme (from potato) produced by Fluka Company, other materials and chemical solutions with high analytical purity (produced by Merck Company) were used.

2-2- Production method

To produce the product (cake), all raw materials were weighed according to the percentages mentioned in Table 1, and the amount of hydrocolloids (hydroxypropyl methyl cellulose, chitosan, ketira) in total amount to 2% based on the weight of flour and emulsifiers (glycerol monostearate mono sodium, propylene glycol and lecithin) in total amount of 1% based on the weight of flour according to table 2 was weighed and prepared. The liquid raw materials were combined and mixed for 2 minutes using a moulinex mixer. Then, other ingredients except flour and baking powder were mixed and mixing was done again for 2 minutes. After the above step, the combination of hydrocolloids and emulsifiers was added to the prepared formulation and mixing was done for one minute and finally flour and baking powder were added and a partial mixing was done to combine the raw materials with flour and baking powder. After preparing the dough, 30 grams of dough was injected into the cake capsules (paper molds) using a funnel and then baked in the oven for 10 minutes at 170 degrees Celsius. After baking, the cakes were separated from the respective molds and after cooling in the cooling tunnel for 10-15 minutes, they were packed in the respective machine. The products produced based on the statistical design were tested at 0, 6 and 12 weeks of shelf life at room temperature and at the prescribed time according to the statistical table.

Table 1. The prepared cake formulation along with the corresponding percentages

Percentage (%)	Ingredients	Number
38	Zero flour	1
21.7	Sugar	2
10.66	Liquid oil	3
12.2	egg	4
4.57	Invert syrup	5
8.4	Water	6
0.15	Salt	7
0.114	vanilla	8
0.76	milk powder	9
1.06	starch	10
1.6	Glucose	11
0.78	Baking powder	12

Table 2. Experimental design used to produce cakes based on the studied factors

Run	Block	Chitosan	HMC	Tragacanth	PG	Lecithin	GMS	Time
								weeks
1	Block 1	0.5	0.5	0	0.667	0.667	0.667	12
2	Block 1	0	0	1	2	0	0	0
3	Block 1	1	0	0	0	2	0	6
4	Block 1	0	0	1	2	0	0	0
5	Block 1	0	1	0	0	2	0	0
6	Block 1	0.5	0.5	0	0.667	0.667	0.667	0
7	Block 1	0	0	1	0	0	2	12
8	Block 1	1	0	0	2	0	0	12
9	Block 1	0	0	1	0	2	0	0
10	Block 1	0	0	1	0	0	2	0
11	Block 1	0	1	0	0	0	2	0

12	Block 1	0	0	1	0	0	2	0
13	Block 1	0	1	0	0	2	0	12
14	Block 1	0	0	1	0	2	0	0
15	Block 1	0	0	1	0	2	0	12
16	Block 1	1	0	0	2	0	0	0
17	Block 1	0	1	0	0	0	2	12
18	Block 1	0	0	1	0	2	0	12
19	Block 1	1	0	0	0	0	2	0
20	Block 1	0.333	0.333	0.333	0.667	0.667	0.667	6
21	Block 1	1	0	0	2	0	0	12
22	Block 1	0	1	0	2	0	0	0
23	Block 1	0	0	1	2	0	0	12
24	Block 1	0	1	0	2	0	0	12
25	Block 1	1	0	0	0	2	0	12
26	Block 1	0	0	1	2	0	0	12
27	Block 1	1	0	0	0	0	2	12
28	Block 1	1	0	0	0	2	0	0
29	Block 1	1	0	0	2	0	0	0
30	Block 1	1	0	0	2	0	0	6
31	Block 1	The formulation produced according to the company's formula (control)						

2-3- Colorimetry

Colorimeter (Minolta.CR400, Japan) was used to evaluate the color of manufactured products.

2-4- Tissue measurement

A texture analyzer (Texture Analyzer, TA-XTPlus, stablemicrosystem, UK) was used to evaluate the texture of the produced cakes.

5-2- Determining the amount of water activity

Labmaster.aw (novasina) device was used to determine the amount of water activity of manufactured products.

6-2- Measurement of amylose content

In order to measure the amylose content of soluble starch, a UV spectrophotometer (Shimadzu) at a wavelength of 620 nm was used [18].

7-2- Humidity measurement

Moisture measurement of cakes produced according to standard number 2705 was done as follows. The sample was completely homogenized from the product and the moisture content of the cake was calculated based on the weight loss by placing the samples in an iron at 105 degrees Celsius. 3 samples from each RUN were tested and the average results were reported as the moisture percentage of each sample.

8-2- Measuring mold and yeast

Measuring the amount of mold and yeast in each of the manufactured products based on the national standard number 2-10899 in food with water activity (a_{In}) equal to or less than 95% was done using DG18 culture medium (dichlorine 18% glycerol agar). For this purpose, after preparing the culture medium in the plates and preparing the relevant dilution, the culture was carried out on the surface and the plates were aerobically placed in a greenhouse at a temperature of 25 degrees for 5-7 days [19].

9-2- Mass density measurement

Using a sampler, a specific volume of cake was prepared and after weighing the cake, the bulk density was calculated using a scale of 0.001. It should be noted that the necessary samples were taken from three samples of each experiment and the results were obtained as the average of the results obtained from three samples [20].

2-10- Measurement of real density

Using a cylindrical mold, a compact sample was prepared from three samples of each test and after weighing with a scale of 0.001, the actual density was calculated. It is necessary to explain that in order to prepare a compressed sample, the samples were compressed as much as possible and from all parts of the cake (core, shell) [21].

2-11- Determination of color indicators

By making a cut from the middle section using a sharp spatula, the color indices L*, a*, b* were obtained directly from the Hunter Lip device. Before measuring the color, the device was calibrated with a standard white screen. For each test, the average of three repetitions was measured, and after collecting the data, the hue angle and the chroma index were obtained using the following relations [22].

$$\text{Hue angle} = \arctan(b^*/a^*)$$

$$\text{Chroma} = (a^{*2} + b^{*2})^{1/2}$$

12-2- Statistical analysis

In this study, a mixed statistical design was used to study the effect of the ratio of three hydrocolloids and the ratio of three emulsifiers, as well as the storage time, on the quality indicators of the cake, and after processing the data into "Shefe" models and regression analysis, the optimal conditions were determined using the method The utility function was determined.

3. Results and Discussion

3-1- Real density

In the real density studies comparing different ratios of three types of hydrocolloids (chitosan, tragacanth and hydroxypropyl methylcellulose) with the increase in the amount of chitosan, the real density increases, while in the case of hydroxypropyl methylcellulose this relationship is inverse (with the increase of hydroxypropylmethylcellulose the density value increases real decreases) (Figure 4). Changing the amount of tragacanth does not result in a significant difference in the actual density. Comparing these three types of hydrocolloids, chitosan had the greatest effect on the actual density ($p < 0.05$). In the comparison of the ratios of two types of hydrocolloids, hydroxypropyl methylcellulose and chitosan during shelf life (12 weeks) with an increase in the ratio of chitosan to hydroxypropylmethylcellulose up to 4 weeks after production, the highest value of actual density was observed and the lowest value of density was observed with the increase of hydroxypropylmethylcellulose. to chitosan at the end of shelf life (10-12 weeks) was observed (Figure 4). Bárcenas et al. (2007) reported as a result of their investigation that hydroxypropyl methyl cellulose increases the volume of bread produced, which was consistent with the result of this research [23].

The ratio of the two hydrocolloids of chitosan to hydroxypropyl methylcellulose up to 0.05% did not cause a noticeable change in density in total, and the amount of density was only effective from the shelf life of the cake, so that the highest density was observed from 0 to about 2 weeks after production (Figure 5). Turabi et al. (2008) also reported in their study that hydroxypropyl methyl cellulose causes an increase in volume, which ultimately leads to a decrease in density, this study was consistent with the result of this study [21]. Ashwini et al. (2009) reported that hydroxypropyl methyl cellulose is placed in a non-uniform protein network and can decrease the density by increasing the volume of the cake, the result of this research was consistent with the present design [24].

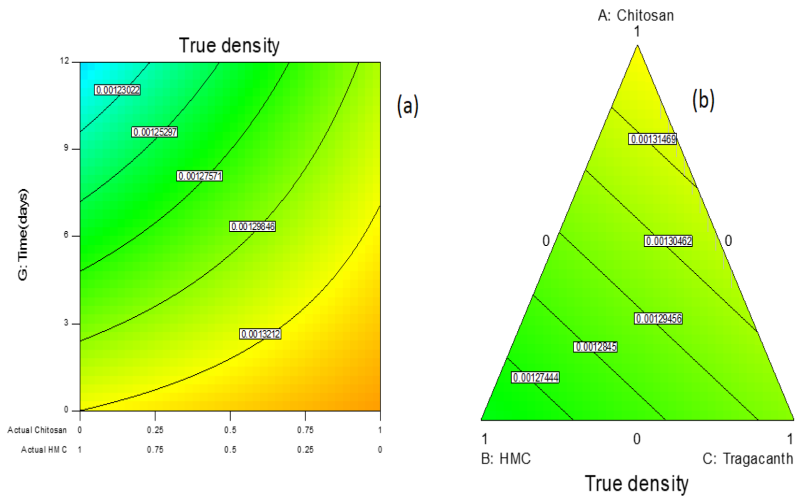

Figure 1. The interaction effect of time and the ratio of chitosan to HPMC on the actual density (a) and the interaction effect of chitosan, tragacanth, HPMC on the actual density (b)

3-2- Bulk density

In the studies conducted on bulk density, the results of tests on three emulsifiers (propylene glycol, glycerol monostearate, and lecithin) indicated that with increasing lecithin amount (from 0 to 2%), the bulk density decreases, which seems to increase With the stability of air bubbles inside the dough, lecithin increases the bulk volume and finally increases the volume of the cake and reduces the bulk density. The highest bulk density was obtained by increasing (1.5-2%) glycerol monostearate. The increase of propylene glycol and glycerol monostearate were almost equally effective in changing bulk density, and unlike lecithin, their amount had a direct relationship with bulk density ($p < 0.05$). The effect of increasing the equal amount of glycerol monostearate and lecithin (1%-1%) to the cake formula was almost the same as the increase of propylene glycol and lecithin in equal proportions in mass density, while as mentioned, the lowest density was in the largest amount of lecithin (Figure 2). . In this context, Ahmadi et al. (2015) investigated the effect of guar gum and propylene glycol monostearate (PGME) emulsifier on the qualitative and physicochemical characteristics of sponge cake and guar gum at zero, 0.3 and 0.5% levels and PGME emulsifier in Zero level and 0.5% were added to the sponge cake formulation. The relevant results have shown that the addition of guar gum and PGME emulsifier improves water absorption, increases porosity and improves texture [16].

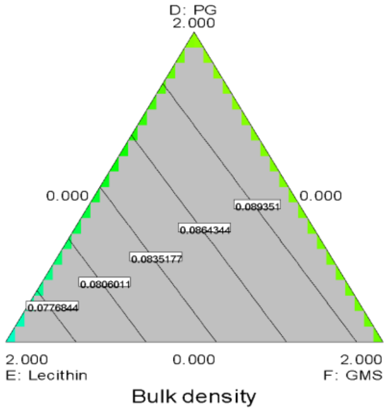

Figure 2. The interaction effect of lecithin, GMS and PG on bulk density.

3-3- Humidity and water activity

The effect of any type of hydrocolloids and emulsifiers on aqueous activity During the shelf life of the cake, it was not significant and water activity It was only affected by the retention time of the highest amount of water activity 0.645 and was in the first week after production, while the amount of water activity Until the sixth week, the shelf life decreased and reached 0.62. In examining the ratio of hydroxypropyl methylcellulose to chitosan (up to 0.05% in total), the results of humidity showed no effect of the ratio of two hydrocolloids. The moisture content of the products was only affected by the storage time, so that it decreased during the storage period, and this amount decreased from about 14.2 in the first three weeks of storage to 12.8 in the 12th week of storage (Figure 3). Krech et al. (2011) showed the effect of chitosan in maintaining moisture in bread texture with medium molecular weight chitosan [14]. Ashwini et al. (2009) reported the effect of hydroxypropyl methyl cellulose on maintaining moisture in cakes. Comparing the results of the present design with the aforementioned study, it can be concluded that chitosan has a greater effect on maintaining moisture in cakes [24].

In a study conducted by Heenan et al. (2010), they reported that humidity is one of the effective factors in the freshness and desirability of cakes. In the investigations carried out on various types of hydrocolloids, it was observed that in the comparison of different ratios of chitosan and hydroxypropyl methyl cellulose, with the increase of the amount of chitosan, in the first three weeks of storing the cakes, the moisture content was the highest, and the moisture content was the lowest in the highest ratio of hydroxypropyl methyl cellulose to chitosan and in The last quarter of maintenance was observed [25]. Mehraban et al. (2016) investigated the physicochemical characteristics of gluten-free sponge cake and reported that the independent effect of adding gum showed a significant increase in the moisture level of gluten-free sponge cake at the 95% confidence level [26]. In this regard, Turabi et al. (2008) produced a gluten-free cake containing rice flour and stated that compounds such as gum, enzyme, and emulsifier can maintain the moisture of gluten-free products during the baking process [21].

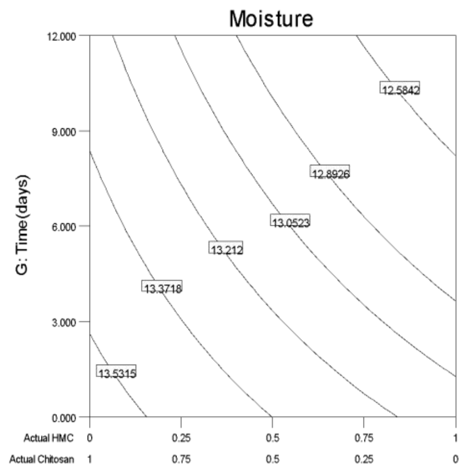

Figure 3. Interaction effect of time and ratio of chitosan to HPMC on moisture content

3-4- Amylose content

Amylose and soluble starch are released in the environment during the gelatinization process, but their amount decreases during the staleness process due to their tendency to re-accumulate and can be considered as a factor in cake staleness [22]. It was observed in the tests conducted in relation to the measurement of amylose in the first week of product production. The increase of lecithin was associated with the increase of amylose, this relationship was the opposite of the effect of glycerol monostearate, so that with the increase of glycerol monostearate in the first week of production, the amount of amylose decreases, although this decrease is less than lecithin. The effect of propylene glycol on the amount of amylose in the first week was not significant ($p < 0.05$). In general, the most effective emulsifier in the first week after production in terms of the amount of amylose (the highest amount) was obtained in very high amounts of lecithin or low glycerol monostearate (Figure 9). .

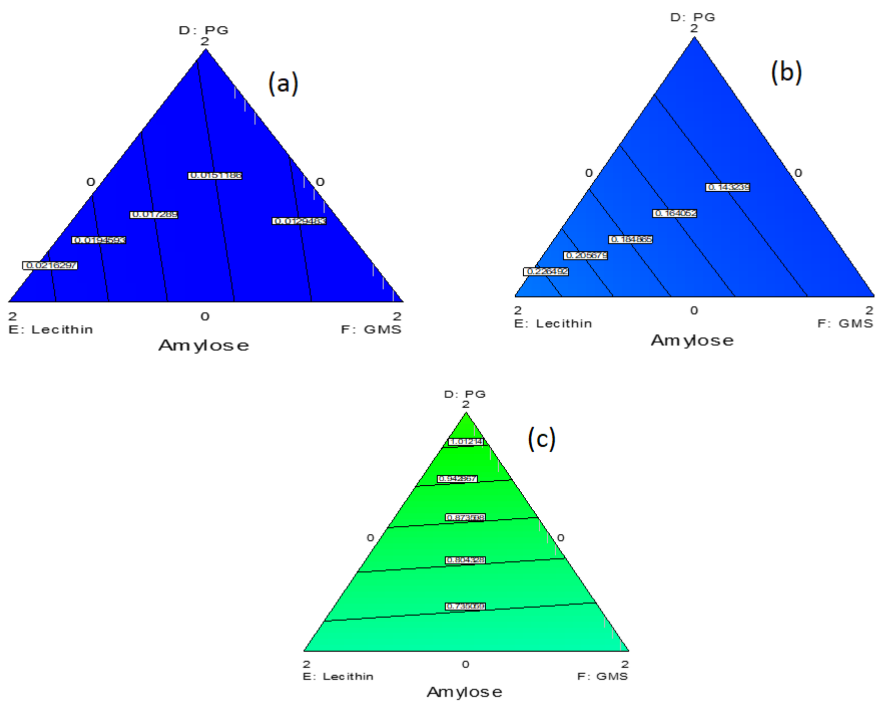

Figure 4. The interaction effect of lecithin, PG, and GMS on the amount of amylose in the first week (a), the sixth week (b) and the twelfth week (c)

In the experiments conducted regarding amylose in the sixth week, the results were almost the same as the first week, so that the most favorable result (the highest amount of amylose) was obtained with high amounts of lecithin. The effect of propylene glycol and glycerol monostearate on the amount of amylose is almost the same, and in both cases, the amount of amylose increases with the reduction of the amount of two emulsifiers, which means that the presence of two emulsifiers is effective in reducing amylose and in the process of staleness (Figure 10). In the twelfth week (the end of the shelf life of the product), the performance of emulsifiers is contrary to the first and sixth weeks, so that the increase of lecithin with a low effect has an inverse relationship with the amount of amylose, and this relationship is almost in accordance with the relationship of glycerol monostearate with amylose, that is, with the increase of glycerol monostearate to the formula The amount of amylose cake decreases. The most effective emulsifier in the twelfth week is propylene glycol. This emulsifier is significantly effective in reducing the staleness process in the twelfth week. Comparing the first, sixth, and twelfth weeks, the amount of amylose increased in the sixth week compared to the first week, but not to the significant extent seen in the twelfth week (Figure 11). Considering the positive effect of lecithin on the quality indicators of cake, it seems that considering the results of the project regarding the effect of lecithin in the first and sixth weeks and propylene glycol, in the twelfth week, the combination of two emulsifiers is effective in reducing the staleness process until the end of the storage period. [27].

5-3- The maximum force required for cutting[6]

In the study conducted regarding the maximum force required for cutting in the first week of production, the increase of lecithin did not have a significant effect on the maximum force required for cutting and the most effective emulsifier in the first week in comparison of three types of emulsifiers is glycerol monostearate, which increases with the amount of glycerol monostearate (from 0 to 2 percent) the maximum force required for cutting is reduced. The effect of propylene glycol is on the amount of the maximum force required for direct cutting, and with the increase of propylene glycol, the maximum force required for cutting increases, which indicates the lack of effect of this emulsifier on the quality indicators of the cake. The most desirable quality (less force) was obtained in the first week with the highest concentration of glycerol monostearate (Figure 5 a). In a similar study, Ahmadi et al. (2015) investigated the effect of guar gum and propylene glycol monostearate (PGME) emulsifier on the qualitative and physicochemical properties of sponge cake and guar gum at zero, 0.3 and 0.5% levels and PGME emulsifier in Zero level and 0.5% were added to the sponge cake formulation. Examining the textural properties of the cake using a texture tester revealed that the addition of gum and emulsifier reduces the hardness of the cake due to the passage of time [16].

1- [6]Maximum Force

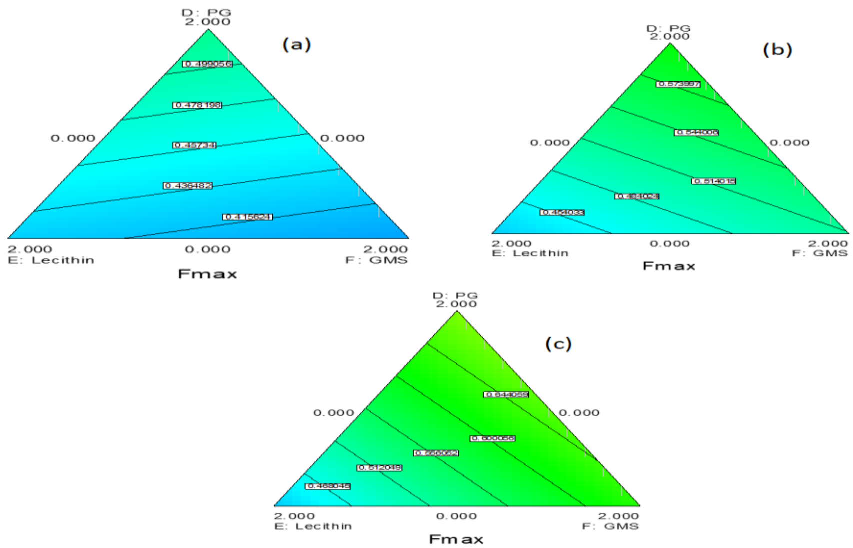

Figure 5. The interaction effect of lecithin, PG, GMS on Fmax in the first week (a), the sixth week (b) and the twelfth week (c)

It was observed in the survey conducted in the sixth week. Glycerol monostearate has no effect on the maximum force required for cutting, and increasing the amount of propylene glycol has a direct relationship with the maximum force required for cutting, so this emulsifier was not effective in improving the quality indicators, while this relationship is completely significant in the case of lecithin, so that with increasing the amount of lecithin The maximum force required for cutting is significantly reduced (Figure 5 b). In the results of the studies, propylene glycol had a negative effect on the quality indicators as in the first and sixth weeks, the effect of glycerol monostearate was not significant in the twelfth week, but the effect of lecithin was significant. The lowest amount of the maximum force required for cutting was obtained in the highest amounts of lecithin in the twelfth week (Figure 5 c).

3-6- Hugh index[7] and chroma index[8]

In the investigations carried out on the Hue angle in the manufactured products, it was found that this index is not effective from the amount of hydrocolloids and emulsifiers and is only affected by the shelf life. The Hue angle in all types of products was 94.45 in the first week of production and 90 in the twelfth week. It was found that these changes, although statistically significant, are not significant from an industrial point of view. The highest transparency in the resulting color in the first week was the result of the presence of lecithin in the product, so that propylene glycol did not have a significant effect on the chroma index, and the effect of glycerol monostearate on chroma was reversed (the chroma index decreased with the increase in the amount of glycerol monostearate) (Figure 6 a).

1- [7]Hu Index
2- [8]Chroma Index

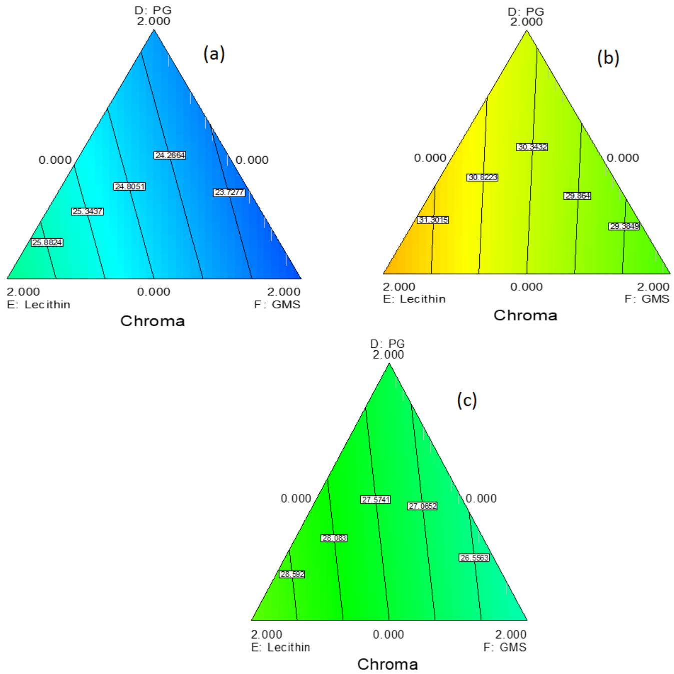

Figure 8. The interaction effect of lecithin, PG, GMS on Chroma in the first week (a), the sixth week (b) and the twelfth week (c)

The effect of three types of emulsifier on the chroma index in the sixth week was the same as the first week, and lecithin had the greatest effect on the chroma index (Figure 8 b). In the twelfth week, as in the first and sixth weeks, the greatest effect on the transparency and color intensity was related to lecithin. During the shelf life of the product, the best result was related to the maximum amount of lecithin in the product (31.3) (Figure 8 c).

3-7- mold and yeast

In the investigation carried out on the manufactured products during the shelf life, no mold and yeast growth was observed in them, therefore, a significant difference was observed in terms of the increase of each type of hydrocolloids and emulsifiers in different proportions in the cake formulation in terms of mold and yeast growth. did not look It seems that considering that the cake product is the result of baking at high temperature, if the standard conditions in the production process, the absence of secondary contamination and the control of raw materials are followed, the microbial growth in the product can be minimized.

4 - Conclusion

In this study, a combined design was used to study the effect of the ratio of three hydrocolloids and the ratio of three emulsifiers, as well as storage time, on cake quality indicators. The present study showed the possibility of using two hydrocolloids, hydroxypropyl methyl cellulose and chitosan, in the cake formulation in order to achieve quality goals, including improving the indicators related to the real density and maintaining moisture in the cake texture. Increasing the amount of kathira in different proportions did not make a significant difference in terms of improving the quality indicators of the cake. In the use of different proportions of emulsifiers, lecithin among the three types of emulsifiers used in the project had a more positive role in improving the quality indicators, so that the use of lecithin increased the chroma index compared to the control group, more crispiness of the cake top and Increasing the amylose content and thus reducing the staleness of the cake.

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اثر نسبت‌های مختلف هیدروکلوئیدها و امولسیفایرهای غذایی بر خصوصیات فیزیکوشیمیایی، بافتی و میکروبی کیک اسفنجی در طی دوره نگهداری

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چکیده

در این تحقیق به منظور بهبود شاخص‌های کیفی کیک اسفنجی، سه نوع هیدروکلوئید (کیتوزان، کتیرا، هیدروکسی پروپیل متیل سلولز) به میزان ۲٪ بر پایه وزن آرد و سه نوع امولسیفایر (پروپیلن گلیکول، گلیسرول مونو استئارات و لسیتین) به میزان ۱٪ بر پایه وزن آرد در نسبت‌های مختلف اضافه گردید. دانسیته توده‌ای، دانسیته واقعی، فعالیت آبی، رطوبت، محتوای آمیلوز، ویژگی‌های بافتی، کپک و مخمر و شاخص‌های رنگ به عنوان شاخص‌های کیفی در طول مدت ماندگاری ۱۲ هفته ای کیک مورد بررسی قرار گرفتند. افزودن امولسیفایرها و هیدروکلوئیدها در نسبت های مختلف، تفاوت معنی‌داری در شاخص‌های رنگ، فعالیت آبی و سفتی از نظر صنعتی نداشتند و این سه فاکتور صرفاً تحت تاثیر زمان ماندگاری کیک بودند. افزایش هیدروکسی پروپیل متیل سلولز بیشترین تاثیر (۶/۸۱ ٪) در کاهش دانسیته واقعی و افزایش لسیتین بیشترین تاثیر (۱۳/۴۸ ٪) در کاهش دانسیته توده‌ای را داشت. در مقایسه سه نوع هیدروکلوئید، کیتوزان بیشترین تاثیر بر روی حفظ رطوبت را داشت. لسیتین در طول شش هفته اول ماندگاری و پروپیلن‌گلیکول در طول سه هفته آخر از نظر بالا نگهداشتن محتوای آمیلوز موثر بودند. لسیتین بیشترین تاثیر را در کاهش حداکثر نیروی لازم برای برش داشت، به طوری که کیک‌های حاوی لسیتین رویه تردتر داشتند و این امولسیفایر تا هفته ششم نیز تاثیر مهمی در جلوگیری از سفتی بافت کیک داشت. به دلیل عدم رشد کپک و مخمر در نمونه های مورد آزمون، تفاوت معنی داری از نظر جمعیت میکربی در نسبت های مختلف هیدروکلوئیدها و امولسیفایرها مشاهده نگردید ($p < ۰,۰۵$). افزایش لسیتین در مقایسه با دو نوع امولسیفایر دیگر سبب افزایش شاخص کروما گردید.