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Scientific Research

The modeling and optimization of Fat Replacer Permixformulation by using response surface methodology (RSM)

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ABSTRACT

One of the most common problems in modern communities is long-term high energy intakes due to consumption of high energy foods, resulting in overweight and obesity. Therefore the aim of this study was to produce low calorie cake, by reducing fat and optimization of formulation with whey protein concentrate, Maltodextrin and Inulin to calorie reducing. In this study, response surface methodology and central composite design In order to evaluate and optimization of theindependent variables including whey protein concentrate (x1:3-13%), Maltodextrin (x2: 0-0.3%) and Inulin (x3:0-1%) on the characteristics of the final product were used. The results of optimization showed that with reduced fat and add Maltodextrin and Inulin, moisture content and water activity of the cake, better preserved which leads to reduced stiffness and increases the cohesiveness, therefore softer cake with a longer sshelf-life was produced. The uses of these compounds in the cake formulation can offset the negative effect from the fat reducing results in reduce the porosity and volume of the cake. Formulation optimization done to minimize stiffness as well as to maximize the volume and cohesiveness of cake that was confirmed in practical tests for Independent parameters of the WPC, Maltodextrin and Inulin 6.6%, 0.3% and 1% respectively. At this point, the optimal response levels include humidity, aw, stiffness, the cohesiveness and volume of samples was 18.07%, 0.78, 0.18 N, 1.26 and 96 cm^3 respectively.

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1. Introduction

Today, low mobility and consumption of high amounts of fat is one of the factors that cause obesity and many diseases in human societies. The average per capita consumption of Iranian oil was announced as 22 kg, while the average per capita consumption in developed countries is 19 kg. As a result, nutritional goals have been considered to limit total fat intake to less than 31% of total calories and saturated fat to less than 91% of total energy intake [1]. Because fat changes or creates many characteristics in all kinds of food, it is difficult to replace it [2]. Fat substitutes are compounds that have the same functional properties, stability, physical and chemical properties as fats, but produce fewer calories per gram compared to fats. In replacing fat, the functional properties of those compounds in the formulation of the product such as emulsion stability, shelf life and organoleptic properties should be taken into consideration [3]. Fat substitutes can be classified based on their chemical structure into three categories based on carbohydrate, protein and fat [4]. Gelling capacity, the ability to increase the viscosity of aqueous solutions and the effect on rheological properties are the most important characteristics of fat substitutes [4]. The most important physical characteristics of the cake are its color, size, shape and texture. The difference in the ratio of the materials used and on the other hand the characteristics of the dough as an intermediate product between the raw materials and the final product have an effect on the characteristics of the final product [5]. Reducing fat increases the viscosity of the dough and using a fat substitute reduces the density of the dough [6]. Beth et al. (1992) found that doughs prepared with more fat are better insulators than doughs containing less fat (due to the introduction of air and more fat) [7]; Therefore, during baking, there is a strong thermal gradient from the outside to the center of the cake, which causes the surface of the cake to rise. Modified fat systems can provide better health and nutritional properties [8]. The effect of fat substitutes on cake dough properties was evaluated by Simoli et al. (2013). They used fat substitutes including maltodextrin, inulin, oligofructose, citrus pectin and small molecule proteins separately. In the cake samples with more than 65% replacement of fat substitute, hardness and elasticity increased in all samples, while the amount of volume decreased. Also, in the samples, with the increase in the amount of fat substitute, its taste and aroma scores decreased, and in general, the samples with 100% substituted fat were not acceptable; But in the replacement rate, 65% of the samples were acceptable in terms of texture, physical and sensory [9]. In the research of Rodrigues et al. (2014), several levels of fat replacement by inulin in sponge cake were investigated in terms of physicochemical and microstructural characteristics. Substitution of oil with inulin significantly reduced the viscosity of the cake batter and created non-uniform bubbles in it that could be seen by light microscopy. The fat placed in the layer inside the bubbles caused the development of the cake structure during baking. Cakes with a fat substitution rate of up to 70% had more air bubbles in their texture, the texture was softer and they were more acceptable according to sensory evaluators [10]. Sanders et al. (1993) used whey protein isolate and xanthan gum as a mixture to replace fat in bread. Texture characteristics and viscosity of samples with reduced fat content were evaluated for optimization of fat replacement formulation using response surface method. The results showed that the mixture of whey protein and xanthan has a positive effect and in terms of texture and viscosity, they create suitable conditions in samples with reduced fat [11]. Rodrigues et al. (2014) studied the performance of lipase and emulsifier enzymes in cake batter containing inulin as a fat substitute. The addition of emulsifier decreased the relative density in the cake batter. It also increased the viscoelastic properties of cake dough [10]. The technological role of fat in grain-based products includes keeping air in the dough and forming a membrane around the air cells and creating porosity in the product, softening the texture and improving the taste, favorable mouthfeel, improving the rheological characteristics and increasing the shelf life of the product. Therefore, fat substitutes based on fat, protein and carbohydrates are used to prepare alternative mixtures. The aim of this research

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was to find a suitable fat substitute for baking products (in a case, cake). In order to evaluate the fat replacement mixture, the textural characteristics, moisture, water activity and volume of the resulting cake were evaluated and the optimal combinations of fat replacement were selected.

2- Materials and methods

The raw materials of this research include null flour 28% (moisture 12.6%, ash 0.56%, wet gluten 26.7%, protein 9.67%, Zelani number 21.7%), sugar 25%, fat 12% , water 27%, milk powder 3%, egg 3%, salt 1%, baking powder 1%, which were obtained from grocery stores. Whey protein concentrate[1] (Hilmar 8010-USA), maltodextrin (China) and inulin were obtained from Poyakabek Company.

2-1- Cake production

First, eggs and sugar were mixed for one minute at the lowest speed, then oil was added and mixed, all dry ingredients and water were added respectively and mixed for three minutes. 36 grams of cake batter was weighed in paper molds, then placed in a regular oven for 25 minutes at 180 degrees Celsius. After baking, the cakes were cooled at room temperature for 20 minutes and packed [12]. WPC, maltodextrin and inulin were added to the cake formulation in gel form after initial preparation (mixing and staying overnight). Baking of samples and physical and chemical tests were done in three repetitions.

2-2- Measurement of flour characteristics

Flour moisture was measured using the AACC 15-44 method, ash according to the AACC 08-01 method, wet gluten using the AACC 10-38 method, protein using the AACC 12-46 method, and Zeleny number according to the AACC 60-56 method [13]. .

2-3- Volume measurement

AACC standard, 2000 No. 72-10 was used to calculate the volume of cake samples. The cake samples were weighed with an accuracy of 0.001 after cooling completely, and then to calculate the volume of the samples, the displacement method with rapeseed seeds was used, in this order, a 1000 ml measuring cup of processed rapeseed seeds was poured into a 2000 ml beaker, the sample inside Bishr was placed and it reached the volume of 1000. The volume of the remaining grain in the mesoor represented the volume of the cake samples in cubic centimeters [14].

2-4- Determination of humidity

To calculate the humidity level, the AACC standard, 2000 No. 16-44 and using an infrared hygrometer device and based on the manufacturer's instructions were used to calculate the humidity [14].

5-2- Determining water activity

To determine the water activity of the test device and model 400, and the water activity of the samples was determined according to the instructions of the manufacturer of this device. The cell of the machine was filled with ground cake on the day of production and the amount of water activity was determined at a temperature of 25 degrees [15].

6-2- Tissue evaluation

To determine the characteristics of the cake texture (including firmness[2]Being gummy[3] and continuity[4]) tissue measuring device and TPA test were used based on the method of Ronda et al. (2005) [16]. In this test, a piece of 20 x 20 x 20 cubic mm of cake core was cut by an electric knife and placed under the probe of the device, a flat cylindrical probe with an external diameter of 35 mm to compress each sample up to 50% of its initial height (20 mm) at a speed 30 mm/min, the starting point of 0.05 newtons and the force of 5 kg were selected to perform this test. Texture characteristics were evaluated on the day of production [16].

2-7- Statistical analysis

In this research, the central compound design (CCD) with three independent variables and six repetitions in the central point of the design, in order to find the effect of independent variables (fat x_1, xanthan gum x_2, starch x_3) was used on some quality characteristics of microwave-baked cake. The data obtained in this project

[1]. whey protein concentrate: WPC
[2]. Hardness
[3]. Gumminess
[4]. Cohesiveness

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were modeled using Design Expert software to draw response level curves to investigate the relationship between responses and independent variables. The levels of independent variables are presented in real and coded form in Table 1. To evaluate the conditions suggested by the software, the optimal sample of the formula proposed by the Design Expert software was produced in three iterations and SPSS statistical software (version 21) was used for comparison.

Table 1 Independent variables and their values

Independent variables	code	-1	0	+1
WPC(%)	X_1	3	8	13
Maltodextrin(%)	X_2	0	0.15	0.3
Inulin(%)	X_3	0	0.5	1

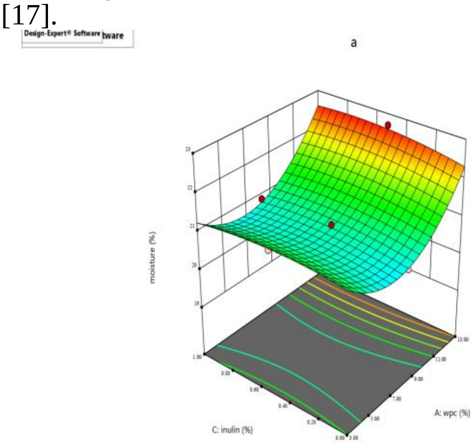
Table 2 Statistical analysis result of reduced second-order polynomial fitted model on the response data

Test	Model	Average	Standard deviation	R^2	R^2-adj	Lack of fit
Moisture	$M = 21.30 - 0.56x_1 - 12.54x_2 - 0.60x_3 + 0.042x_1^2 - 26.92x_2^2 - 3.51x_2x_3$	21.13	0.19	0.95	0.93	0.133
Water activity	$aw = 0.66 + 0.022x_1 - 0.136x_2 - 0.0304x_3 + 0.67x_2^2 - 0.017x_1x_2 + 0.16x_2x_3$	0.87	0.013	0.97	0.96	0.317
Hardness(N)	$H = 0.244 - 0.0046x_1 - 0.044x_2 - 0.025x_3$	0.21	0.0058	0.92	0.91	0.692
Cohesiveness	$Coh = 0.924 + 0.014x_1 + 1.22x_2 - 0.107x_3 - 00067x_1^2 - 3.86x_2^2 + 0.085x_3^2 + 0.0106x_1x_3$	1.09	0.0042	0.99	0.99	0.121
Volume	$V = 96.72 - 5.13x_1 - 2.52x_2 - 4.27x_3 + 0.402x_1^2 + 3.21x_1x_2 + 1.98x_1x_3$	95.67	1.38	0.98	0.98	0.248

3- Discussion and conclusion

3-1- Examining the effect of independent variables on the moisture level of the cake

As the effect of independent variables on moisture percentage is shown in Figure 1, the amount of fat had a great effect on the changes in the moisture content of the final product. The results of analysis of variance and response surface shapes show that with the increase of WPC in the formulation to 8%, there was no significant change in the amount of moisture, but with its increase to 13%, the moisture content of the product increased significantly ($p<0.05$). However, the changes in inulin did not have a significant effect on the moisture content of the cake. The results of the effect of maltodextrin also showed that by adding maltodextrin up to 0.2%, the moisture level in the final product increased, while by adding maltodextrin up to 0.3% in the cake formulation, the moisture content of the product did not change much, so the cake samples contained 13% WPC. and 0.15 maltodextrin had the highest amount of moisture. The response function (model relation) to estimate the moisture content of the cake according to the calculated regression coefficients was obtained as the relation in Table 2, the higher the R coefficient^2 and R^2 modified as well as the non-significance of the Lack of fit test confirms the high power of the reduced quadratic model. The order of influence of independent variables on this parameter was: WPC > maltodextrin > inulin. Rahm et al. (2012) showed that the use of inulin as a fat substitute in muffins did not have a significant effect on the moisture content [17].



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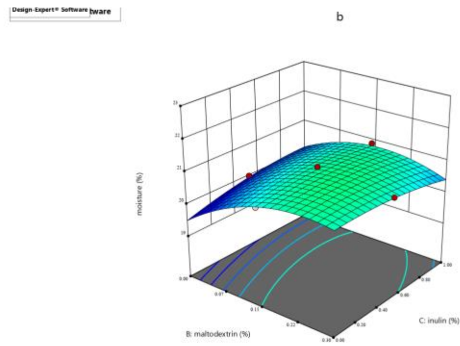
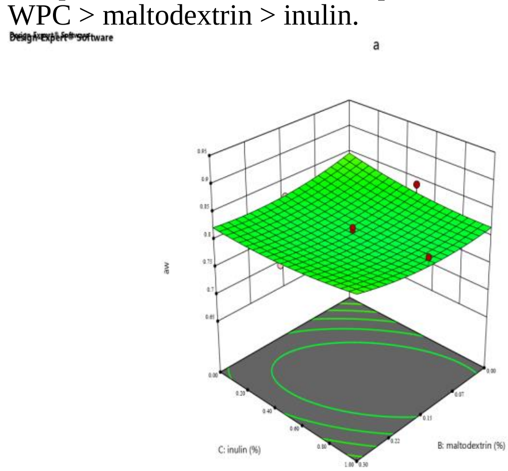


Fig 1 The effectiveness of the response surface curves a) Inulin and WPC b) Maltodextrin and Inulin on moisture content of cake

2-3- Examining the effect of independent variables on the activity of blue cake

Figure 2 shows that when maltodextrin and inulin are used together, due to the increase in the number of functional groups and its effect on increasing the amount of water absorption, it has more water activity than when maltodextrin and inulin are used separately, which indicates the synergistic effect of these two compounds on This is the parameter (Figure 2). Also, the results showed that the independent effect of the amount of WPC and its interaction with maltodextrin was significant ($P<0.05$) and with the increase of the amount of WPC in the formulation from 3 to 13%, the water activity of the cake samples increased significantly and the highest water activity was in the samples containing 13 The percentage of WPC was observed (Figure 2). The order of influence of independent variables on this parameter was: WPC > maltodextrin > inulin.



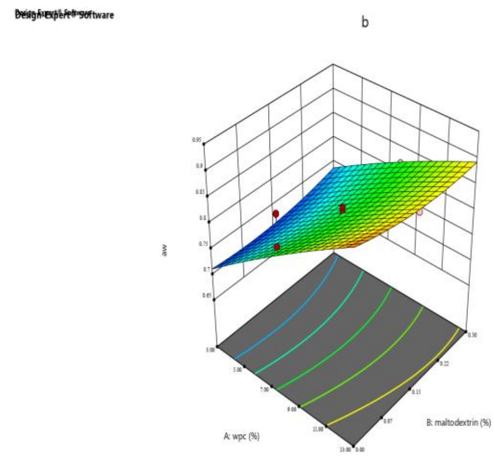


Fig 2 The effectiveness of the response surface curves a) Maltodextrin and Inulin b) Maltodextrin and WPC on water activity of cake

3-3- Examining the effect of independent variables on the textural characteristics of the cake

3-3-1- tissue stiffness

Texture is one of the important qualitative characteristics that strongly affects the consumer's opinion of a product. The number, size and distribution of air cells affect the texture and consequently the edible quality of the product. Also, the number and size of air cells is effective on the structure of the cake, on the thickness of the cell walls and, as a result, on the force required for biting, chewing and swallowing it [18]. Since the fat globules trap the air in the dough matrix and during the mixing process, a bulky product with a soft texture is obtained during the cooking process, also fat has an emulsifying property and binds with a large amount of water in the dough, which causes It improves and softens the texture [19]. By reducing the amount of oil, due to the fact that oil keeps air bubbles, therefore, with the reduction of oil, the amount of air bubbles decreases and the cake becomes more compact and the texture is firmer, and adding inulin to the low-fat sponge cake samples reduced the hardness of the texture [20]. The influence of independent variables on the degree of tissue stiffness is shown in Figure 3. The results showed that maltodextrin and inulin significantly affected the firmness of the product, so that with the increase of maltodextrin and inulin at a fixed concentration of WPC (8%), the firmness of the cake texture decreased significantly ($P<0.01$), thus, the highest firmness related to The cake samples contained the lowest amounts of these compounds. As can be seen, the amount of WPC in the formulation had a significant effect on the hardness of the cake samples, and with the increase in the amount of WPC, the hardness of the texture decreased (Figure 3).

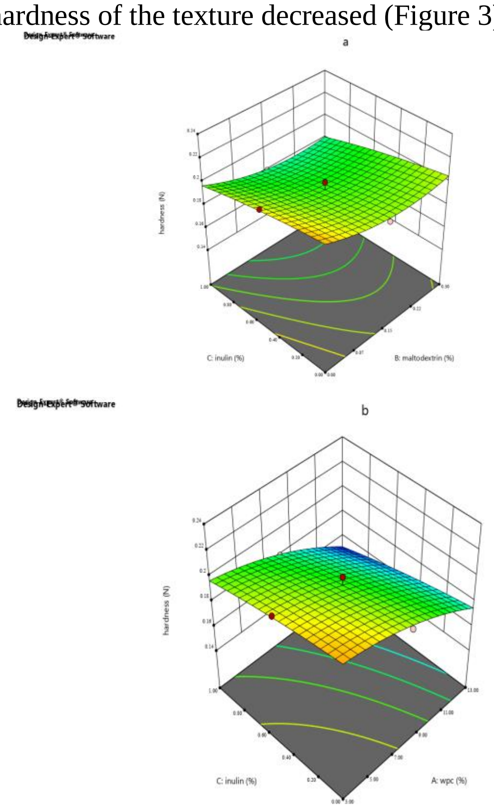


Fig 3 The effectiveness of the response surface curves a) Maltodextrin and Inulin b) WPC and Inulin on hardness of cake

Probably, the reason for the decrease in cake hardness with the increase of maltodextrin, inulin and WPC is that by increasing the amount of all three independent variables in the formulation, the amount of moisture retention and as a result the water activity of the samples increases after baking. The order of influence of independent variables on this parameter was: WPC > inulin > maltodextrin.

3-3-2- Tissue continuity

As seen in Figure 4, WPC and inulin variables synergistically increased the consistency of the cake texture after baking, at all levels of inulin, the increase of WPC significantly increased the texture consistency of the samples.

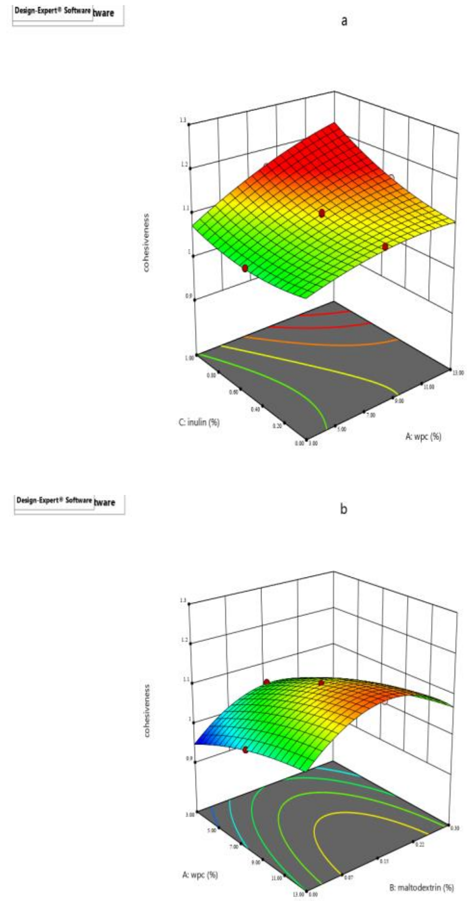


Fig 4 The effectiveness of the response surface curves a) Inulin and WPC b) Maltodextrin and WPC on cohesiveness of cake

Due to the synergistic effect of these two compounds, the consistency of the samples containing these compounds has increased. According to the results of analysis of variance and response surface shapes, the addition of maltodextrin up to 0.15% in the cake dough formulation also increased the consistency of the texture of the final product, while with the increase of maltodextrin up to 0.3%, the consistency of the texture decreased (Figure 4). Based on the values and significance of the coefficients of the reduced model shown in Table 2, the order of influence of the independent variables on tissue cohesion was as follows: WPC > inulin > maltodextrin. In 2012, by adding inulin to a gluten-free layer cake, Russell et al showed that adding inulin to the cake formulation increases consistency compared to the control sample [21].

3-4- Examining the effect of

independent variables on changes in cake volume

As seen in Figure 5, WPC had the greatest effect on the increase in the volume of cake samples, and with the increase in the amount of WPC in the dough formulation, the volume of cake samples increased.

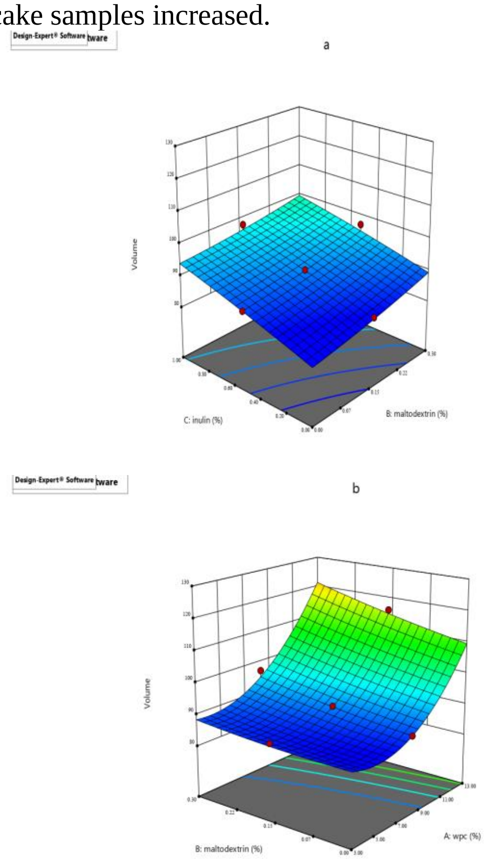


Fig 5 The effectiveness of the response surface curves a) Maltodextrin and Inulin b) Maltodextrin and WPC on volume of cake

The results also showed that the increase of maltodextrin and inulin had a positive and significant effect on increasing the volume of cake samples ($p<0.05$), so that with the increase of maltodextrin and inulin in the formulation, the volume of cake samples increased linearly. One of the important factors on the volume of the cake is the aeration of the dough, which is a function of the viscosity of the dough. Reducing fat increases the viscosity of the dough and using a fat substitute reduces the density of the dough [2].

5-3- The results of sensory evaluation

To determine the presence or absence of a significant difference between the prepared low-calorie cake and the control cake, a three-way test was used, so that the samples with three-way numerical codes along with the evaluation sheet were provided to the evaluators. The total number of evaluators was 20 and the number of correct answers was 8. This means that out of 20 participating evaluators, 8 evaluators were able to recognize the difference and 12 evaluators failed to recognize the difference. There was no significant difference at the statistical level ($p<0.01$) between the optimal production sample and the control sample, in other words, for the difference between the two samples to be significant at this probability level, at least 13 out of 20 evaluators should be able to recognize the difference.

6-3- Optimization

Optimum conditions for fat replacement premix formulation for preparing low-calorie cake using independent variables of WPC, maltodextrin and inulin on measured parameters using numerical optimization technique[5] Design Expert software was reviewed. For this purpose, first the optimization goals were determined and then the levels of responses and independent variables were adjusted. For this purpose, the amount of volume and continuity at the maximum and the amount of tissue stiffness at the minimum and humidity and a_{In} And also the independent variables were selected in the in range mode. After the final optimization, the values of the responses including moisture, water activity, stiffness and continuity of the tissue and the volume of the samples were equal to 18.08%, 0.78, 0.18 newtons, 1.26 newtons and 96 cubic centimeters respectively. In optimal conditions, the values of independent variables including WPC, maltodextrin and inulin were obtained as 6.6, 0.3 and 1%, respectively (Table 3).

[5] .Numerical optimization

Table 3 The results of the optimization of formulation of low calorie

	Moisture (%)	well	*hardness(N)	*cohesiveness	Volume(cm^3)
Low fat cake	18.08	0.78	0.18	1.26	96
control	17.91	0.76	0.21	1.24	95

* (significant difference at P < 0.05)

The results of the optimization stage of premix formulation for fat replacement showed that by reducing WPC and adding maltodextrin and inulin, the moisture content and water activity of the cake samples were better preserved, and as a result, it reduced the stiffness and also increased the consistency of the texture of the cake samples, and as a result, it led to the production of a higher quality final product. became. According to the results, the reduction of WPC in the formulation leads to a decrease in the volume of cake samples, which is relatively compensated by the addition of maltodextrin and inulin. The optimal formulation showed that by adding 0.3% maltodextrin and 1% inulin, the amount of fat in the formulation can be reduced by half, and as a result, a low-calorie product with more healthful properties can be produced. Finally, to show the effectiveness of the permix effect as a fat substitute compared to fat , three replicates were prepared with the same formulation of optimal point of premix fat substitute (6.6% WPC, 0.3% maltodextrin and 1% inulin) and then the average characteristics of the baked cake were compared with the control sample containing fat. The results showed that there was no significant difference between the two cake samples in terms of the examined characteristics, except for the stiffness and consistency of the texture (Table 3). As can be seen, the samples containing fat substitute premix had less tissue stiffness compared to the control sample due to moisture retention and as a result higher water activity. Also, the cakes containing fat substitute permix also showed superiority in terms of texture consistency and compared to the control cakes, they had significantly more texture consistency and cohesion.

4- General conclusion

Due to the fact that fat has the highest factor in calorific value calculations (9 kcal/g), its reduction in the formulation has been given much attention. On the other hand, due to the key role of fat in the cake, a suitable alternative should be chosen to preserve its quality characteristics such as taste and color. The fat substitute containing optimal levels of WPC, maltodextrin and inulin were determined by response level statistical method, 6.6, 0.3 and 1%, respectively.

5- Resources

[1] Anonymous. 2010. Dictionary of food science and technology, 2nd ed. International food information service. Wiley-Blackwell.

[2] Hui, Y.H. 2007. Bakery products: science and technology, Wiley-Blackwell.

[3] Rusinek, M. 2012. Cake: The centerpiece of celebrations. In: McWilliams, M. Editor.

Celebration Proceedings of the Oxford Symposium on Food and Cookery 2011. Jellyfish Solutions. 308.

[4] Jia, C. Kim, Y.S. Huang, G. (2008). Sensory and instrumental assessment of Chinese.

[5] Laneuville, S. Paquin, P. Sylvie, L.2005 Formula Optimization of a Low-fat Food System Containing Whey Protein Isolate–Xanthan Gum Complexes as Fat Replacer. Journal of food science. Vol. 70, Nr. 8, 2005.

[6] Kalinga D.N. 2010. Delivering β–glucan via selected bakery systems: cake. MS Thesis, School of Biomedical and Health Sciences Faculty of Health, Engineering and Science Victoria University, Blacksburg, Montgomery County, Virginia, USA.

[7] Bath, D. Shelke, K. Hoseney, R. (1992). Fat replacers in high ratio layer cakes. Cereals Foods Word, 37.

[8] Hesso, N. Le-Bail, A. Loisel, C. Chevallier, S. Pontoire, B. Queveau, D. and Le-Bail, P. 2015. Monitoring the crystallization of starch and lipid components of the cake crumb during staling. Carbohydrate polymers, 133: 533-534.

[9] Psimouli, V. Oreopoulou, V. The Effect of Fat Replacers on Batter and Cake Properties. Journal of Food Science. Vol. 78. No. 10. 2013

[10] Rodríguez-García, j. Sahi, S. Hernando, I.

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Functionality of lipase and emulsifiers in low-fat cakes with inulin. LWT - Food Science and Technology. 58 (2014) 173-182.

[11] Sanders, S.W.1993. Dried Plums: A Multi-Functional Bakery Ingredient. Bulletin, 228:1-2.

[12] Seyhun, N. Sumnu, G. Sahin, S. 2005. Effects of different starch types on retrogradation of staling of microwave baked cakes, Food and Bioproducts Processing, 83(C1): 1–5.

[13] AACC, 1991, Approved methods of the AACC. Method 10-91. American Association of Cereal Chemists, St Paul, MN.

[14] AACC.2000. Approved methods of the American of Cereal Chemists, 10th Ed., Vol. 2. American Association of Cereal Chemists, St. Paul, MN.

[15] Roa, V and Tapia, D.D. 1991. Evaluation of water activity measurement with a dew point electronic humidity meter. Lebensmwiss. Technol., 24(3): 208-213.

[16] Ronda, F., Gomez, M., Blanco, C. A., & Caballero, P. A. 2005. Effects of polyols andnondigestible oligosaccharides on the quality of sugar-free sponge cakes. Food Chemistry, 90(4), 549–555.

[17] Rohm, H., Zahn, S. and Pepke, F.(2010). Effect of inulin as a fat replacer on texture and sensory propertiesof muffins. Journal of Food Science and Technology, 45: 2531–2537.

[18] Cauvain, S.P. Young, L.S. (2006). Baked products: Science, technology and practice Wiley on line library.

[19] O’Sullivan, M. G. (2019). Nutritional optimisation through reductions of salt, fat and sugar using sensory and consumer driven techniques. In R. Vasilios (Ed.)

[20] Go´mez, M., Mancho n, L., Oliete, B., Ruiz, E. and Caballero, C.M. (2005). Effects of polyols and nondigestibleoligosaccharides on the quality of suger –free sponge cakes. Food Chemistry, 90: 549-555.

[21] Rosell, M., Gularte, M.A., Hera, E. and Gómez, M. (2012). Effect of different fibers on batter and gluten-free layer cake properties. Food Science and Technology, 48: 209-214

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مقاله علمی_پژوهشی

بهینه یابی فرمولاسیون پرمیکس جایگزین چربی به روش سطح پاسخ و بررسی خصوصیات فیزیکوشیمیایی کیک با چربی کاهش یافته

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کیک کم‌کالری،

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اینولین،

خصوصیات بافتی،

متدولوژی سطح پاسخ

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چکیده

یکی از مشکلات شایع در جوامع امروزی، میزان کالری دریافتی و افزایش وزن به علت مصرف طولانی محصولات پرکالری است. از این‌رو هدف از این تحقیق تولید کیک کم‌کالری، با کاهش میزان چربی و بهینه‌سازی فرمولاسیون آن توسط کنستانتره پروتئین آب‌پنیر، مالتودکسترین و اینولین به‌منظور کاهش کالری بود. در این پژوهش از متدولوژی سطح پاسخ و طرح مرکب مرکزی به‌منظور بررسی و بهینه‌سازی متغیرهای مستقل شامل کنستانتره پروتئین آب‌پنیر (۳-۱۳ درصد;x_1)، مالتودکسترین (۰-۰/۳ درصد;x_2) و اینولین (۰-۱ درصد;x_3) بر ویژگی‌های محصول نهایی استفاده شد. نتایج مرحله بهینه‌سازی نشان داد که با کاهش چربی فرمولاسیون و افزودن مالتودکسترین و اینولین میزان رطوبت و فعالیت‌آبی نمونه‌های کیک بهتر حفظ شده که منجر به کاهش سفتی و همچنین افزایش پیوستگی بافت نمونه‌های کیک و درنتیجه محصولی نرم‌تر با بیاتی کمتر تولید گردید. همچنین کاربرد این ترکیبات در فرمولاسیون کیک اثر منفی ناشی از حذف بخشی از چربی بر کاهش تخلخل و حجم کیک را تا حد زیادی جبران نمود. شرایط بهینه فرمولاسیون جهت به حداقل رساندن سفتی و همچنین به حداکثر رساندن حجم و پیوستگی کیک که درآزمایش‌های عملی مورد تأیید قرار گرفت، برای پارامترهای مستقل شامل میزان کنستانتره پروتئین آب‌پنیر، مالتودکسترین و اینولین به ترتیب ٦/٦٪، ۰/۳٪ و ۰/۱٪به دست آمد. در این نقطه بهینه مقادیر پاسخ‌ها شامل رطوبت، فعالیت‌آبی، سفتی، پیوستگی بافت و حجم نمونه‌ها به ترتیب برابر ۱۸/۰۷ درصد، ۰/۷۸، ۰/۱۸ نیوتن، ۱/۲٦ و ۹٦ سانتی‌متر مکعب بود.