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The Effect of Natural Sugar Substitute on the Physicochemical Indices of Cupcake

N.G. Hovhannisyan, K.S. Khanamiryan
Armenian National Agrarian University
narinehovhannisyan1984@mail.ru, kristinekhanamiryan@gmail.com

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ABSTRACT

Most of the sugar substitutes differ from each other in chemical composition, ways of their production, exerted effect on the metabolism of organism, as well as in their assimilability.

The main goal of the current research is to develop a recipe for new functional food product by applying alternative natural sugar substitute. The extract produced from the licorice roots has been used as a natural substitute.

The recommended product range is a single type of food product in the domestic market of functional foods and can stimulate the development of the mentioned branch.

Introduction

Along with traditional food production technologies, new health-promoting food manufacturing technologies have started to develop. These are natural food products, the permanent use of which takes some regulatory effect both on human organism and on their individual organs or their functions (Nechaev, 2015).

Recently, the demand for therapeutic confectionery products has grown up among the population. It is first of all related to the overall detorioration of population's health. Numerous research works confirm that there is a direct relationship between the taken food and cardiovascular diseases, diabetes, obesity and atherosclerosis (Baturin, 2005, www.who.int/ru/news/).

The number of people with diabetes has increased throughout the recent years. This has resulted in the increased use of natural and artificial sweeteners instead of saccharose. Both types of sugar substitutes have the same sweetness index and can be successfully used in the food production for diabetics (Martirosyan, 2010, Nechaev, 2015).

The advantage of licorice roots is that glycyrrhizin, which is in the root's chemical composition, is sweeter than sugar in 50-100 times (Matveeva and Koryachkina, 2012). The licorice root contains glycyrrhizin, glycyrrhizic acid and salts, flavonoid glycosides (liquiritin, liquiritigenin, liquiritoside), isoflavonoids (formononetin, glabren, glabridin, glabrol, 3-hydroxyl glycerol, glycyrrhizin), steroids, essential oils (in small quantities), etc. (Matveeva and Koryachkina, 2012).

For medical purposes licorice root is usually used in combination with other medicinal herbs. The glycemic index (blood sugar rising level after food product intake) of licorice is only 20, while that of common sugar is 89 (Matveeva and Koryachkina, 2012, Nechaev, 2015).

Materials and methods

The flour confectionery product – cupcake, and the extract produced from licorice root have been used as study subjects. The samples of licorice roots have been taken from the Maralik province of Shirak region and from Gegharkunik region of the Republic of Armenia. During the extraction it was revealed that depending on the specific province, there is a considerable difference in the plants' roots regarding their taste and structural properties. Eventually, the investigations went on upon the application of the root extract, sampled from the Maralik province of Shirak region.

It has been identified that 160-200 kg sugar substitute, 10-12 kg flavonoid fraction (antioxidant), 20-40 kg lipid fraction and 500-800 kg fodder beats can be produced from one ton of licorice root (Martirosyan, 2010).

The research has been conducted in compliance with the current technical conditions and in line with the CU TR 021/2011 normative document. The consecution of technological procedures and calculation of the recipe has been implemented per the technological orders and instructions. The investigations have been conducted in the "Division of Plant-Based Raw Material and Foodstuff Processing Technology" at the ANAU Scientific Research Institute of Food Science and Biotechnology, as well as in the accredited "FDA Laboratory" LLC.

The sugar content has been determined via in-house method with the application of HPLC-refractive index detector column-nucleosil carbohydrate EC250/4 phasa device at the phase of ACN:H20 83:17. Since no special research method for such product types was developed yet, the research method has been developed and identified for that specific food product.

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The current research aims to develop a recipe for a new functional food product by using alternative natural sugar substitute.The primary objectives of the research are as folows:

- to scientifically justify the functional property of the extract produced from the licorice roots, as a natural sugar substitute,
- to develop a new cupcake recipe using the optimal dosage of the extract,
- to identify the factual saccharose content in the finished product,
- to determine the energy value of the new food product.

Development of the new recipe for the mentioned functional food product upon the application of the extract manufactured from the local raw material, as a natural sugar substitute, is a scientific novelty for the branch.

Results and discussions

The investigations have been caried out based on the studies of control and experimental samples.The optimal amount of the used exract has been identified empirically. When developing the technlogy, the entire sugar quantity was substituted with certain dosages of the extract per grams. The following dosages have been chosen: 50 g, 100 g, 150 g per 1 kg finished product. During the experiments it has been found out that in case of using small amount of extract, sweetness is almost missing and in case of using more than 150 g extract the taste of the finished product becomes somewhat unpleasant and bitter, sometimes even burning taste is felt. The studies on organoleptic indices are presented in Table 1.

According to the preliminary organoleptic evaluation carried out via scoring system (ranging from 1 to 5 points), we'll have the data introduced in the presented Figure when calculating average indices.

As the data of the diagram indicate, parallel with the increase of extract doses, a decline in the organoleptic scoring points is observed. In case of using 50 g extract, the sweetness almost lacks in the product and the latter obtains dark color, as a result of which this option has scored low points – 2.1. Similar points with the control sample (4.7 points) have been recorded in case of adding 100 g extract. This option ensures a rather pleasant taste and bright yellowish color. Nevertheless, with further addition of the extract, a decline in all organoleptic indices have been observed.

The recipe for the new cupcake production calculated per 1 kg finished product is introduced in Table 2.

Table 1. Evaluation of organoleptic indices of control sample and experimental sample produced with licorice extract*

Name of indicator	Control sample	Investigated options (recalculation of the substituted sugar amount per 1 kg product)		
		50 g	100 g	150 g
Appearance	Correspoding to the discussed food product			
Structure of finished product	Average porosity	Uniformly porous, with large pores		Small-sized porosity
Color	Yellowish	Intense/pronounced yellowish		Dark yellowish
Taste	Correspoding to the discussed food product	Unsweet	Well-pronounced pleasant sweetness	Excess sweetness with bitter tones
Smell	Correspoding to the discussed food product			

*Composed by the authors.

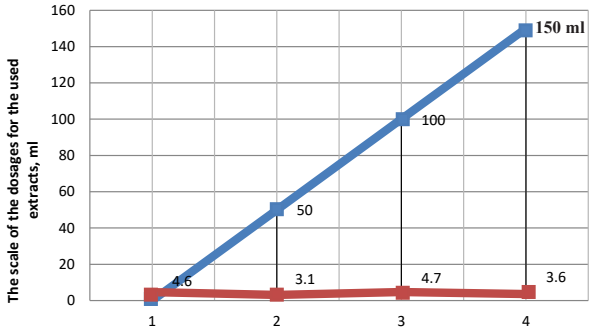

Figure. Organoleptic evaluation of the control and experimental samples *(composed by the authors)*.

Table 2. The recipe of cupcake for control and experimental samples (produced with licorice extract)*

Name of raw material	Control sample (per 1t finished product), kg	Experimental sample (per recalculation of 1kg finished product), g
High-grade wheat flour	360.74	360. 74
Butter	180.42	180.42
Chicken egg	108.27	108.27
Licorice root extract	-	100
Edible salt	1.07	1.07
Sodium bicarbonate	3.60	3.60
Vanilla	1.0	1.0
Sugar	25.28	-
Raisin	108.27	-
Water	210.0	200
Total	998.65	955.1

*Composed by the authors.

Egg, butter and licorice extract is poured and mixed in the mixer machine for 15 minutes, after which the other ingredients, as listed in the recipe, are added. The dough is mixed up to the uniform mass and then the flour is added and mixed until the creamy mass is formed. In the experimental sample, the entire mass of sugar was substituted with licorice extract. Unlike the traditional technology, here the baking takes place at the temperature of 150-170 ^{0}C, since in case of higher temperature decomposition of glycosides is recorded, which is practically irrelevant, as it results in the production of toxic matters. Therefore, the baking temperature has been set up possibly lower and baking duration – much longer.

In the experimental sample the contents of protein, fats, carbohydrates, saccharose, glucose and fructose, as well as energy value of the product has been determined. The results of the analyses are presented in Table 3.

Table 3. Evaluation of the chemical indicators and energy value of the new cupcake product*

Name of indicator	ND, Name of document according to the experiment type	Measuring unit	Control sample	Outcomes
Protein, g	-	%	5.1	7.7
Fat, g	-	%	22	19.71
Carbohydrates, g	-	%	42.5	35.89
Glucose	IHM	%	12.0	<0.5
Fructose	IHM	%	11.2	<0.5
Saccharose	IHM	%	19.3	<0.5
Energy value	TP TC 022-2011	kcal/ 100g	388	352.03

As the laboratory results show, the index of <0.5 testifies that there is almost no sugar content in the experimental sample, which proves the feasibility of the extract application in the dietary structure of diabetics as well. The analysis has also shown that besides the absence of sugar content, the amounts of fats and carbohydrates, as well as the energy value have declined, which is again a positive tendency for the new food product. It is worthwhile to notice that the protein content has increased in the finished product, which can serve as a base for further investigations.

Conclusion

In the result of conducted research and experimental investigations, the following conclusions can be drawn:

Based on the experimental studies a scientifically justified technology for functional cupcake production has been developed by applying licorice extract.

The research has revealed that when using licorice extract in the experimental sample, almost no sugar content, particularly glucose, has been detected, which substantiates the fact, that the new cupcake product can be used in the food ration of diabetics.

It has been proved that the extract produced from licorice roots can be used in the food production as a natural sugar substitute.

The contents of carbohydrates, fats and energy value have been reduced. For a certain group of people, such as diabetics, these food indices are of vital significance for maintaining health.

The developed recipe and methods of producing a new cupcake product can be definitely involved in the dietary structure of the people affected by diabetes, since it has a functional significance and lacks glucose in its sugar content. The technology is conformed to the current productions and doesn't require any additional investments.

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