PREPARATION OF SPONGE CAKES WITH FLOUR OF TOPINAMBUR TUBERS

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Abstract: The possibility of the use of a topinambur /Helianthus tuberosus L./, which application is almost unknown in our confectionary, is presented in this article. Four types of sucrose-sweetened sponge cakes made by a partial substitution of wheat flour with flour of topinambur tubers are proposed. The sponge cake batter recipe composition is specified as the physical characteristics of the goods are determined. The methods of descriptive sensory analysis are used for a comparative analysis of the new and the control sucrose-sweetened sponge cake. The newly obtained baker's goods are characterized with good quality properties. On the grounds of the received results it can be expected a potential consumer interest in pastry food products enriched with vegetable biologically active components.

Key words: sucrose-sweetened sponge cake, flour of topinambur tubers, physical characteristics, descriptive sensory analysis.

Introduction

A new natural biologically active component is flour prepared with topinambur tubers, named as earth apple or Jerusalem artichoke [6, 7, 8, 10, 11]. Many authors [2, 3, 6, 8, 10, 11] consider that introduction of topinambur tubers flour in pastry food products is more expedient than that of inulin obtained from the topinambur tubers. The reason is the fuller enrichment of the pastry products with biologically active substances containing besides polysaccharides of inulin nature but pectin, irreplaceable amino acids, macro (potassium, calcium, phosphorous) and micro elements (silica, iron, magnesium, zinc, copper, nickel, manganese) and vitamins. It is proved [2, 3, 4, 5, 7, 9, 10], that the flour of topinambur tubers possesses physical and organoleptic properties, which impart a higher quality and a smaller degree of aging of baker's and pastry food products made-up with it. Zhelenkov [2, 3] has developed and published new technologies for the preparation of confectionary, baker's and pastry products with which the biologically active substances in topinambur flour defining its curative, preventive and dietetic properties are kept. He has recommended the inserting of topinambur flour in confectionaries and pastry food products to be in optimum quantity from 1 to 10 % of the total mass of the components according the recipe. Koryachkina et al. [4] have regarded the possibilities for the use of topinambur flour in the production of pastry food goods intended to ill people with sugar diabetes type 2. In the same aspect Sinyakovskaya et al. [5] suggest compositions and technologies of sugar-free and sweetened biscuits containing flour of topinambur tubers. The have found that the inserting of topinambur flour in sweetened and sucrose-free biscuits (with sorbitol or fructose) in amount up to 7 and up to 5 % of white wheat flour mass, respectively, has not worsened the structural and mechanical properties of the sponge cakes and biscuits. The topinambur flours brings to both kinds of biscuits a sweet taste, specific odor, brown color with gray nuance, and on the other hand decreases their energetic value and increases their

biological activity. It is proved [9] that the flour of topinambur tubers can be used as a low-calorie bulking agent in pasta or baked goods. In a bread or cake, it can substitute for up to 10% of the flour. At these levels, it does not compromise the functionality of the wheat gluten or flour. The nut-like, slightly sweet flavor of the flour of topinambur tubers complements the flavor of hearty breads and cakes. The flour disperses readily in food systems. Some adjustments to baked goods formulations may be necessary, such as changing the moisture level, the leavening system, and the ration of sugar to flour. Pasta made with the flour takes on a light brown color. Gedrovica and Karklina [7] studied characteristics of cakes enriched with Jerusalem artichoke powder /flour of topinambur tubers/ at a concentration of 10, 20, 30, 40, 50%. The cakes enriched with Jerusalem artichoke powder (at a concentration of 30 and 40%) stayed soft longer during the storage time (two days) than control samples without this powder. The highest content of moisture was observed in cakes enriched with Jerusalem artichoke powder at a concentration of 20 and 30%. The concentration of Jerusalem artichoke powder and moisture with a probability of 95% substantially influenced the colour components L*a*b*. The highest changes in colour were reflected by the values L* (darkness) a* (redness). The best quality of cakes was determined in samples with a 30% addition of Jerusalem artichoke powder.

The objective of this article is the investigation of the possibility for the preparation of newly sucrose-sweetened sponge cakes by the addition of flour of topinambur tubers.

Materials and Methods

Sponge cake preparation: The standard raw materials - wheat flour type 500, granulated sugar, eggs, used in our investigations, are authorized by the Ministry of Health, as one part of them was manufactured in Bulgaria, while the other was imported. The flour of topinambur tubers was delivered by the company ET "Charodeitzi - 07", Purvomay as import from Russia. The flour was characterized as follows – particle massiveness 200 μm, slightly beige-cream colour, sweetish taste, without side taste and odour. The flour of topinambur was qualified by an independent laboratory which is under the control of Bulgarcontrol. The flour of topinambur contained 9.28 % moisture. A sucrose-sweetened sponge cake (a control sample) was included in the analysis. The mixture for the sucrose-sweetened sponge cake (batter-control) was prepared following a traditional technology and formulation [1] as double mixing procedure by partitioning whipping of whites and yolks of egg was used. Each sponge cakes batter with a mass of 95 g and was poured out in metallic forms and baked in an electric oven (Rahovetz - 02, Bulgaria) for 30 min at 180 ^{o}C. The sponge cakes were prepared in laboratory conditions.

Physical characteristics of the batters and cakes: The specific gravity of the sponge cake was calculated by dividing the weight of a standard cup of batter by the weight of an equal volume of distilled water according to AACC Method 10-95 at batter temperature (20.7 ± 0.5 °C). The physical characteristics of sponge cakes were measured two hours after baking. The volume was determined by small uniform seed displacement method Method AACC 10-05 2000 and the porosity according to the method of Yackoby (BDS 3412-79). The porosity of sponge cake was defined as the ratio between the volume of the air-pockets in the cake crumb and the volume of the crumb. The porosity determination was done using a cylinder driller – a device of Zhuravljov (BDS 3412-79). The specific volume was expressed as the ratio between the sponge cake volume and its mass. The water-absorbing capacity of the sponge cake was measured by the method of determination of biscuits swelling according BDS 15221-81. For the determination of the sponge cake structure were

done photographs of cross sections of the half-cut cake. The indices of the structural and mechanical properties of the sponge cake crumb such as shrinkage and springiness were determined with automatic penetrometer (model DSD VEB Feinmess, Dresden, Germany). The total moisture of the samples was determined after drying of the sample at 105 °C up to the state of a constant mass according standard method (BDS 3412-79, BDS 5313-85).

Sensory characteristics: The descriptive test for quantitative sensory profiling was used to establish the textural sensory characteristics (shape, color, cells size and uniformity, odor, sweetness, aftertaste, crumb tenderness) of the sponge cakes, 6 hours after baking, according Method of ISO 6564 and ISO 6658. A panel of twelve experienced degustatiors was selected to guarantee the evaluation accuracy. The intensity of each sensory characteristic was recorded on a ten-point linear scale after one hour's orientation sessions of the panelists where they specified terminology and anchor points on the scale. The coded samples were shown simultaneously and evaluated in random order among panelists.

Mathematical and staistical methods: Depending on the type of the studied characteristic from 3 to 12 repetitions of each measurement were done. For the valuation of results was used a method with a level of statistical significance $p \leq 0.05$.

Results and Discussion

The worked-up recipe composition for sponge cakes with an additive of topinambur flour was prepared by the replacement of wheat flour with flour of topinambur in amount of 5, 10, 15 and 20 %. The batter formulations of the control sample and the investigated sponge cakes containing flour of topinambur are given in Table 1. The stages of technology were kept because of their easy fulfillment and the considerably small duration of the technological cycle. The sponge cakes containing topinambur flour were processed at constant regime of baking concurrent with that of the control sample, which according to the technological instruction was baked for 30 min at 180 °C. For a precise valuation of the qualitative indices of the batter with topinambur flour and the cakes made with it, the indices of the control sample are also given.

The data in Table 2 show that the volume of cakes with 5 % and 15 % content of topinambur flour is greater. The investigation showed that the cake containing 20 % topinambur flour had 4.2 % greater moisture than that of the control sample. Probably the pronounced hydrophilic properties of topinambur flour proved by a series of investigators [2, 3, 4, 5, 7, 9, 10] influence the quantity and the state of the retained moisture in the sponge cake with 20 % flour of topinambur. This effect leads not only to a difference in the amount of the retained moisture of both cakes but also to a difference in the indices of the structural and mechanical properties of the cakes given in Table 2. A difference in the sensory characteristics concerning the texture (shape, cells size and uniformity, crumb tenderness) can be seen on Table 3.

Table 1 Sponge cake batters formulations

Ingredients	Amount based on:				
	flour weight, %	flour mix /wheat flour and flour of topinambur/ weight, %			
	Control sample	with 5 % topinambur	with 10 % topinambur	with 15 % topinambur	with 20 % topinambur
Yolk of egg	43.23	43.23	43.23	43.23	43.23
White of egg	96.77	96.77	96.77	96.77	96.77
Refined granulated sugar	83.87	83.87	83.87	83.87	83.87
Wheat flour type 500	100.00	95.00	90.00	85.00	80.00
Flour of topinambur	-	5.00	10.00	15.00	20.00

Table 2 Physical characteristics of the sponge sucrose-sweetened batters and cakes

Physical characteristics[1]	Sponge sucrose-sweetened cake type				
	Control sample	with 5 % topinambur	with 10 % topinambur	with 15 % topinambur	with 20 % topinambur
Specific gravity (for batter)[2]	0.71 ± 0.01	0.72 ± 0.01	0.72 ± 0.02	0.73 ± 0.01	0.74 ± 0.02
Volume, cm^3	244.40 ± 4.93	255.80 ± 6.76	234.60 ± 22.80	250.20 ± 9.36	230.20 ± 7.16
Specific volume, cm^3/g	3.00 ± 0.09	3.31 ± 0.10	3.01 ± 0.30	3.27 ± 0.14	2.82 ± 0.08
Porosity, %	69.07 ± 3.12	65.34 ± 4.27	68.89 ± 2.03	71.11 ± 3.10	68.15 ± 2.03
Spinginess, PU[3]	33.40 ± 5.13	30.30 ± 3.21	35.80 ± 5.26	45.60 ± 7.23	47.00 ± 3.54
Shrinkage, PU	115.20 ± 4.49	85.40 ± 5.77	95.40 ± 10.71	114.20 ± 8.04	128.80 ± 7.40
Water-absorbing capacity, %	335.60 ± 8.47	376.52 ± 22.60	374.08 ± 19.87	372.50 ± 26.57	314.50 ± 12.89
Total moisture, %	27.05 ± 0.50	30.48 ± 0.50	29.37 ± 0.18	29.55 ± 0.43	31.25 ±1.32

[1] The values are mean ± SD ($p \leq 0.05$).

[2] The temperature of the batter is on the average 20.7 ± 0.5 °C.

[3] PU - Penetrometer Units.

For the sponge cake containing 15 % topinambur flour was determined the greatest porosity. The cake with 20 % topinambur flour had the greatest shrinkage (with 128.80 PU) and springines (with 47.00 PU) in respect to all other cakes, which shows the positive influence of topinambur flour upon cake structure. The best physical characteristics were reached for the cake containg 20 % topinambur flour.

The obtained sensory values of the investgated sponge cakes are given in Table 3. Our investigations showed (Table 3) that both cakes, the control sample and the one with 5 % topinambur flour, had approximately similar shape, while equal crumb tenderness was found for the control sample and the cake with 10 % topinambur flour. The data showed that there was not a great difference in the values of size and uniformity of cells, odour and

crumb tenderness for the investigated cakes with 5 and 15 % topinambur flour. The cells of the new sponge cakes with topinambur flour were small and equal, uniformly distributed in the crumb, as at the same time they were thin-wall (Table 3 and Fig. 1) and juxtaposed but discernible with the cells in the control sample.

Table 3 Sensory characteristics of the sponge sucrose-sweetened cakes

Sensory characteristics[1]	Sponge sucrose-sweetened cake type				
	Control sample	with 5 % topinambur	with 10 % topinambur	with 15 % topinambur	with 20 % topinambur
Shape	8.00 ± 0.95	7.67 ± 1.67	7.17 ± 1.95	6.58 ± 2.07	6.17 ± 1.47
Colour	7.75 ± 1.54	7.58 ± 0.90	7.75 ± 0.97	6.92 ± 1.24	6.67 ± 1.15
Cells size and uniformity[2]	6.92 ± 1.08	6.83 ± 1.64	6.42 ± 1,98	7.08 ± 1.38	7.33 ± 1.23
Odour	7.17 ± 1.59	6.50 ± 2.20	6.67 ± 1.97	6.50 ± 2.32	6.08 ± 2.39
Sweetness	6.92 ± 1.31	6.00 ± 1.86	5.08 ± 2.19	5.58 ± 1.78	5.83 ± 1.40
Aftertaste	3.33 ± 3.14	4.00 ± 3.19	3.67 ± 2.67	3.92 ± 2.43	3.92 ± 2.47
Crumb tenderness	7.42 ± 1.31	7.00 ± 1.71	7.33 ± 1.44	6.92 ± 1.62	6.58 ± 1.51

[1] The values are mean ± SD ($p \leq 0.05$).
[2] A scale from 0 to 9 was used to evaluate sensory characteristics. Nine is ideal for the third sensory characteristic when the cells are small and equal in size

a) **b)** **c)** **d)** **e)**

Fig. 1 Photographs of cross sections of sucrose-sweetened sponge cakes: **a)** Without an additive of topinambur flour (control cake-sample); **b)** With an additive of 5 % of topinambur flour; **c)** With an additive of 10 % of topinambur flour; **d)** With an additive of 15 % of topinambur flour; **e)** With an additive of 20 % of topinambur flour.

The colour of the sucrose-sweetened cakes and those containing 15 and 20 % topinambur flour was evaluated by the sensor experts as significantly discernible from that of the control sample as it is evident from Table 3. The control sample had a lightly yellow colour, while the others due to the presence of topinambur flour had a brown surface and a brown crumb with gray nuance. The odour of the cakes with topinambur flour was more strongly expressed and more specific towards the sample odour, and was not perceived by the sensor testers as unpleasant. For the sucrose-sweetened cakes and those with topinambur flour a weaker expressed sweetness towards the sample taste was found. The control sample had the smallest aftertaste.

Conclusions

1. The addition of topinambur flour in sucrose-sweetened sponge cakes improves their physical characteristics. The investigated sponge cakes with an additive of topinambur flour have a greater specific volume (with the exception of the cake containing 20 % topinambur flour), a bigger porosity (with the exception of the cake containing 5 % topinambur flour), and an improved stability of the crumb form in respect to those of the control sample.

2. The sponge cakes containing an additive of topinambur flour have good sensory characteristics. The sensory analysis demonstrates that the structure is fine-porous in allkinds of investigated sponge cakes. The properties of topinambur flour change the rest sensory cakes characteristics as the odour becomes more specific, the sensation for sweetness is weaker expressed, the colour of the surface and the crumb is brown, the shape and the crumb tenderness are discernible, but close to those of the control sample.
3. The physical and sensory characteristics of the sucrose-sweetened sponge cakes and with an additive of topinambur flour are juxtaposed with those of the control sample. On the grounds of this we consider that newly prepared products have good qualitative characteristics, and they are suitable as intermediate products in confectioneries designed for rational and dietetic nutrition.

References

1. Ангелов, Л., Бекиров, Б., Генадиева, М., Атанасов, Ст. ОН 146200-72. Сборник-отраслови нормали, разходни норми и технологични инструкции за сладкарското про-изводство // ЦСК, София, 1974, том I, стр. 176-183.
2. Зеленков, В. Н. Способ производства хлебобулочных и мучных изделий с использованием топинамбура // Патент России № 2128439, 1999.
3. Зеленков, В. Н. Способ производства кондитерских изделий с лечебно-профилактическими свойствами с использованием топинамбура // Патент России № 2130273, 1999.
4. Корячкина, С. Я., Калинина, В. С., Ладнова, О. Л. Разработка мучных кондитерских изделий диабетического назначения // Издательство Российская Академия Естествознания, Москва, Научный журнал "Успехи современного естествознания", 2003, № 12, стр. 79-81.
5. Синявская, Н. Д., Кузнецова, Л. И., Мельникова, Г. В. Использование топинамбура для создания новых сортов хлеба и печенья функционального назначения // По материалам 1-ой Международной научно-практической конференции "Растительные ресурсы для здоровья человека". www.topinambur.net
6. Cieślik, E., Kopeć, A., Praznik, W. Healthly properties of Jerusalem artichoke flour (Helianthus Tuberosus L.) // Electronic Journal of Polish Agricultural Universities, 2005, Vol. 8, Issue 2.
7. Gedrovica, I., Karklina, D. Characteristics of cakes enriched with Jerusalem artichoke powder // Cheminė Technologija, 2009, Nr. 3 (52), pp. 50-55.
8. Kays, S. J., Nottingham, S. F. Biology and Chemistry of Jerusalem Artichoke: Helianthus Tuberosus L. // CRC Press, ISBN 1420044958, 9781420044959, 2007, pp. 478.
9. LaBell, F. Low-calorie tuber flour for pasta, baked goods // Food Processing, 1992, Nr. 53 (4), pp. 56-58.
10. Praznik, W., Cieślik, E., Filipiak-Florkiewicz, A. Soluble dietary fibres in Jerusalem artichoke powders: composition and application in bread // Nahrung/ Food, 2002, Vol. 46, Issue 3, pp. 151-157.
11. Yamazaki, H. Process for preparing flour from Jerusalem artichoke tubers // United States Patent 4871574, 1989.