PHYSICAL AND SENSORY CHARACTERISTICS OF SPONGE CAKES CONTAINING AN ADDITIVE OF CACAO HUSKS

***Baeva Marianna, Gogova Tzvetana, Milkova-Tomova Iliana, Panchev Ivan, Goranova Zhivka**

University for Food Technologies – Plovdiv, Bulgaria

***Baeva Marianna, mbaevadoctor@gmail.com**

Abstract: The possibility of the use of cacao husks, which application is almost unknown in our confectionary, is presented in this article. Three kinds of sucrose-sweetened sponge cakes made by a partial substitution of wheat flour with milled cacao husks 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 very good quality properties in comparison with those of the cake without cacao husks (the control cake-sample). 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, cacao husks, physical characteristics, descriptive sensory analysis.

Introduction

The investigations in the recent years [3, 8] show that the low-energy and biologically enriched foods are of great interest. One of the ways for the making-up of healthy goods is the exclusion or the reducing of some calorie charged ingredients [7]. The usage of alternative sweeteners, which can replace the sweet functions of sucrose, is one possibility for the reducing of the energetic value of goods [3].

The enrichment of pastry food products with biologically components possessing functional properties can be realized by inserting in their composition wheat germ, fully-grained wheat and other flours, which are bearers of dietary fibre, minerals and vitamins [2, 8]. The making-up of pastry food products by including of poly-functional biologically active additives in them requires these goods to have a quality commensurable with that of the sweetened with sucrose products, and it is a question of present interest all over the world. A new natural vegetable biologically active component is the cacao husks, which are themselves vegetable waste from the processing of cacao grains [6, 10]. The cacao husks are considered [5, 6, 9] as a valued source of dietary fibre, mineral elements on the basis of potassium, magnesium, calcium, proteins with balanced amino acidic composition, and polyphenolic compounds which manifest a strong antioxidant activity. Considering the health benefits associated to the consumption of dietary fibre and polyphenols in the diet, the presence of both bioactive components in cocoa bean husks could highlight the interest of such a product as a potential ingredient for the functional food industry. It is proved [4] that in cacao beans husks the quantity of dietary fibre varies from 38 % to 44 %, as the mean insoluble fibre concentration is 64.5% of total fibre quantity. The dietary fibre have a good water-holding capacity, as they determine the low-energy value of cacao husks. The physico-chemical properties of this cocoa fibre make it a suitable product to be used in the preparation of low calorie, high-fibre foods like chocolate cookies, chocolate cakes, dietetic chocolate supplements, etc. where the colour and flavour of this cocoa fibre might be

advantageous [9]. A study [10] was made of the texture, composition, appearance, colour and descriptive sensory analysis of low-fat chocolate muffins in which part of the oil ingredient (25%, 50% and 75%) had been replaced by soluble cocoa fibre and full-fat (no fat replacement) control sample to which cocoa powder had been added for comparison purposes. The results indicate that soluble cocoa fibre is an encouraging option for replacing oil in a chocolate muffin formulation. The main advantages were that adding soluble cocoa fibre gave muffins higher moisture and a more tender and crumbly texture, as they were more fragile than the control, and reduced the signs of hardening during storage. Also, adding soluble cocoa fibre gave a fair amount of colour. However, there are points that require improvement, such as the loss of height, perception of bitter taste and a certain surface stickiness.

The objective of this article is the investigation of the physical and sensory characteristics of sucrose-sweetened sponge cakes with and without an additive of cacao beans husks.

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 cacao husks were vegetable waste from bio-cacao beans Hispaniola and were delivered by "Gayo Chocolate – Ltd" company, Plovdiv. The cacao husks were fine milled, and the contained 5.4 % moisture. A control sample of sucrose-sweetened with cake batter was included in the studying. 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 13 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 developed recipe composition of sponge cakes with an additive of cacao husks was prepared by the replacement of wheat flour with grinded cacao husks in quantity 20 %, 35 % and 50 %. The recipe compositions of the control sample and the investigated cakes containing an additive of cacao husks are presented in Table 1.

Table 1 Sponge cake batters formulations

Ingredients	Amount based on:			
	flour weight, %	flour mix /wheat flour and flour of topinambur/ weight, %		
	control sample	with 20 % cacao husks	with 35 % cacao husks	with 50 % cacao husks
Yolk of egg	43.23	43.23	43.23	43.23
White of egg	96.77	96.77	96.77	96.77
Refined granulated sugar	83.87	83.87	83.87	83.87
Wheat flour type 500	100.00	80.00	65.00	50.00
Cacao husks	-	20.00	35.00	50.00

The stages of technology were kept because of their easy fulfillment and the considerably small duration of the technological cycle. The sponge cakes containing cacao husks 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.

The most accurate evaluation of the merits of the suggested technology can be given by juxtaposing the qualitative characteristics of cakes batter for the control batter-sample and the three kinds of batter containing an additive of cacao husks, as also juxtaposing the same characteristics of the baked sponge cakes. In this studying the sponge cakes batter with cacao husks had a bigger specific gravity towards the same of the control batter-sample (0.72 ± 0.02) as it is shown in Table 2.

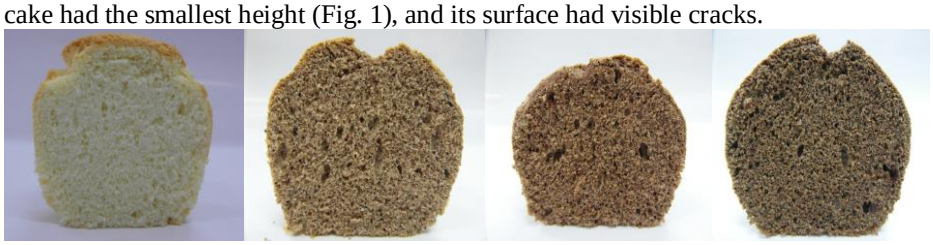
Table 2 Physical characteristics of the sponge sucrose-sweetened batters and cakes

Physical characteristics[1]	Sponge sucrose-sweetened cake type			
	Control sample	with 20 % cacao husks	with 35 % cacao husks	with 50 % cacao husks
Specific gravity (for batter)[2]	0.72 ± 0.02	0.77 ± 0.00	0.83 ± 0.01	0.77 ± 0.02
Volume, cm^3	244.40 ± 4.93	214.00 ± 8.94	177.00 ± 10.95	163.00 ± 8.37
Specific volume, cm^3/g	3.00 ± 0.09	2.70 ± 0.20	2.30 ± 0.18	2.10 ± 0.10
Porosity, %	68.85 ± 3.34	61.47 ± 3.29	63.69 ± 1.63	64.42 ± 1.99
Spinginess, PU[3]	32.96 ± 2.55	25.80 ± 4.92	21.80 ± 2.39	22.90 ± 0.96
Shrinkage, PU	86.10 ± 2.19	67.60 ± 8.29	61.80 ± 4.72	68.60 ± 2.16
Water-absorbing capacity, %	327.00 ± 17.05	314.60 ± 15.03	309.00 ± 24.98	280.00 ± 8.66
Total moisture, %	31.49 ± 0.36	28.30 ± 0.33	27.81 ± 0.26	23.24 ± 0.31

[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.

A reverse relationship between the batter specific gravity and the sponge cakes physical characteristics such as volume and porosity (Table 2) was established. For the sponge cake-sample, which batter had a smaller specific gravity, a larger volume and bigger porosity were determined. In this studying the volume of cake-sample (244.40 ± 4.93 cm^3) was larger than this of cakes containing cacao husks, as the volume of the cake with 20 % cacao husks (214.00 ± 8.94 cm^3) is the largest, while the cake with a higher quantity of cacao husks (50 %) had the smallest volume (163.00 ± 8.37 cm^3). The data in Table 2 show that the control sample had greater percentage retained moisture than cakes with cacao husks, which lead to a difference in the indices for the structural and mechanical properties. The sponge cake-sample had a higher shrinkage (86.10 PU) and spinginess (32.96 PU) than the same for the cakes with cacao husks.

During our investigations was found that the control sample and the goods with cacao husks had similar form with an exception for the cake with 50 % cacao husks. That cake had the smallest height (Fig. 1), and its surface had visible cracks.



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

Fig. 1. Photographs of cross sections of sucrose-sweetened sponge cakes: **a)** Without an additive of cacao husks (control cake-sample); **b)** With an additive of 20 % of cacao husks; **c)** With an additive of 35 % of cacao husks; **d)** With an additive of 50 % of cacao husks.

For the cake-sample it was found that its crust was softer and its crumb had a higher spinginess in comparison with the cake containing cacao husks. The cake spinginess is a

surface response of its microstructure. The crumb pores cells of the cakes with cacao husks had thicker walls, and they were larger and equal in size, which can be seen on Fig. 1. This fact corresponded with the same index of its sensor profile represented in Fig. 2.

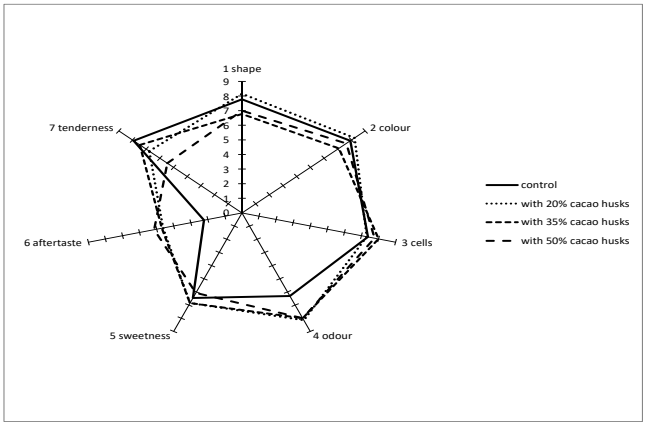


Fig. 2. Sensory profiles of sucrose-sweetened sponge cakes (1 shape, 2 colour, 3 cells size and uniformity, 4 odour, 5 sweetness, 6 aftertaste, 7 crumb tenderness)*

*****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

As a result the spinginess of the cakes with cacao husks was smaller; their crumb tenderness was also smaller, while their structure was stable at high loads, expressed by lower shrinkage in respect to sponge cake-sample. The water-absorbing capacity of the cakes with cacao husks was lower than that of the cake-sample (327.00 ± 17.05 %), as it is shown in Table 1. The cells of the sponge cake-sample were smaller and almost equal, uniformly distributed in the crumb, and at the same with thinner walls (Fig. 1 and Fig. 2). That was the reason this cake to have higher water-absorbing capacity in respect to the other cakes.

The odour of the cakes with cacao husks was peculiar to this of natural chocolate, and was perceived by the sensor evaluators as more pleasant than the odour of the cake-sample. The cake-sample had a crust and crumb with more pronounced light-yellow colour due to the presence of the dying components in the yolks of egg (especially carotenoids). The colour of the crust and crumb of the cakes with cacao husks was from light-brown to dark-brown depending on the percentage of the added cacao husks. The intensity of the sweetness for all investigated sponge cakes is close, but when the concentration of the cacao husks is greater a bitter aftertaste is read.

Conclusions

1. The sponge cakes containing an additive of cacao beans husks have good physical properties. The spinginess of cakes with cacao husks is smaller, the crumb tenderness is smaller, while the structure is stable at high loads expressed by a lower shrinkage in comparison with the control cake-sample.
2. The difference in respect the porosity and specific volume between the control cake-sample and the sponge cakes with cacao husks is minimal.

3. The control cake-sample and the cakes with cacao husks have approximately similar form. The crumb pores of cakes with cacao husks in the investigated three kinds of cakes are with thicker walls, larger and equal in size. The odour of the cakes with cacao husks is perceived as more pleasant than the control cake-sample one. The brown colour of the cakes with cacao husks is perceived well from the testers. The intensity of the sweetness for all investigated sponge cakes is close, but when the concentration of the cacao husks is greater a bitter aftertaste is read.
4. The physical and sensory characteristics of the sucrose-sweetened sponge cakes and with an additive of cacao beans husks are juxtaposed with those of the control cake-sample. On the grounds of this we consider that newly prepared sweetened sponge cakes containing cacao beans husks 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. Василева, Р., Йочева, Л. Пълнозърнени храни – основен химичен състав и биологично активни растителни хранителни съставки // Хранително-вкусова промишленост, 2007, № 9, стр. 44 – 48.
3. Терзиева, В. В., Баева, М. Р., Янев, Я. Нетрадиционни сладкарски изделия // «40 години Колеж - Сливен» - Юбилейна научна конференция - Сливен, Сборник доклади, 2001, том 2, стр. 246-249.
4. Bonvehi, J. S., Beneria, M. A. Composition of dietary fiber in cocoa husk // Zeitschrift fur Lebensmittel-Untersuchung Und-Forschung A-Food Research and Technology, 1998, 207 (2), pp. 105-109.
5. Bonvehi, J. S., Coll, F. V. Protein quality assessment in cocoa husk. Food Research International, 1999, 32, pp 201-208.
6. Chung, B.Y., Iiyama, K., Han, K.W. Compositional characterization of cacao (*Theobroma cacao* L.) hull // Agric. Chem. Biotechnol., 2003, 46, pp. 12-16.
7. Fiber Enriched, Sugar Reduced Fermented Bakery Products // Food Marketing & Technology, 2007, June, p. 4 - 6.
8. Hamaker, B. R. Technology of Functional Cereal Products // Hardback ISBN 9781845691776, 2007, 568 pages.
9. Lecumberri, E., Mateos, R., Izquierdo, M., Rupérez, P., Goya, L., Bravo, L. Dietary fibre composition, antioxidant capacity and physico-chemical properties of a fibre-rich product from cocoa (*Theobroma cacao* L.) // Food Chemistry, 2007,104 (3), pp. 948-954.
10. Martínez-Cervera, S., Salvador, A., Muguerza, B., Moulay, L., Fiszman, S. M. Cocoa fibre and its application as a fat replacer in chocolate muffins // LWT – Food Science and Technology, 2010, 44, pp. 729-736.