Heliyon 9 (2023) e20029

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Increasing the functionality of sponge cakes by mint, and cocoa powder addition

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ARTICLE INFO

Keywords:
Mint
Cocoa powder
Polyphenols
Antioxidants
Functional sponge cake
Spectrophotometry

ABSTRACT

While sponge cake is one of the most well-liked cookies in the world, mint and cocoa have both been shown to be excellent sources of antioxidant compounds. Therefore, the aim of the study was to create functional sponge cakes with the addition of Dutch cocoa powder and different types of mint, with proven increased total antioxidant and polyphenol content. Additionally, made an effort to produce functional sponge cakes enhanced with cocoa powder and dried, ground mint leaves. To accomplish this, the cakes with cocoa addition were also added 1, 3, and 5% of the ground mint variety, and then the changes in their antioxidant and polyphenol content were assessed. To prove the functionality of cakes, total polyphenol content was detected by Folin-Ciocalteu, while all antioxidant content was measured by the FRAP method. The spectrophotometric analysis supported the functionality of sponge cakes and the baking losses of identified components. The total polyphenol content of baked goods ranged from 1.37 to 1.66 mg GAE/g for peppermint cakes, from 1.66 to 1.87 mg GAE/g for spearmint cakes, and from 1.20 to 1.68 mg GAE/g for strawberry mint sponge cakes. The total antioxidant content of the functional cakes changed between 1.84 and 2.82 mg AAE/g for peppermint cakes, from 1.84 to 4.00 mg AAE/g for spearmint cakes, and from 1.56 to 2.94 mg GAE/g for strawberry mint sponge cakes. The natural control samples, and control sponge cakes made without mint addition with only cocoa powder always had lower levels of polyphenols and antioxidants. All samples had baking loss (control samples had the highest in all cases), but strawberry mint samples had the least of it when it came to antioxidant content and spearmint samples had the least in the case of polyphenol content. Overall, mints and Dutch cocoa powder are appropriate for the production of functional bakery goods because they give the final product a tasty flavor and provide a significant amount of antioxidants and polyphenols despite baking.

1. Introduction

Functional foods are products with additional ingredients like nutrients, dietary fibers, and phytochemicals. In sufficient amounts, these ingredients may have a positive impact on the human body due to their health-protecting and preserving properties [1]. Grain-based products are well-liked among people around the world and widely consumed daily. Bakery products are significant sources of energy and nutrients, as they contain large amounts of carbohydrates, proteins, B vitamins, and minerals [2].

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https://doi.org/10.1016/j.heliyon.2023.e20029
Received 5 June 2023; Received in revised form 7 September 2023; Accepted 8 September 2023
Available online 9 September 2023

Along with traditional flours and goods, the baking industry's growth has increased the demand for foods containing functional ingredients. One type of bakery product in the confectionery sector is sponge cake [3]. In order to enhance the physicochemical and sensory qualities of sponge cakes, numerous studies have been conducted. The products were enriched during the experiments with cereal flour, vegetable or fruit powder, and extract. Green tea [4], black carrot [5], broccoli leaves [6], chickpeas [7], sweet potato varieties [8], and ginger extract [9] were a few of the used plant additives.

Spices and herbs have long been recognized for their significant antioxidant properties, thus in the food industry and medicine frequently use species from the *Lamiaceae* family, including mint, basil, rosemary, sage, savory, oregano, and thyme [10]. Due primarily to phenolic acids and flavonoids, the leaves of the various mint varieties have significant antioxidant and free radical scavenging properties. Mint leaves can be used as functional food products as health-protective additives due to their beneficial physiological effects [11]. *Theobroma cacao* (cocoa tree) is a member of the *Malvaceae* family. The plant's fruits, the cocoa beans, are a well-known source of polyphenols; the active compounds build up in polyphenolic cells [12]. The non-fat components of the fruit contain sizable amounts of the cocoa bean's polyphenolic compounds and comprise about 15% of the dry matter in beans. The color, flavor, and subsequent processing of cocoa beans are all influenced by polyphenols, and in addition to all of this, they also have positive physiological effects [13].

Recent studies have documented the successful augmentation of various baking and confectionery products with natural ingredients and their impact on the functional properties of cakes [9,14–18]. To our knowledge, there is no publication that examines the cocoa and mint enrichment of sponge cakes, therefore the aim of the study was to make sponge cakes with the addition of Dutch cocoa powder and three different types of mint (*Mentha x piperita* L., *Mentha spicata* var. *crispa* L., *Mentha spicata* subsp. *citrata* '*Strawberry*') and determined the functionality of the herbal ingredients and confectionary products with spectrophotometric methods. Since a significant part of the investigated compounds are heat sensitive, another goal of the study was to measure baking losses by contrasting the amounts of active ingredients in raw dough and baked sponge cakes.

2. Materials and methods

2.1. Chemicals

To the determination of total antioxidant content with FRAP assay, sodium acetate (Merck, Germany), 2-4-6-tripyridyl-*s*-triazine (TPTZ) (Sigma-Aldrich, USA), anhydrous iron chloride (Merck, Germany), ascorbic acid (Sigma-Aldrich, USA), acetic acid (Reanal, Hungary), methanol (Reanal, Hungary), and 37% hydrochloric acid (Reanal, Hungary) were used. Methanol (Merck, Germany), 37% hydrochloric acid (Reanal, Hungary), anhydrous sodium carbonate (Riedel-de Haën, Germany), gallic acid (Sigma-Aldrich, USA), and Folin-Ciocalteu reagent (Ficher Chemical, USA) were used to the determination of total polyphenol content with Folin-Ciocalteu method.

2.2. Cocoa powder and mint samples

The dried mint leaf samples were purchased from a herbarium (Mosonmagyaróvár, Hungary). The studied varieties were the following: peppermint (*Mentha x piperita* L.), spearmint (*Mentha spicata* var. *crispa* L.), and strawberry mint (*Mentha spicata* subsp. *citrata* '*Strawberry*'). The Dutch cocoa powder from *Theobroma cacao* L. fruit was obtained commercially (Mosonmagyaróvár, Hungary).

2.3. Cocoa powder, and mint sample preparation

The active compounds had to be extracted from the matrix with solvent extraction in order to determine the amounts of antioxidants and polyphenols from mint species, and cocoa powder. On an analytical balance (Sartorius TE214S, Hungary), 0,5g of ground mint samples and cocoa powder were weighed into 250 mL Erlenmeyer flasks for extraction. Then, 100 mL of an extraction solution

Table 1
The amount of ingredients used for baking sponge cakes.

Sponge cake type	Ingredients [g]					
	5 egg	Powdered sugar	Flour	Mint	Dutch cocoa powder	Baking powder
Control	325.00 ± 2	100.00	100.00	Ø	Ø	2.40
Cocoa control	325.00 ± 2	100.00	100.00	Ø	20.00	2.40
Peppermint 1%	325.00 ± 2	100.00	99.00	1.00	20.00	2.40
Peppermint 3%	325.00 ± 2	100.00	97.00	3.00	20.00	2.40
Peppermint 5%	325.00 ± 2	100.00	95.00	5.00	20.00	2.40
Spearmint 1%	325.00 ± 2	100.00	99.00	1.00	20.00	2.40
Spearmint 3%	325.00 ± 2	100.00	97.00	3.00	20.00	2.40
Spearmint 5%	325.00 ± 2	100.00	95.00	5.00	20.00	2.40
Strawberry mint 1%	325.00 ± 2	100.00	99.00	1.00	20.00	2.40
Strawberry mint 3%	325.00 ± 2	100.00	97.00	3.00	20.00	2.40
Strawberry mint 5%	325.00 ± 2	100.00	95.00	5.00	20.00	2.40

containing methanol, high purity water (70:30 V/V%), and 0,1 mL 37% hydrochloric acid was added. Elpan 358 S (Poland) laboratory shaker at 120 RPM was used for the extraction, which was carried out at room temperature for 1 h. The extracts were centrifuged (Hermle Z206 A, Germany) for 20 min at 6000 RPM also at room temperature, and the supernatant was further analyzed.

2.4. Sponge cake baking process

The eggs were separated and then the protein was whisked into a firm foam during the preparation of the control sample. Sugar, flour, and baking powder were combined and added to the yolk. Then the whipped foam was carefully mixed into the dought in three parts. For further measurements, a small portion of the raw dough was separated. The dough was poured into a pan that had been lined with baking paper, and it was baked at 130 °C for 30 min. Similar to the previous method, the Dutch cocoa powder was also mixed into the mass before adding the sugar in the case of the cocoa control sponge cake. In the case of samples enriched with mint species, the addition of sugar was followed by the appropriate amount of herbs (1, 3, 5%), then Dutch cocoa powder, flour combined with baking powder, and hard foam. The quantity of used ingredients to make the sponge cakes are shown in Table 1.

2.5. Sponge cake preparation

The baked sponge cakes were ground, and the raw sponge dough were weighed directly with an analytical balance into 100 mL Erlenmeyer flasks. For extraction, 20 mL of an extraction solution containing methanol and high-purity water (80:20 v/v%) was added to Erlenmeyer flasks containing 1 g of each sample. The extraction conditions were the same as used for cocoa powder and medicinal herbs.

2.6. Determination of total antioxidant, and polyphenol content

2.6.1. FRAP assay

The FRAP assay procedure was based on Benzie and Strain's [19] method. The following ingredients were pipetted into a test tube: 50 μl of mint/cocoa powder extract or 200 μL of extracted sponge cake sample, 3 mL of FRAP solution, 100 μL of water. The finished solutions were left in the dark for 5 min. A Spectroquant Pharo 100 spectrophotometer (Merck, Germany) was used to measure the absorbance of the finished solutions at a wavelength of 593 nm in comparison to a blank that contained only water and FRAP solution. (To select the wavelength, measuring solution with the highest concentration were used, the absorption maximum was checked against the blank solution in the wavelength range of 500 and 600 nm). Ascorbic acid (40–500 mg/L, the R^2 value of the calibration curve was 0,9995) was used as a standard, and the results were expressed as ascorbic acid equivalent capacity (AAE)/g dry matter.

2.6.2. Folin-Ciocalteu assay

Determination of total polyphenol content based on the Folin-Ciocalteau method described by Singleton et al. [20] with some modifications [21]. To 50 μL of mint, and cocoa powder extract, or 200 μL of sponge cake extract, 1.5 mL of high-purity water was pipetted, and the reagents were added. First 2.5 mL of 10% Folin-Ciocalteu reagent, then 2 mL of 7,5% Na_2CO_3 solution. The tubes containing the mixture were placed in a dark place for 90 min, and then the absorbance was measured at 725 nm versus the blank which contained only the water, and the reagents. (To select the wavelength, measuring solution with the highest concentration were used, the absorption maximum was checked against the blank solution in the wavelength range of 600 and 700 nm). Gallic acid was used as a standard (25–1000 mg/L, the R^2 value of the calibration curve was 0,9999).

2.7. Examination of the sensorial properties of sponge cake varieties

33 panelists, including 18 women and 15 men, who are faculty and students at the Albert Kázmér Faculty of Mosomagyaróvár, István Széchenyi University, evaluated the samples used in the points test. The average age of the respondents was 26. Average consumers with average sensory sensitivity. The samples were evaluated by the panellists with a questionnaire. The sensory properties of the sponge cakes were: shape, color, texture, fragrance, taste, and total impression. All sensory parameters could be evaluated from 0 to 5. The sensory properties of the sponge cakes were: shape, color, texture, fragrance, taste, and total impression. All sensory parameters were evaluated from 0 to 5. The sponge cakes could be seen by the panellists without being cut. The samples provided for judging were cut into 2.5 × 2.5 cm cubes, and each sample was presented simultaneously to allow for proper comparison. The sponge cakes' edges were pre-emptively cut off because tasting them would have impacted the outcomes. The average scores for each parameter and the standard deviations were used to present the results.

2.8. Data analysis

The total antioxidant, and polyphenol contents of mint samples, cocoa powder, and sponge cakes were determined in Microsoft Office Excel (2016) (Microsoft, Redmond, Washington (state), USA) from the absorbance values measured for samples using the equation of the second-order least squares analytical curve fitted to the measurement solutions using the nonlinear least-squares method. Analyses of variance (ANOVA) were used to compare the significant difference for the data ($p \leq 0.05$). All the results are expressed as means ($n = 3$) ± standard deviation.

3. Results and discussion

3.1. Antioxidant and polyphenol content of cocoa powder, and mint species

The antioxidant and polyphenol content of the used enrichment materials are shown in Table 2.

Spearmint (98.50 mg AAE/g) had the highest antioxidant content, and Dutch cocoa powder had the smallest (20.78 mg AAE/g). Mentha species have been used medicinally to treat various diseases, including irritable bowel syndrome, diarrhea, breast tenderness, dyspepsia, headaches, abdominal distention, abdominal pain, and bad breath [22]. Carotenoids, ascorbic acid, and phenolic compounds, among others, are prevalent in medicinal plants of the *Mentha* genus and can delay or inhibit the oxidation of various molecules. For instance, phenolic compounds act as free radical scavengers and prevent lipid peroxidation [23,24]. There have been numerous studies on the antioxidant properties of spearmint, but the results have differ significantly. While Direito et al. [25] found that the antioxidant content of dried spearmint leaves was 33.96 mg AAE/g, Henao-Rojas et al. [26] measured 19.63 mg AAE/g. Additionally, different values for peppermint can be found in the literature. While Oh et al. [27] only measured 40.70 mg AAE/g, Hazarika & Gosztola [28] calculated an antioxidant content of 210.2 mg AAE/g.

The same order can be observed for the polyphenol content as for the antioxidant content. Thus, spearmint was the richest in polyphenolic compounds (26.91 mg GAE/g), while Dutch cocoa powder had the lowest level (13.43 mg GAE/g). The literature data on spearmint's polyphenol content also shown significant differences. While Kaloteraki et al. [29] measured 39.61 mg GAE/g, Henao-Rojas et al. [26] reported values of 11.83 and 17.81 mg GAE/g. For peppermint, Oh et al. [27] reported a polyphenol content of 33.68 mg GAE/g, while Jeong et al. [30] discovered polyphenol contents ranging from 55.23 to 98.27 mg GAE/g for peppermints from various countries. In the case of strawberry mint, we did not find any relevant literature for comparison. Nanda et al. [31] mention it in their scientific communication but only describe its botanical properties.

Numerous antioxidants, such as caffeine, theobromine, and theophylline, as well as soluble phenolic compounds (phenolic acids, catechin, epicatechin, and proanthocyanidins) and insoluble polymeric phenolics (catechin, epicatechin, and theophylline) are found in cocoa [32]. Using the Folin-Ciocalteu method, Razola-Diaz et al. [33] measured the GAE/g total polyphenol contents of various cocoa powders from different growing regions. These results ranged between 9.2 and 57.4 mg.

3.2. Antioxidant content of raw and baked sponge cakes

In general, processed food products have lower nutritional values than their fresh or less-processed counterparts because of the losses that occur during processing. Consequently, the antioxidant activity and phytochemical concentrations of the product may be impacted by food processing. The majority of food processing involves high-temperature unit operations like blanching, boiling, steaming, microwaving, extrusion, drying, frying, or baking. The effects of heat processing on food production lines result in a range of differences in antioxidant activity and phytochemical concentration, but these changes are generally substantial regardless of the conditions of the process or the nature of the goods (or ingredients) [34].

The total antioxidant content of raw and baked sponge cakes, including baking losses, are shown in Table 3.

Each of the enriched samples had a higher antioxidant content than the control sponge cake, proving that Dutch cocoa powder and particular herbs are effective at increasing the antioxidant and polyphenol content of confectionery goods.

The 5% raw spearmint cake had the highest level of antioxidants (5.21 mg AAE/g), while the raw 1% strawberry mint sample had the lowest level (1.77 mg AAE/g).

The same is true for the baked sponge cakes; the 5% spearmint sample had the highest antioxidant value (4.00 mg AAE/g), while the 1% strawberry mint cake had the lowest (1.56 mg AAE/g). It can be seen that spearmint displayed an outlier compared to the other herbal samples added at 5%, both for raw and baked goods. However, it can generally be said - examining the group of samples containing each herb separately-that the antioxidant content increased proportionally with the increase in % of the added herbs. There are many successful examples in the literature of increasing the total antioxidant content of confectionery products with plant additives. Some publications have reported a linear relationship between the amount of antioxidants and phenolic compounds in plants [35–37]. Song et al. [5] enriched the sponge cakes with black carrot flour and with the addition of 4% flour they achieved a detectable change in antioxidant and polyphenol content. Nhung et al. [38] added powdered green tea extract to the sponge cakes and the dose increase resulted in higher antioxidant and polyphenol content, however, these compounds were not tested in the control cakes.

The heat-sensitive nature of the tested compound groups made it crucial to identify which sample lost the fewest antioxidants while baking. Based on Tables 3 and it can be seen that the control and cocoa sponge cakes suffered the greatest baking losses, while the antioxidant compounds of the sample containing 5% strawberry mint suffered the least losses (10.37%).

Table 2
Total antioxidant and polyphenol content of mint species and cocoa powder (n = 3), different letters (a, b, c, and d) denote significant differences ($p \leq 0.05$).

Supplementary materials	TAC mg AAE/g	TPC mg GAE/g
Peppermint	73.97 ± 1.16^a	24.59 ± 1.81^a
Spearmint	98.50 ± 8.79^b	26.91 ± 1.76^a
Strawberry mint	64.61 ± 2.28^c	22.06 ± 1.42^b
Cocoa powder	24.78 ± 0.74^d	13.43 ± 0.65^c

Table 3
Total antioxidant content of raw and baked sponge cakes (n = 3), and the baking loss of antioxidants, different letters (a, b, c, d, e, f, g and h), and symbols (*, **) denote significant differences (p ≤ 0.05).

Sponge cake type	TAC mg AAE/g		Baking loss (%)
	Raw dough	Baked sponge cake	
Control	1.42 ± 0.06^{a,*}	0.81 ± 0.06^{a,**}	42.96
Cocoa control	2.04 ± 0.11^{b,*}	1.16 ± 0.26^{b,**}	43.14
Peppermint 1%	2.78 ± 0.10^{c,*}	1.84 ± 0.18^{c,**}	32.74
Peppermint 3%	3.27 ± 0.06^{d,*}	2.79 ± 0.14^{d,**}	14.68
Peppermint 5%	4.13 ± 0.37^{e,*}	2.82 ± 0.11^{d,**}	31.72
Spearmint 1%	2.62 ± 0.09^{c,*}	1.84 ± 0.37^{c,**}	29.78
Spearmint 3%	3.45 ± 0.14^{d,*}	3.09 ± 0.02^{e,**}	10.44
Spearmint 5%	5.21 ± 0.15^{f,*}	4.00 ± 0.08^{f,**}	23.23
Strawberry mint 1%	1.77 ± 0.09^{g,*}	1.56 ± 0.06^{g,*}	11.87
Strawberry mint 3%	2.35 ± 0.17^{h,*}	2.07 ± 0.07^{c,*}	11.92
Strawberry mint 5%	3.28 ± 0.18^{d,*}	2.94 ± 0.16^{e,*}	10.37

3.3. Polyphenol content of raw and baked sponge cakes

The total polyphenol contents of unbaked and baked sponge cakes, including baking losses, are shown in Table 4.

The 5% peppermint samples had the highest polyphenol content (2.07 mg GAE/g), but samples of strawberry mint and spearmint also had high values in the case of raw doughs enriched with medicinal herbs. The least amount of polyphenols (1.73 mg GAE/g) was found in the dough containing 1% spearmint. Additionally, the samples with the highest concentrations of polyphenols (1.87 mg/GAE g) in the baked sponge cakes with herbs were the goods with the 3% and 5% spearmint. The least amount of polyphenols (1.20 mg GAE/g) was found in the 1% strawberry mint cake. In comparison to the other two herbal sponge cakes, spearmint had a very low baking loss due to its high polyphenol content. The polyphenol content of the raw doughs with cocoa and 1% herbal enrichment did not significantly change, but the 3% and 5% herbal enrichment clearly showed an increase. Drabińska et al. [6] added broccoli leaves to gluten-free mini sponge cakes, and as the amount of broccoli was increased, the samples' polyphenol content also increased. *Clitoria ternatea* extract was added by Pasukamonset et al. [39] to the sponge cakes, and as the extract concentration increased, so did the cakes' antioxidant and polyphenol content. When green, white, and ginger tea extracts were combined and added to sponge cakes by Pourzafar et al. [9], the polyphenol content of each cake increased.

In both the control and the cocoa sponge cakes, the baking loss was the greatest. The sponge cake with 3% spearmint addition (0.54%) showed the least amount of polyphenol loss, and the 1% strawberry mint sample had the highest loss (25.5%). The loss of phenolic compounds during food production and storage is almost unavoidable because they are volatile and sensitive to environmental factors [40].

3.4. Sensorial test results

Table 5 1 shows the result of the sensorial test. The herbal addition had a negligible impact on the shape, color, and texture of the sponge cakes, according to the results. The 5% dosage had a noticeable negative impact on the products' fragrance in the case of peppermint and spearmint. Because not everyone enjoys the distinct mint flavor, the taste of the sponge cakes divided the reviewers. The majority of reviewers reported positive effects from the 1% dosage, but the 3% and 5% dosages had very strong mint flavors. Overall, it can be said that the reviewers preferred the taste of spearmint in the products over the other 3 types of added mint however, there are no statistically significant differences for the individual parameters.

Table 4
Total polyphenol content of raw and baked sponge cakes (n = 3), and the baking loss of phenolic components, different letters (a, b, c, d, e, and f), and symbols (*, **) denote significant differences (p ≤ 0.05).

Sponge cake type	TPC mg GAE/g		Baking loss (%)
	Raw dough	Baked sponge cake	
Control	1.02 ± 0.02^{a,*}	0.62 ± 0.02^{a,**}	39.22
Cocoa control	1.72 ± 0.02^{b,*}	1.12 ± 0.03^{b,**}	34.89
Peppermint 1%	1.75 ± 0.05^{b,*}	1.37 ± 0.09^{c,**}	21.72
Peppermint 3%	1.95 ± 0.02^{c,*}	1.66 ± 0.03^{d,**}	14.88
Peppermint 5%	2.07 ± 0.08^{d,*}	1.62 ± 0.03^{d,**}	21.74
Spearmint 1%	1.73 ± 0.06^{b,*}	1.66 ± 0.03^{d,*}	4.05
Spearmint 3%	1.88 ± 0.05^{c,*}	1.87 ± 0.04^{e,*}	0.54
Spearmint 5%	1.94 ± 0.10^{c,d,*}	1.87 ± 0.06^{e,*}	3.61
Strawberry mint 1%	1.75 ± 0.02^{b,**}	1.20 ± 0.03^{f,**}	25.15
Strawberry mint 3%	1.89 ± 0.04^{c,**}	1.49 ± 0.05^{c,**}	21.17
Strawberry mint 5%	1.89 ± 0.05^{c,**}	1.68 ± 0.04^{d,**}	11.12

Table 5
The results of the sensory examination of the sponge cakes (average ± standard deviations).

	Parameters					
Sponge cake type	Shape	Color	Texture	Fragrance	Taste	Total impression
Control	4.75 ± 0.44	4.69 ± 0.59	4.58 ± 0.50	4.50 ± 0.80	4.61 ± 0.67	4.49 ± 0.78
Cocoa control	4.73 ± 0.50	4.75 ± 0.51	4.59 ± 0.58	4.27 ± 0.79	4.31 ± 0.83	4.16 ± 0.71
1% peppermint	4.75 ± 0.51	4.50 ± 0.57	4.58 ± 0.61	4.28 ± 0.77	4.00 ± 1.21	3.90 ± 0.82
3% peppermint	4.59 ± 0.67	4.41 ± 0.67	4.42 ± 0.61	4.13 ± 0.91	3.77 ± 1.12	3.65 ± 0.90
5% peppermint	4.72 ± 0.58	4.72 ± 0.46	4.21 ± 0.74	3.97 ± 1.03	3.45 ± 1.12	3.26 ± 0.78
1% spearmint	4.66 ± 0.60	4.56 ± 0.67	4.48 ± 0.76	4.28 ± 0.77	4.16 ± 0.86	4.07 ± 0.73
3% spearmint	4.59 ± 0.61	4.47 ± 0.62	4.52 ± 0.51	4.25 ± 0.80	4.06 ± 0.89	4.00 ± 0.82
5% spearmint	4.56 ± 0.72	4.38 ± 0.71	4.42 ± 0.83	3.88 ± 1.01	3.42 ± 1.12	3.29 ± 0.88
1% strawberry mint	4.44 ± 0.80	4.41 ± 0.71	4.24 ± 0.79	4.09 ± 0.96	3.94 ± 0.96	3.86 ± 1.08
3% strawberry mint	4.53 ± 0.67	4.59 ± 0.56	4.18 ± 0.73	4.09 ± 0.78	3.65 ± 0.84	3.53 ± 0.99
5% strawberry mint	4.38 ± 0.83	4.59 ± 0.67	4.21 ± 0.74	4.21 ± 0.79	3.42 ± 1.06	3.29 ± 1.06

4. Conclusion

Based on the results, Dutch cocoa powder and mints have also proven to be an excellent source of antioxidants and polyphenols. By comparing the results, it can be concluded that the tested species of mint contain different amounts of the measured components. Antioxidants and polyphenols are usually heat-sensitive compounds, so maybe sponge cakes lose these analytes during baking, however, the use of herbs and cocoa powder still resulted in favorable properties in confectionery products. The baking loss of these compounds in the sponge cake samples was decreased after the addition of herbs, but this value was also influenced by the type of used mint. Due to the compounds' heat sensitivity—part of them decompose or change during baking—there were more antioxidant and polyphenolic compounds in the raw sponge dough. Overall, it can be concluded that the used mint and cocoa powder were suitable for enhancing confectionery products because they markedly increased their antioxidant and polyphenol content despite the detrimental effects of baking. The intense taste of mint is divisive among consumers, however, the 1% dosage does not result in such an intense taste that it negatively affects the product. Among the three types of used mint, spearmint was preferred during the sensory test.

5. Ethics statement

All regulations were followed, and consent was sought and obtained from all panelists. Sensory tests did not require ethical approval.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contribution statement

Beatrix Sik: Analyzed and interpreted the data; Wrote the paper.
Krisztina Kovács: Performed the experiments.
Erika Lakatos: Analyzed and interpreted the data.
Viktória Kapcsándi: Contributed reagents, materials, analysis tools or data.
Rita Székelyhidi: Conceived and designed the experiments; Wrote the paper.

Data availability statement

Data included in article/supp. material/referenced in article.

Ethical Statement for heliyon

Hereby, I/insert author name/consciously assure that for the manuscript/insert title/the following is fulfilled.

1) This material is the authors' own original work, which has not been previously published elsewhere.
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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Not relevant.

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