

RESEARCH ON THE DEVELOPMENT OF A LOW CARB MINI-BAGUETTE FORTIFIED WITH *SPIRULINA* POWDER, INTENDED FOR DIABETICS AND OBESE INDIVIDUALS

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Abstract

Diabetes mellitus is a condition with a high incidence both nationally and internationally. In Romania, according to data provided by the Romanian Society of Diabetes, Nutrition, and Metabolic Diseases, 1 in 10 romanians suffer from diabetes mellitus. In diabetes and obesity, diet is an essential therapeutic element, and therefore, the development of low-carb bakery products is of real interest. This paper presents research on the development of a mini-baguette fortified with Spirulina powder (fortification levels 1-4%), intended for diabetics and obese individuals. The low-carb mini-baguette fortified with 4% Spirulina powder exhibits superior sensory qualities and has the lowest total carbohydrate content (39.47%) and available carbohydrates (30.57%). It stands out due to its protein content (13.98%), total fiber (8.90%), mineral elements (K =315.67 mg/100 g; Mg =92.85 mg/100 g; Ca =68.47 mg/100 g; Fe = 3.576 mg/100 g; Zn = 2.387 mg/100 g), total polyphenols (158.75 mg GAE/100 g) and demonstrates antioxidant capacity (182.45 mg Trolox Equivalents/100 g).

Key words: fortification, mini-baguette, Spirulina, diabetics, obese.

INTRODUCTION

Significant increases in the prevalence of physiological dysfunctions are caused by a sedentary lifestyle, along with an unbalanced diet and contaminants resulting from soil and environment pollution (d'Angelo et al., 2019).

According to data from the World Health Organization (WHO), approximately 200 million men and 300 million women worldwide are classified as obese, while around 1.5 billion people are classified as overweight (WHO, 2024).

Excess weight and obesity are contributing factors to the development of metabolic syndrome, which increases the risk of diabetes, atherosclerosis, liver diseases, brain disorders, and cancer. All these disorders share a predominant feature: low-grade inflammation caused by overnutrition, which can be diagnosed at the molecular level (Hatch-McChesney & Smith, 2023).

According to statistics, in 2021, 537 million adults aged 20–79 worldwide were affected by diabetes.

In Europe, 61 million people were affected by diabetes in the same year. By 2030, the global number of people with diabetes is expected to rise to around 643 million, and in Europe to about 67 million (IDF Diabetes Atlas 10th edition, 2021; <http://www.idf.org/EU-diabetes-policy-audit>). In Romania, 2021 recorded a record number of diagnosed diabetes cases: approximately 1.5 million.

Of these, the majority are cases of type 2 diabetes, specifically 83.9% of the total cases reported by diabetes specialists.

In terms of prevalence, Romania is close to the European average, slightly below it: in Romania, 1 in 12 adults has diabetes, compared to 1 in 11 adults in Europe (<https://www.rodiaabet.ro/barometrul-datelor-privind-diabetul-zaharat-in-romania-1-din-12-romani-are-diabet-zaharat/>).

The prevalence of diet-related chronic diseases, such as obesity and type 2 diabetes, has led to the development of starch-rich foods with added functional ingredients, aimed at controlling starch digestibility and providing health benefits (Torres et al., 2024).

Thus, bread formulation can be modified by adding functional ingredients such as phytochemicals and dietary fiber (Onacik-Gür et al., 2022). Dietary fibers are biopolymers resistant to digestion in the small intestine but can be fermented in the large intestine (Zhou et al., 2021). Depending on their water solubility, dietary fibers are classified as soluble and insoluble fibers. In bread formulations, the addition of soluble fibers improves dough texture, lowers cholesterol levels, and reduces postprandial blood glucose (Ferreira et al., 2021). Inulin and methylcellulose are often used in the composition of starch-rich products (Papagianni et al., 2024). Catană et al. (2022) developed and qualitatively characterized a product called "Mini baguette fortified with Jerusalem artichoke flour" intended for people with diabetes and obesity. This mini baguette has a reduced carbohydrate content (48.64-49.17%) and available carbohydrates (43.93-44.37%), but a high content of proteins (11.60-12.15%) and fiber (4.43-4.99%).

This paper presents research on the development of a mini-baguette fortified with *Spirulina* powder (fortification levels 1-4%), intended for diabetics and obese individuals.

MATERIALS AND METHODS

Materials

To obtain the product "Low carb mini-baguette fortified with *Spirulina* powder", natural sourdough fortified with *Spirulina* powder, whole wheat flour, white wheat flour type 650, butter 65% fat, milk 1.5% fat, ground Pecan nut, freeze-dried fruits (cranberries, raspberries, etc.), *Spirulina* powder, white sesame seeds, sea salt, and other ingredients rich in proteins and dietary fiber were used.

For the control sample ("White mini baguette"), the following materials were used: natural sourdough, white wheat flour, butter 65% fat, milk 1.5% fat, white sesame and black sesame seeds, and sea salt. Figure 1 shows the natural sourdough fortified with *Spirulina*

powder, along with the yeast and lactic acid bacteria present in its composition.

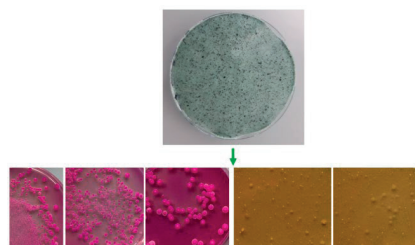


Figure 1. "Natural sourdough fortified with *Spirulina* powder" and its composition with yeasts and lactic acid bacteria

it was developed and tested at the Human Nutrition Laboratory in IBA-Bucharest. The *Spirulina* powder was produced and provided by Arborvitae S.R.L.

Mini baguette-making

For the development of the "Low carb mini-baguette fortified with *Spirulina* powder," four experimental variants were created (Figures 2-6), corresponding to the levels of fortification with *Spirulina* powder: 1%, 2%, 3%, and 4%. In parallel, a control variant was used ("White mini baguette"- C) (Figure 2).



Figure 2. The "White mini baguette" (Control sample)

For the development of the bakery products, a biphasic method was applied. This method ensures superior sensory qualities (appearance, taste and aroma), good protein digestibility, high bioavailability of minerals (Fe, Ca, Mg, Zn, etc.) and bioactive compounds, as well as a reduced glycemic impact after the consumption and digestion of the mini-baguettes (Catană et al., 2022; Ribet et al., 2022).

Methods

Statistical Analysis

"Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and "White mini baguette" (Control sample) were

analyzed in triplicate, and the obtained results are presented as the arithmetic mean and standard deviation.



Figure 3. "Low carb mini-baguette fortified with *Spirulina* powder" - V1



Figure 4. "Low carb mini-baguette fortified with *Spirulina* powder" - V2

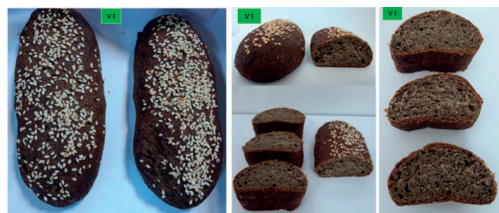


Figure 5. "Low carb mini-baguette fortified with *Spirulina* powder" - V3



Figure 6. "Low carb mini-baguette fortified with *Spirulina* powder" - V4

Sensory analysis

The sensory analysis of the "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and "White mini baguette" (Control sample) it was done by evaluating the sensory characteristics (appearance, color, taste, and smell) and by "Comparison method with unitary score scales" method (Burnete et al., 2020).

Instrumental analysis of color (L^* , a^* and b^*) was performed with CM-5 colorimeter (Konica Minolta, Japan), using SpectraMagic NX software.

Instrumental texture analysis was performed with Instron Texture Analyzer (model 5944, Illinois Tool Works Inc., USA) equipped with Bluehill 3.13 software.

Physico-chemical analysis

Nutritional composition of the mini-baguette samples it was determined by the method AOAC: 979.09 (protein content), 963.15 (fat content), 923.03 (ash content) and 985.29 (total dietary fiber). Moisture content of the mini-baguette samples was determined by Halogen Moisture Analyzer HE53 (Mettler Toledo). Total carbohydrates were calculated with the formula: 100 (%) - moisture (%) - protein (%) - fat (%) - total dietary fiber (%). The energy value is calculated using the conversion factors of 9 kcal/g for fat, 4 kcal/g for carbohydrates and protein, and 2 kcal/g for fiber, in accordance with the provisions of Commission Regulation no. 1169/2011 (European Commission, 2011).

Determination of iron, copper, manganese and zinc was performed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS, model NexION300Q, Perkin Elmer) after dry digestion of the samples. The determination of sodium, potassium, calcium and magnesium was carried out by High-Resolution Continuum Source Atomic Absorption Spectrometry (Analytik Jena, model contraAA 700 - High-Resolution Continuum Source Atomic Absorption Spectrometer), flame technique, after dry digestion of the samples.

Bioactive compounds content

The determination of the total polyphenol content was carried out using the Folin-Ciocalteu spectrophotometric method, according to Horszwald and Andlauer (2011), with some modifications (extraction medium, extraction mode and time, volume of extract used in analysis) using a UV-VIS Jasco V 550 spectrophotometer, at a wavelength of $\lambda = 755$ nm. For quantification, a calibration curve of gallic acid in the concentration range of 0-0.20 mg/mL was used, and the results were expressed as mg of Gallic Acid Equivalents (GAE) per g of product. The content of total carotenoids was determined using a spectrophotometric method (Chinnadurai et al., 2013).

Antioxidant capacity

Antioxidant capacity was assessed using the DPPH (1,1-diphenyl-2-picryl hydrazyl) method, according to Horszwald and Andlauer (2011), with some modifications (extraction medium, extraction mode and time, volume of extract used in analysis), using a UV-VIS Jasco V 550 spectrophotometer at a wavelength of $\lambda = 517$ nm. For quantification, a calibration curve of Trolox (6-Hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic Acid) in the concentration range of 0-0.4375 mmol/L was used, and the results were expressed as μmol Trolox Equivalents per g of cauliflower stalks powder.

Microbiological analysis

The microbiological analysis of cauliflower stalks powder was carried out using the following methods: SR ISO 21527-1:2009 (Yeasts and molds), SR EN ISO 21528-1:2017 method (Enterobacteriaceae), ISO 21807:2004 (Water activity). Water activity was determined using Aquaspector AQS 31 equipment.

RESULTS AND DISCUSSIONS

Sensory analysis

As a result of the sensory analysis of the "Low carb mini-baguette fortified with *Spirulina* powder," it was found that the addition of *Spirulina* powder (fortification levels of 1%, 2%, 3%, and 4%) in its composition does not affect the taste and smell/aroma. Thus, the mini-baguettes fortified with this microalga, at the specified concentrations, have a pleasant taste and smell/aroma, characteristic of a well-baked bakery product with added *Spirulina* powder. Moreover, the "Low carb mini-baguette fortified with *Spirulina* powder" has an elastic, dense crumb, with uniform pores, brown in color with a purplish tint, and without clumps.

The addition of ingredients necessary for lowering the glycemic index and increasing the antioxidant potential causes the product "Low carb mini-baguette fortified with *Spirulina* powder" to have a darker color compared to the "White mini baguette" (Control sample), which is reflected in the decrease in L^* brightness by 1.40-1.47 times (Figure 7).

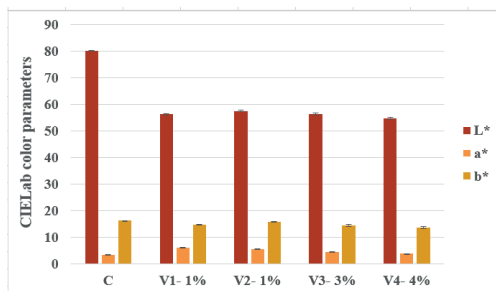


Figure 7. Color parameters of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and of the Control sample (C)

The instrumental texture analysis revealed that, after 7 days from the production date, the firmness of the "Low carb mini-baguette fortified with *Spirulina* powder" product is similar to that of the "White mini baguette" (Control sample):

- "White mini baguette" (Control sample) - Firmness = 23.48 N;
- "Low carb mini-baguette fortified with *Spirulina* powder" (V1) - Firmness = 23.30 N;
- "Low carb mini-baguette fortified with *Spirulina* powder" (V2) - Firmness = 18.24 N;
- "Low carb mini-baguette fortified with *Spirulina* powder" (V3) - Firmness = 20.43 N;
- "Low carb mini-baguette fortified with *Spirulina* powder" (V4) - Firmness = 23.48 N.

Figures 8-12 present the compression curves obtained for the "Low carb mini-baguette fortified with *Spirulina* powder" product, following the instrumental texture analysis, 7 days after the production date.

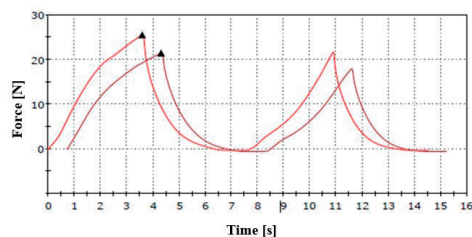


Figure 8. Compression curves for the "Control sample"

Firmness is sensorily correlated with the softness of the crumb: a lower firmness represents a crumb with a soft texture, while a higher firmness represents a denser, firmer crumb. Therefore, firmness is an important

sensory characteristic that defines the sensory quality of bakery products.

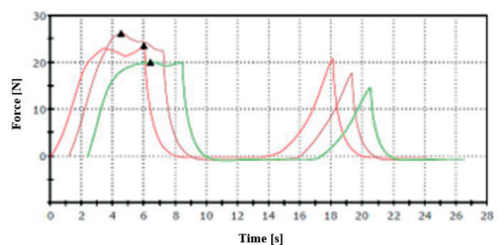


Figure 9. Compression curves for the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1)

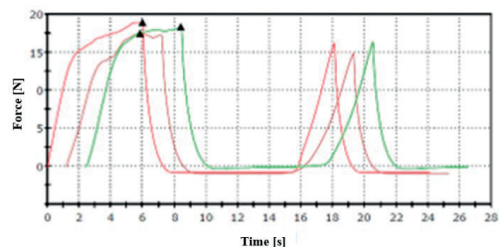


Figure 10. Compression curves for the product "Low carb mini-baguette fortified with *Spirulina* powder" (V2)

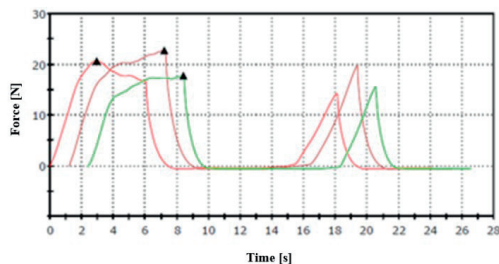


Figure 11. Compression curves for the product "Low carb mini-baguette fortified with *Spirulina* powder" (V3)

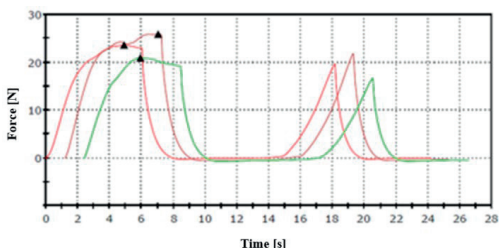


Figure 12. Compression curves for the product "Low carb mini-baguette fortified with *Spirulina* powder" (V4)

As a result of the sensory evaluation, using the "Method of comparison with unitary scoring scales," the products "White mini baguette" (Control sample) and "Low carb mini-baguette

fortified with *Spirulina* powder" (V1, V2, V3, V4) received the rating "very good," with the following scores (Figure 13):

- Control sample - 20 points
- V1 - 19.52 points
- V2 - 19.44 points
- V3 - 19.28 points
- V4 - 19.04 points.

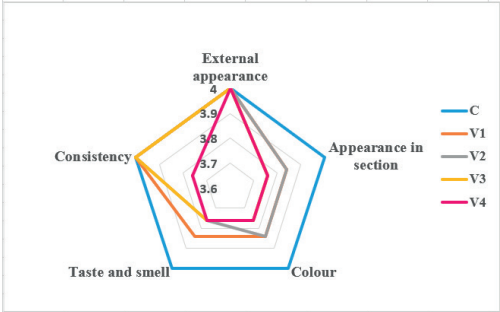


Figure 13. Sensory evaluation of the product "Low carb mini-baguette fortified with *Spirulina* powder" and of the Control sample

Physico-chemical analysis

The physico-chemical composition of the product "Low carb mini-baguette fortified with *Spirulina* powder" and of the Control sample is presented in Table 1.

Table 1. Physico-chemical composition of the product "Low carb mini-baguette fortified with *Spirulina* powder" and of the Control sample

Component	C	V1	V2	V3	V4
Acidity (degrees)	3.7±0.03	3.10±0.03	3.20±0.03	3.30±0.03	3.4±0.03
Moisture (%)	34.09±0.82	35.17±0.84	35.42±0.85	35.85±0.86	36.45±0.87
Ash (%)	0.84±0.01	2.11±0.04	2.19±0.04	2.28±0.04	2.35±0.04
Protein (%)	9.65±0.12	12.87±0.18	13.23±0.19	13.61±0.19	13.98±0.20
Fat (%)	1.88±0.02	7.56±0.08	7.63±0.08	7.70±0.08	7.75±0.08
Carbohydrates (%)	53.54±0.04	42.29±0.03	41.53±0.03	40.56±0.03	39.47±0.39
Available carbohydrates (%)	52.73±0.04	33.61±0.02	32.77±0.02	31.72±0.02	30.57±0.25
Total dietary fiber (%)	0.81±0.01	8.68±0.16	8.76±0.16	8.84±0.16	8.90±0.16
Salt (NaCl) (%)	0.70±0.004	0.74±0.005	0.68±0.004	0.72±0.005	0.69±0.004
Energy value (kcal/100g)	268	271	270	268	266
Energy value (kJ/100g)	1137	1139	1134	1126	1115

According to the results, the product "Low carb mini-baguette fortified with *Spirulina* powder" has a reduced content of carbohydrates, specifically available carbohydrates, but a high content of protein, ash, and total fibers compared to the Control sample. The highest values for protein, ash, and total fiber content were recorded in the experimental variant V4, which corresponds to the maximum level of fortification with *Spirulina* powder, namely 4%. The protein content of the "Low carb mini-baguette fortified with *Spirulina* powder" (V4) is comparable to the one reported by Fratelli et al. (2023) for wheat bread fortified with

Spirulina (fortification level of Spirulina powder in wheat flour: 3%): 14.96 g/100 dry matter. The "Low carb mini-baguette fortified with *Spirulina* powder" is a source of protein, as, according to the provisions of Regulation (EC) No 1924/2006 of the European Parliament and of the Council, at least 12% (in this case 19.06-21.02%) of its energy value comes from proteins. The ash content of the "Low carb mini-baguette fortified with *Spirulina* powder" is 1.36-1.52 times higher compared to the one reported by Tătaru and Iatco (2024) for the "Mini baguette fortified with *Spirulina*" (1.55%). At the same time, the total dietary fiber content of the "Low carb mini-baguette fortified with *Spirulina* powder" is about 2.3 times higher, comparable to the value reported by Tătaru and Iatco (2024) for the "Mini baguette fortified with *Spirulina*" (3.75%). It is noteworthy that the product "Low carb mini-baguette fortified with *Spirulina* powder" is rich in fiber, in accordance with the provisions of Regulation (EC) No. 1924/2006 of the European Parliament and of the Council, having a fiber content greater than 6 g/100 g. The carbohydrate content, specifically available carbohydrates, of the product "Low carb mini-baguette fortified with *Spirulina* powder" varied between 39.47% and 42.29%, and 30.57%–33.61%, respectively, which are lower than those reported by Burnete et al. (2020) for the product "Hypoglycemic bread with antioxidant potential" (carbohydrates=42.64%; available carbohydrates=39.49%) and those reported by Fratelli et al. (2023) for wheat bread fortified with *Spirulina* (fortification level of *Spirulina* powder in wheat flour: 3%) (carbohydrates = 57.30 %). Due to its high content of proteins and fibers and its low content of carbohydrates and available carbohydrates, the product "Low carb mini-baguette fortified with *Spirulina* powder" is suitable for the diet of diabetics and obese individuals, as it ensures quick and stable satiety and, at the same time, has a low glycemic impact after consumption and digestion. The product "Low carb mini-baguette fortified with *Spirulina* powder" is an important source of minerals (K, Ca, Mg, Zn, and Fe). The mineral element content of this product is presented in Figures 13 and 14.

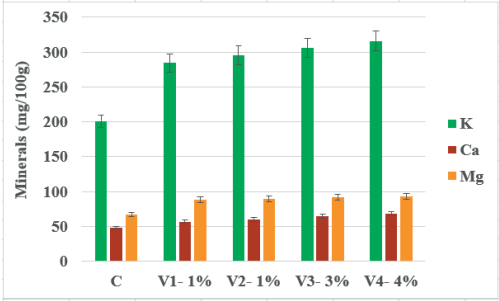


Figure 13. Mineral content (K, Ca and Mg) of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and of the Control sample

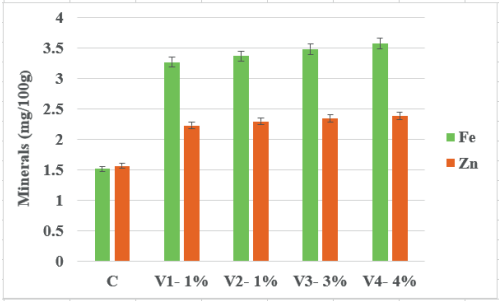


Figure 14. Mineral content (Fe and Zn) of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and of the Control sample

The potassium content of the product "Low carb mini-baguette fortified with *Spirulina* powder" ranged between 284.48-315.67 mg/100 g, with the highest value recorded in the experimental variant V4 (fortification level with *Spirulina* powder: 4%). The potassium content of this *Spirulina*-fortified mini-baguette is 1.59-1.76 times higher compared to the one reported by Fratelli et al. (2023) for wheat bread fortified with *Spirulina* (fortification level of *Spirulina* powder in wheat flour: 3%) which was 178.85 mg/100 dry matter. Additionally, the potassium content of this mini-baguette is higher compared to that reported by Catană et al. (2022) for the product "Mini baguette fortified with Jerusalem artichoke flour," which was 260.85 mg/100 g. The calcium content of the product "Low carb mini-baguette fortified with *Spirulina* powder" ranged from 56.60 to 68.47 mg/100 g, being significantly higher (7.09-8.58 times) compared to the calcium content reported by Fratelli et al. (2023) for formulated bread with *Spirulina*

residual biomass, which was 7.98 mg/100 dry matter.

The magnesium content of the product "Low carb mini-baguette fortified with *Spirulina* powder" is 1.36-1.56 times higher than its calcium content.

The iron (Fe) content of the product "Low carb mini-baguette fortified with *Spirulina* powder" is 1.53-1.63 times higher than that reported by Fratelli et al. (2023) for wheat bread fortified with *Spirulina* (fortification level with *Spirulina* powder in wheat flour: 3%), which was 2.20 mg/100 dry matter.

The zinc content of the product "Low carb mini-baguette fortified with *Spirulina* powder" is lower compared to its iron content, ranging between 2.23-2.39 mg/100 g. Bread is a staple food in countries around the world and is therefore important in nutrition. The metabolic effect of bread depends on several qualitative aspects, from the type of cereal, its carbohydrate content, and other nutrients, to its chemical structure and processing. The qualitative aspects of bread are best captured by its content of dietary fiber, whole grains, sugars, etc. (Ludwig et al., 2018; Pagliai et al., 2021). Therefore, it is very important for bread and bakery products (mini-baguettes, croissants, rolls, etc.) to have a high content of mineral elements.

Bioactive compounds content

Due to the valuable ingredients used in the composition of the fortified mini-baguettes (*Spirulina* powder, freeze-dried cranberries and raspberries, etc.), the product "Low carb mini-baguette fortified with *Spirulina* powder" stands out for its content of total polyphenols and total carotenoids. The total polyphenol content of this product ranged from 131.87 to 148.93 mg/100 g, with the highest value recorded in the experimental variant V4 (fortification level with *Spirulina* powder: 4%) (Figure 15). The polyphenol content of this *Spirulina*-fortified mini-baguette is 1.49-3.3 times higher compared to that reported by Hernández-López et al. (2023) for *Spirulina*-fortified bread (fortification levels: 1.5% and 2.5%): 40-100 mg GAE/100 dry weight).

In recent years, dietary polyphenols have gained significant interest among researchers due to their chemopreventive/protective

potential in maintaining human health and preventing diseases.

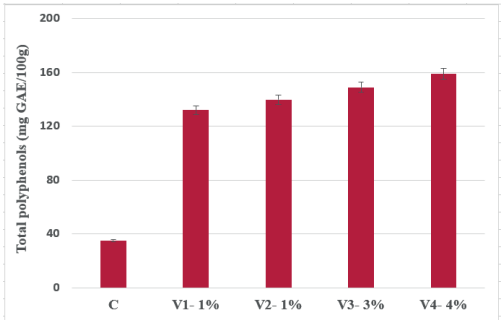


Figure 15. Total polyphenols of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and of the Control sample

It is believed that dietary polyphenols/flavonoids exert a strong antioxidant action to protect against reactive species and cellular oxidative stress, aiming to prevent pathological conditions or diseases associated with oxidative stress. Preclinical and clinical evidence suggests that following long-term polyphenol-rich diets provides protection against the development of various chronic diseases (neurodegenerative diseases, cardiovascular diseases, cancer, diabetes, etc.) (Rudrapal et al., 2022).

Figure 16 shows the total carotenoid content of the *Spirulina*-fortified mini-baguette.

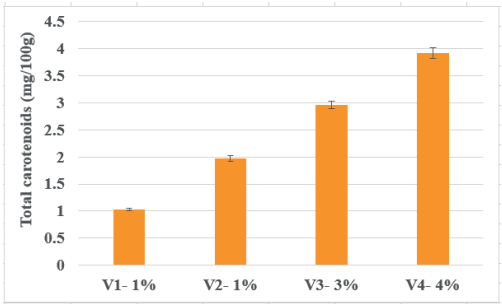


Figure 16. Total carotenoids of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4)

The product "Low carb mini-baguette fortified with *Spirulina* powder" stands out due to its total carotenoid content: 1.03-3.92 mg/100 g (the highest value was recorded in the experimental variant V4).

The carotenoid content of the *Spirulina*-fortified mini-baguette (with a fortification level of 4%) is comparable to that reported by Dipra et al. (2020) for gluten-free bread fortified with *Chlorella sorokiniana* powder (fortification level 2.5%): 4.72 mg/100 g. The total carotenoid content of the "Low carb mini-baguette fortified with *Spirulina* powder" (V3 and V4) is higher compared to that reported by Chikpah et al. (2025) for bread fortified with pumpkin flour (wheat flour 85%; pumpkin flour 15%): 2.46 mg/100 g d.b.

Carotenoids have been associated with a range of health benefits. Their dietary intake and circulating levels have been linked to a reduced incidence of obesity, diabetes, certain types of cancer, and even lower overall mortality (Eroglu et al., 2023).

Considering the beneficial effects of antioxidants (polyphenols, carotenoids, etc.) on the human body, the fortification of bread and bakery products with functional ingredients rich in antioxidants is very important.

Antioxidant capacity

Due to its content in antioxidants (phenolic compounds, carotenoids, the product "Low carb mini-baguette fortified with *Spirulina* powder" has antioxidant capacity (Figure 17).

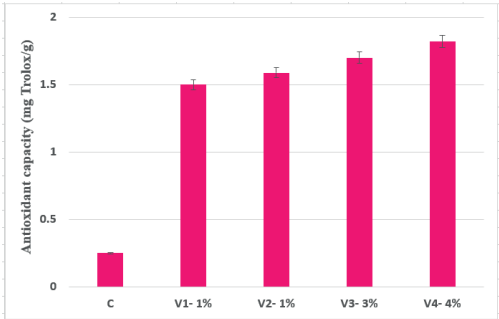


Figure 17. Antioxidant capacity of the product "Low carb mini-baguette fortified with *Spirulina* powder" (V1, V2, V3, V4) and of the Control sample

The highest value of antioxidant capacity was recorded in the experimental variant V4: 1.82 mg Trolox/g. Due to the ingredients used to reduce the carbohydrate content, increase the nutritional value, and enhance the content of bioactive compounds (polyphenols, carotenoids), the product "Low carb mini-

baguette fortified with *Spirulina* powder" has an antioxidant capacity 6-7.28 times higher compared to the Control sample. Moreover, this type of mini-baguette has an antioxidant capacity comparable to that reported by Burnete et al. (2020) for the product "Hypoglycemic bread with antioxidant potential": 1.25 mg Trolox/g.

Considering the results obtained from the sensory analysis, physicochemical properties, content of bioactive compounds, and antioxidant capacity, the experimental variant V4 of the product "Low carb mini-baguette fortified with *Spirulina* powder" was selected as the optimal variant.

Microbiological analysis

The microbiological indicators of the "Low carb mini-baguette fortified with *Spirulina* powder" and of the Control sample are presented in Table 2. The results of the microbiological analysis confirmed the fact that these products fall within the provisions of the legislation in force.

Table 2. Microbiological analysis of the product "Low carb mini-baguette fortified with *Spirulina* powder" and of the Control sample

Microbiological indicators	Control sample	"Low carb mini-baguette fortified with <i>Spirulina</i> powder"				
		V1	V2	V3	V4	
Yeast and molds (CFU/g)	< 10	< 10	< 10	< 10	< 10	
<i>Enterobacteriaceae</i> (CFU/g)	< 10	< 10	< 10	< 10	< 10	
Water activity	0.908	0.915	0.920	0.925	0.936	

The water activity of the products ranged from 0.908 to 0.936. Based on the results of the microbiological analyses, sensory evaluation, and instrumental texture analysis, the shelf life of the product "Low carb mini-baguette fortified with *Spirulina* powder" was set at 3 days.

CONCLUSIONS

The product "Low carb mini-baguette fortified with *Spirulina* powder" has corresponding sensory qualities, high nutritional value, and presents antioxidant capacity, making it suitable for the diet of diabetics and obese individuals. Thus, this mini-baguette features a low content of carbohydrates (39.47-42.29%) and available carbohydrates (30.57-33.61%) and stands out with its protein content (12.87-13.98%), total dietary fiber (8.68-8.90%), and minerals (K: 284.48-315.67 mg/100 g; Ca:

56.60-68.47 mg/100 g; Mg: 88.01-92.85 mg/100 g; Fe: 3.27-3.58 mg/100 g; Zn: 2.23-2.39 mg/100 g). Additionally, the "Low carb mini-baguette fortified with *Spirulina* powder" is remarkable for its content of bioactive compounds: total polyphenols (131.87-148.93 mg/100 g) and total carotenoids (1.03-3.92 mg/100 g). Due to its antioxidant content, this product exhibits antioxidant capacity (1.50 - 1.82 mg Trolox/g). The shelf life of the product "Low carb mini-baguette fortified with *Spirulina* powder" was set at 3 days.

ACKNOWLEDGEMENTS

This work was carried out through the Core Program within the National Research Development and Innovation Plan 2022-2027, carried out with the support of MCID, project no. PN 23 01 01 01.

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