

Article

Impact of Watermelon Seed Flour on the Physical, Chemical, and Sensory Properties of Low-Carbohydrate, High-Protein Bread

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Abstract: Nowadays, many people struggle with various diseases, and to prevent this, a low-carbohydrate diet is recommended. Consumers are also looking for products with a high amount of plant proteins. This study investigated the preparation of low-carbohydrate and high-protein breads using flaxseed flour, buckwheat flour, and pea protein enriched with watermelon seed flour at different contents (0, 5, 10, and 15%). The physical, chemical, and sensory properties of the bread were determined. Based on the research conducted, the loaves of bread with the addition of WSF had a higher volume compared to the control sample, but in the case of parameters of crumb color, no significant changes were observed ($\Delta E < 5$). Taking into account the sensory analysis, it is recommended to add 5% WSF to the base recipe; such bread meets the requirements for low-carbohydrate and high-protein food. The value of the amino acids (mg/g⁻¹) in the obtained bread was in the order of glutamic acid (64.9), followed by asparagine (37.3), arginine (32.6), lysine (20.4), serine (18.0), and alanine (17.0), higher than the corresponding value in the control bread. The findings suggested that the addition of WSF at a concentration of 5% could be used as a valuable functional ingredient to enhance the nutritive content of low-carbohydrate and high-protein bread, especially for the elderly and physically active people.

Keywords: watermelon seed flour; wheat bread substitution; low-carb diet; amino-acid composition high-protein bread; crumb texture



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1. Introduction

Wheat bread has been a staple food in many cultures for ages, with its distinctive texture and taste. Currently, there is also a change in the food industry's dynamics [1,2]. Due to lifestyle-related diseases, such as diabetes, consumers are increasingly reaching for foods with low carbohydrate content and increased protein content [3]. One effective way to combat the global shortage of nutrients in food is to introduce natural dietary supplements to basic products to enrich them [4].

Our previous research [5] enabled us to develop a recipe for low-carbohydrate, gluten-free bread with increased protein content based on buckwheat and linseed flour. The next research stage was to enrich the base recipe with poppy seed flour and walnut flour, mainly to improve the organoleptic properties and increase the protein level. The tests confirmed the possibility of using these flours in producing functional low-carbohydrate bread up to 10 and 15% in the case of poppy seed flour and walnut flour, respectively, without reducing their quality characteristics. Our interests have focused on watermelon seed flour due to its unique properties.

Watermelon flour has excellent functional properties, including a higher content of high-quality protein [6]. The main proteins found in watermelon seeds include arginine, leucine, glutamic acid and aspartic acid [7]. Compared to wheat flour, watermelon seeds are richer in macro- and microelements such as Ca, Mg, P, K, Na and Zn, polyunsaturated fatty acids and vitamins like B3 and B9 [8]. Other authors noticed that the most concentrated phytochemicals in watermelon seed flour are cardiac glycosides and saponins, followed by alkaloids, phenols, and flavonoids. Significant antioxidant properties were demonstrated, including the ability to scavenge free radicals against ABTS and DPPH in watermelon seed flour, which highlights the potential source of natural antioxidants and bioactive compounds for therapeutic purposes [9].

Some sources report the anti-nutritional contents of watermelon seeds [10]. Still, research conducted by Adoo et al. [11] indicates that the anti-nutritional substances contained in the seeds can be reduced by processing, such as roasting or boiling. The investigation conducted by El-Adway and Taha [12] revealed that watermelon seed flour can be added to baked goods, both because it contains valuable substances and also because it serves as a useful ingredient in the composition of baked goods. Bolaji et al. [13] obtained a good-quality whole-wheat bread with the addition of watermelon seed flour. Other authors added watermelon purée and juice to the wheat bread and concluded that these additions enriched the bread with nutrients [14]. The bread was additionally enriched with watermelon rind powder, which is expected to enhance its superior qualities [15,16].

As already indicated above, the watermelon seed flour was incorporated into wheat bread recipes. In confectionery, watermelon seed flour was used as an addition to cookies [17,18] or biscuits [19]. Moreover, it was also possible to prepare nutritious snacks with the addition of watermelon seed flour [20]. In line with a global trend, a growing body of studies has suggested that protein intake significantly higher than the current RDA (Recommended Daily Allowance) can support healthy aging, weight management, appetite control, and achievement of athletic performance goals [21,22]. Hence, we have focused on a higher-protein bread formula.

Analyzing the available literature, no studies were found that would concern the possibility of enriching functional bread other than traditional wheat bread with watermelon seed flour. The addition of WSF seems to be a valuable source of protein and other ingredients that can also be included in special-purpose bread, for example, gluten-free and low-carbohydrate bread. Such an addition has not been tested in a low-carbohydrate and gluten-free bread recipe so far. The ingredients in the recipe for such bread must be chosen carefully because it is difficult to keep the quality of the bread at a good level. Therefore, further testing is necessary. Therefore, in this study, we examined the influence of the addition of different concentrations of watermelon seed flour on the basic physical and chemical properties of the obtained loaves of bread with a reduced carbohydrate content and a high protein content.

2. Materials and Methods

2.1. Materials

Flaxseed flour (Bioplanet, Poland), buckwheat flour (Helcom, Poland), and watermelon seed flour (Efavit, Poland) were purchased from a health food store and used for bread making. The flaxseed, buckwheat and watermelon seed flours contained, respectively, 40.2 g, 13 g and 20 g of protein; 8.8 g, 3.1 g, and 9 g of fat; and 4.1 g, 63.1 g, and 60 g of carbohydrates, per 100 g. Additionally, the recipe uses pea protein powder (BioPlanet, Poland) (with 78 g of protein per 100 g), psyllium (Mediate, Libchavy, ČR), potato fibre (Green Essence, Pyrzyce, Poland), guar gum (Bio Planet, Gniezno Poland), dried yeast (LeSaffre, Maisons-Alfort, France) and Himalayan salt.

2.2. Bread Making Procedure

The subsequent recipe was applied to prepare the control bread: flaxseed flour (45 g), buckwheat flour (45 g), pea protein powder (10 g), potato fiber (2 g), psyllium husk

(4 g), guar gum (2 g), dried yeast (2 g), Himalayan salt (2 g), and 150 mL of tap water. Watermelon seed flour was added to the bread recipe at 5, 10 and 15% (proportionally replacing flaxseed and buckwheat flour, respectively). All dry ingredients were combined with water in which the yeast had previously been dissolved and mixed at 100 rpm for 2 min and then at 200 rpm for 4 min (CLATRONIC KM 3630, Clatronic International GmbH, Kempen, Germany). After completing the dough production stage, it was divided into 120 g pieces, formed into elongated pieces, and placed in moulds (95 mm × 60 mm). The proofing of the dough pieces lasted 60 min (process parameters—30 °C and 75–80% relative humidity), and the baking process took about 20 min at a temperature of 210 °C. The baking chamber was steamed immediately after the bread was placed in the oven. For this purpose, a laboratory oven with a fermentation chamber (Sadkiewicz Instruments, Bydgoszcz, Poland) was used. The control dough and the dough with the addition of WSF were produced in the same conditions, and the parameters of the dough fermentation and baking processes did not differ. After baking, the bread samples were weighed and cooled to room temperature before analysis.

2.3. Analysis of the Basic Properties of Bread

According to the AACC standard, the basic composition, including moisture, protein, dietary fiber, fat and ash content, of low-carbohydrate bread was assessed [23]. Also, available carbohydrates were determined. The volume of the loaves was measured using the millet seed displacement method and then converted into a specific volume of bread ($\text{cm}^3 \cdot \text{g}^{-1}$). The pH level of the bread crumbs obtained was monitored using a pH meter 206-ph2 manufactured by Testo, located in Pruszków, Poland. The weight loss of the dough resulting from baking was also calculated (the difference in mass between a piece of dough and the loaf immediately after baking divided by the mass of the dough piece).

2.4. Color Measurements of Bread

The CIE $L^*a^*b^*$ system was used to measure the crumb color parameters. For this analysis, the Colorimeter model CR30-16 (4Wave, Tychy, Poland) was used. The letter L denotes lightness, while the letter a denotes red/green saturation and the letter b denotes yellow/blue saturation. Between the control bread and the WSF-enriched bread, the total color difference (ΔE) was calculated. The tests were carried out three times.

2.5. Texture Properties of Bread Crumb Evaluation

The texture of the crumbs was evaluated 24 and 48 h after baking with a ZWICK Z0 20/TN2S machine (Zwick Roell Group, Ulm, Germany). The samples were cut out of the middle part of the slice using a cutter (diameter 14 mm, thickness 15 mm). Each sample underwent compression twice to a depth of 60% at a speed of 20 mm s^{-1} . The following texture parameters were calculated based on the curves obtained in the testXpert V 7.1 simulation software: hardness, cohesiveness, springiness, and chewiness [24]. The measurement results were taken in eight repetitions.

2.6. Sensory Evaluation of Bread

Sensory evaluation was performed 24 h after baking according to a 9-point scale: 9—I extremely like; 5—I neither like it nor dislike it; and 1—extremely dislike [25]. Sixty untrained panelists (from 20 to 73 years, 28 females and 32 males) participated in the analysis. For analysis, slices of bread approximately 1.5 cm thick were prepared and packed in string bags immediately after being cut on a slicer. Once coded, the samples were given to the panelists for evaluation in a different order. The bread attributes were assessed, such as appearance, color, taste, smell, texture and overall acceptability. The room in which the assessment was carried out was closed and free from foreign odors.

2.7. Amino Acid Profile Analysis

The determination of the amino acid composition of the low-carbohydrate bread samples obtained by incorporating WSF was conducted through acid protein hydrolysis, as per the methodology outlined by Davis and Thomas [26]. The contents of tryptophan and sulfur amino acids were evaluated according to Schramm et al. [27]. The concentration of the amino acids with tryptophan was assessed using the method described by Ziemichód et al. [28] using the acid analyzer type AAA 400 (Ingos, Prague, Czech Republic).

2.8. Calorific Value of Bread Calculation

Both the control bread and the bread with the optimal WSF addition were evaluated for their caloric values. The methodology outlined by Costantini et al. [29] utilized the Atwater coefficients.

2.9. Statistical Analyses

As a result of the tests, four distinct groups of variables were identified, which characterized the tested characteristics of bread by incorporating varying amounts of WSF additives. The obtained data were analyzed using Statistica 12.0 (StatSoft, Cracow, Poland). Subsequently, it was determined that there were significant differences between the means. A Turkey post hoc test was conducted, allowing multiple comparison procedures to identify means that are significantly different from each other. When comparing two groups of means, where measurements were only made for the control and optimal samples, a *t*-test was performed to determine whether these two means differed from each other.

3. Results

3.1. Basic Properties of Low-Carbohydrate Bread with Different Amounts of WSF

The analysis of the conducted research indicated that the addition of WSF to low-carbohydrate bread increased the crumb moisture of the obtained loaves (Table 1). The highest increase was seen with a 15% addition (from 0.8 to 2.1). As indicated by research conducted by Jaroszewska et al. [30], the addition of WSF to wheat flour resulted in a significant increase in water absorption. Other authors [8] reported that bread crumb moisture also increased with the addition of native and germinated watermelon seeds. The increased crumb moisture could be due to the presence of fiber in the watermelon seed flour, which provides better moisture retention in the resulting bread crumb. Samples containing 10% WSF were characterized by lower baking loss compared to the control bread (about 1%). However, for the sample with 15% WSF, the highest level of baking losses was recorded at 28%. When considering the volume of the obtained loaves, an increase in volume was noticed only for the sample with 5% WSF. Samples with a higher share of WSF were characterized by a lower volume at the level of $1.46 \text{ g} \cdot \text{cm}^{-3}$ but comparable to the control bread ($1.45 \text{ g} \cdot \text{cm}^{-3}$). According to our previous research, the addition of poppy or walnut flour to low-carbohydrate, gluten-free bread resulted in an increase in volume [31,32]. In the present studies, no decrease in this parameter was observed compared to the volume of control bread. In Bolaji et al. [13] study, the addition of WSF to whole-wheat bread significantly increased its volume. The flour which was used to make our bread was gluten-free. According to Kumar et al. [33], gluten-free breads are characterized by reduced crumb softness and a small volume of the resulting loaves. Our study used flaxseed and buckwheat flour as the base flour, which, on average, had less protein than with the addition of watermelon flour. It has been observed that the addition of protein improves the quality of this type of gluten-free bread, which is usually low in protein content. In another study, adding rapeseed protein to gluten-free bread increased the breads volume and pore density as well as reduced crumb porosity compared to the control [34]. Typically, proteins are incorporated into gluten-free systems to increase elastic modulus by cross-linking, improve the structure via gelation, and support foaming [35]. When comparing the pH of the crumb of the obtained loaves, an increase in pH was observed from 5.4 (control sample) to 5.5 (for other breads with the addition of WSF). This

indicates that bread with reduced carbohydrates does not exceed its pH level beyond the optimum for mold growth, i.e., pH = 3.5–5.5 [36].

Table 1. Physical properties of low-carbohydrate and high-protein bread enriched with watermelon seed flour (WSF).

Amount of WSF (%)	Moisture of Bread (%)	Baking Loss (%)	Specific Volume of Bread (cm ³ ·g ^{−1})	pH—
0	55.4 ± 0.52 ^{a*}	24.7 ± 0.45 ^b	1.45 ± 0.02 ^a	5.4 ± 0.03 ^a
5	57.6 ± 0.34 ^b	23.1 ± 0.48 ^a	1.54 ± 0.01 ^b	5.5 ± 0.03 ^b
10	57.9 ± 0.23 ^b	23.6 ± 0.33 ^a	1.46 ± 0.03 ^a	5.5 ± 0.02 ^b
15	58.5 ± 0.33 ^b	28.1 ± 0.49 ^c	1.46 ± 0.01 ^a	5.5 ± 0.06 ^b

* values in the same column marked superscript letters ^{a–c} are significantly ($\alpha = 0.05$) different.

3.2. Color Parameters of Low-Carbohydrate Bread with Different Amounts of WSF

The results of the assessment of color parameters are presented in Table 2. When considering the color parameters of the crumb, an increase in the value of the lightness was noticed from 36.8 to 39 when the WSF concentration was raised. However, the a^* parameter was at a similar level for all analyzed samples and amounted to approximately 6.3. Regarding the b^* parameter, there was a slight increase from 19 to 20 (with the highest share of WSF). Changes in the color of the crumb were hardly noticeable, even though the flour obtained from watermelon seeds was dark. This was the reason for the dark color of the crumb of the control sample due to the presence of linseed flour in the bread recipe, which has an original darker color. The total color difference between samples (control bread and bread enriched with WSF) was less than 5 units, and there was no significant difference that could be visually perceived by consumers [37]. In the study presented by Bolaji et al. [13], the addition of WSF in the range of 0 to 10% to whole-wheat bread significantly increased all color parameters, including bread brightness, redness and yellowness. The color of this whole-wheat bread was not as intense as it was in our bread.

Table 2. Color parameters of low-carbohydrate bread crumb enriched with WSF.

Sample	L*	a*	b*	ΔE
0	36.8 ± 0.08 ^{a*}	6.1 ± 0.02 ^a	18.9 ± 0.03 ^a	—
5	37.0 ± 0.39 ^a	6.1 ± 0.06 ^a	19.5 ± 0.15 ^a	1.31 ± 0.14
10	38.3 ± 0.35 ^b	6.4 ± 0.09 ^a	19.7 ± 0.22 ^a	2.21 ± 0.10
15	39.0 ± 0.20 ^b	6.4 ± 0.01 ^a	19.9 ± 0.16 ^a	3.28 ± 0.13

* values in the same column marked superscript letters ^{a,b} are significantly ($\alpha = 0.05$) different.

3.3. Texture Properties of Low-Carbohydrate Bread with Different Amounts of WSF

Analysis of texture parameters (Figure 1) indicated that the hardness of the bread crumb increased during storage. The lowest value of hardness 24 h after baking was recorded for the sample with the addition of 5% WSF, which was 24.8 N (less than 5 N lower compared to the control bread). Additionally, after 48 h of storage, the lowest value of this parameter was noticed for the bread supplemented with 5% WSF (33.7 N). However, the bread crumb with 15% WSF was characterized by the highest hardness both 24 and 48 h after baking (40.6 and 42.7, respectively). In studies conducted by Korus et al. [38], who used defatted blackcurrant and strawberry seeds as a dietary supplement in gluten-free bread, the hardness of the bread crumb was diminished in comparison with the control. In another study, Ziemichód et al. [28] also observed a decrease in hardness due to the addition of holy basil and chia seeds to gluten-free bread. During our tests, it was observed that the hardness of the flour increased with the addition of WSF, which is likely attributable to the higher content of fiber in this flour. Only in the case of a 5% addition of WSF was there a significant increase in hardness caused by the 5% addition of WSF. The types of fibers, their viscosity and solubility properties, as well as their concentration, are factors

that affect changes in hardness and other texture parameters of bread [39]. Regarding cohesiveness, the addition of WSF to 10% resulted in a slight increase in this parameter. However, after 48 h of storage, the cohesiveness values for breads enriched with WSF decreased; the exception was the control sample, where there was a slight increase in this parameter (from 0.24 to 0.28). Considering the springiness of the obtained loaves of bread, it was noticed that the addition of WSF above 5% reduced the value of this parameter to approximately 0.5 from 0.6 (control bread). After 48 h of storage, no significant changes in the springiness of bread crumbs were observed, except for the control sample, for which an increase in the value of the analyzing parameter was observed (from 0.6 to 0.71). The chewiness after 24 h of storage of bread enriched with WSF was similar to the control bread, except for the bread with the addition of 15% WSF (value increased from 4.2 to 5.3 N). After 48 h from the end of baking, there was a slight increase in chewiness, where the highest increase in the analyzed parameter was recorded for the control sample from 4.2 to 6.5 N.

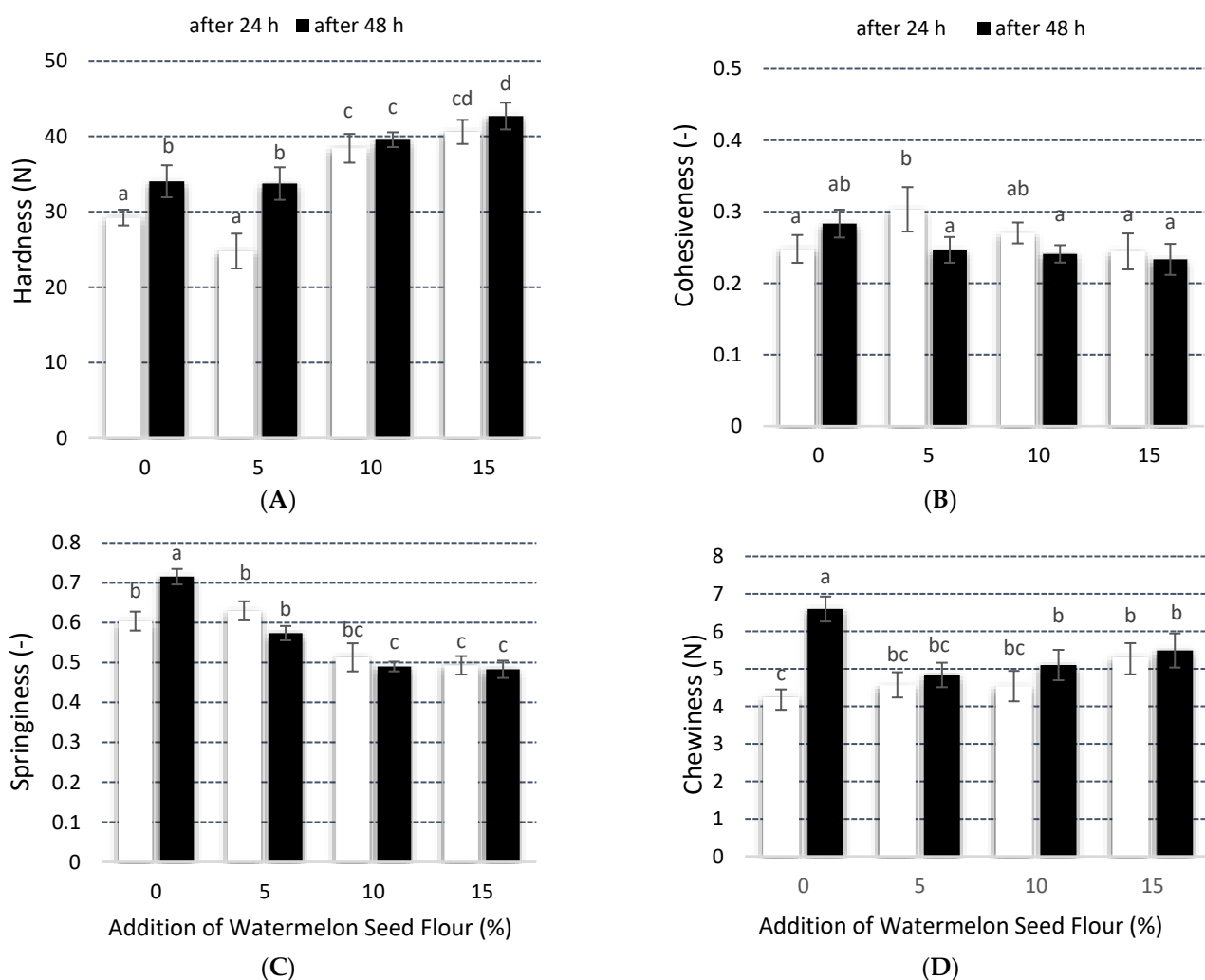


Figure 1. Texture properties of low-carbohydrate and high-protein bread crumbs enriched with watermelon seed flour (WSF). Values with different letters are significantly ($\alpha = 0.05$) different. (A) Hardness, (B) cohesiveness, (C) springiness, (D) chewiness.

3.4. Sensory Evaluation of Low-Carbohydrate Bread with Different Amounts of WSF

The control bread achieved the highest scores in terms of the assessed attributes, i.e., appearance, taste, smell, color, and texture. The overall acceptableness was the highest (8.0) for this bread (Figures 2 and 3). Bread enriched with 5% WSF was rated equally high and comparable to the control bread. A higher share of WSF resulted in a lower score for the assessed characteristics, mainly taste and smell. The lowest scores for these

attributes were obtained by bread with 15% of WSF (5.7 and 7.1, respectively). A lower taste score resulted from the presence of a slightly bitter taste. The results of our research do not coincide with the results of research conducted by Anang et al. [4], which referred to the sensory evaluation of wheat bread with the addition of defatted watermelon seeds, which were added in two percentages: 15 and 25%. In the above-mentioned studies, in the consumer acceptance test, no significant differences were observed between all tests supplemented with WSF. Perhaps no significant differences were obtained in the tested loaves of bread due to the addition of sugar in the base recipe for wheat bread. Other sensory evaluations [13] have shown that whole-wheat bread produced with 2.5% WSF is the most preferred type of bread by panelists and is also said to have excellent properties compared to the control samples. The results of other evaluative tests revealed that up to 15% of the wheat flour could be substituted with watermelon rind flour in balady bread, which is still more acceptable than the control bread samples.

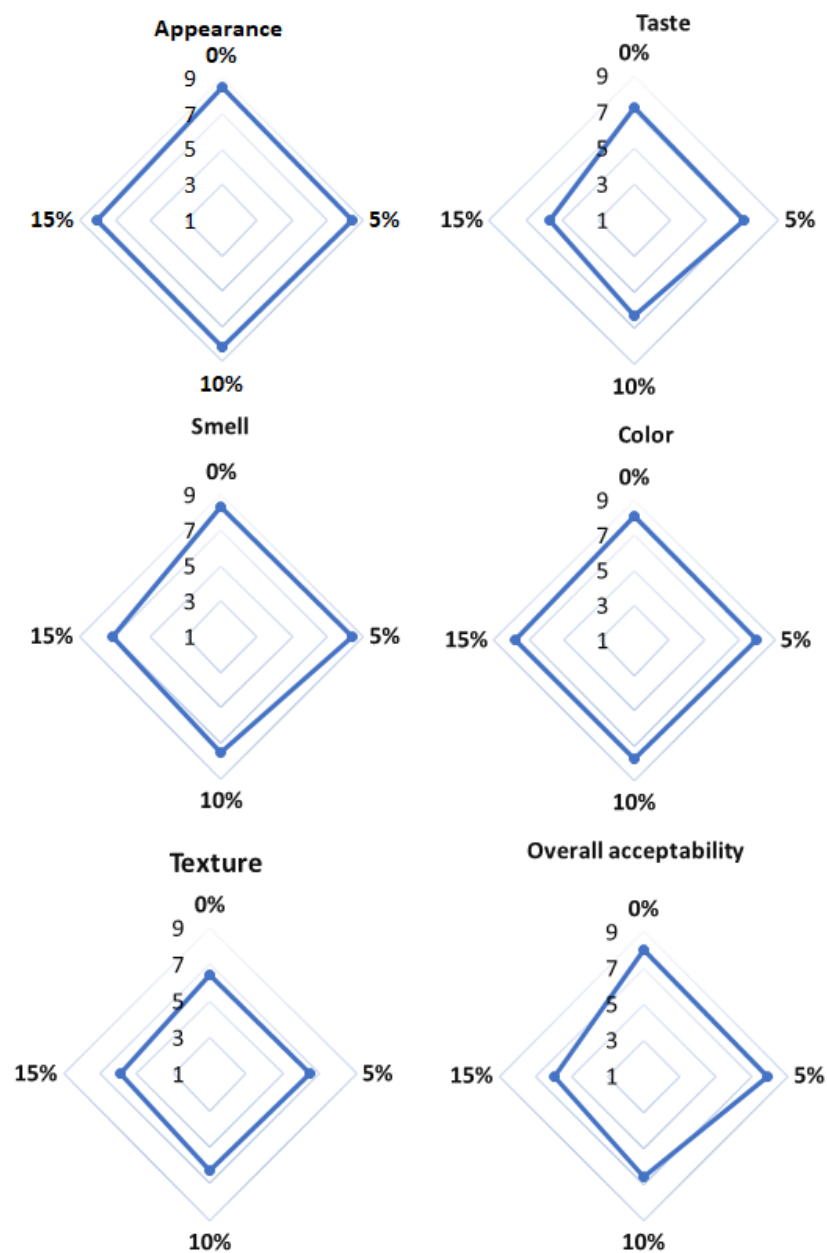


Figure 2. Sensory evaluation of low-carbohydrate and high-protein bread enriched with various amounts (0, 5, 10, 15%) of WSF additive.



Figure 3. The appearance of loaves of low-carbohydrate bread enriched with watermelon seed flour.

3.5. Amino-Acid Composition of Low Carbohydrate Bread with Optimal WSF

The analysis of the composition of amino acids (Table 3) in the obtained low-carbohydrate bread with the optimal addition of WSF (at the level of 5%) revealed a higher content of asparagine, serine, glutamic acid, alanine, lysine, and arginine in comparison to the control bread. According to previous studies, the predominant amino acids in protein fractions were glutamic acid and arginine, depending on the variety of watermelon seeds [40]. Another author [41] found in the amino acid composition of WSF (in order from the highest concentration) the presence of glutamate, then arginine and isoleucine. In our research, we have shown that bread supplemented with 5% WSF may also be a source of asparagine, lysine and leucine in addition to the dominant amino acid, i.e., glutamic acid. Adding proteins from other plant materials to a bread recipe can often provide valuable amino acids [34].

Table 3. Amino acid composition of control low-carbohydrate bread and enriched with 5% watermelon seed flour.

Amino Acids	Amount of Amino Acid (mg·g ⁻¹)	
	Control	5% WSF
Asparagine	36.6 ± 0.22 *	37.3 ± 0.18 **
Threonine	12.8 ± 0.46 *	13.1 ± 0.22 *
Serine	17.2 ± 0.23 *	18.0 ± 0.23 **
Glutamic acid	62.8 ± 0.85 *	64.9 ± 0.20 **
Proline	18.4 ± 0.38 *	19.2 ± 0.17 *
Glycine	16.0 ± 0.12 *	16.5 ± 0.20 *
Alanine	15.5 ± 0.46 *	17.0 ± 0.32 **
Cysteic acid	6.1 ± 0.24 *	5.16 ± 0.12 **
Valine	17.4 ± 0.36 *	18.0 ± 0.24 *
Methionine sulfone	5.5 ± 0.21 *	5.6 ± 0.16 *
Isoleucine	14.1 ± 0.16 *	14.3 ± 0.13 *
Leucine	23.3 ± 0.32 *	23.9 ± 0.18 *
Tyrosine	9.0 ± 0.17 *	9.2 ± 0.25 *
Phenylalanine	16.9 ± 0.33 *	17.2 ± 0.19 *
Histidine	8.2 ± 0.25 *	8.5 ± 0.21 *
Lysine	19.8 ± 0.19 *	20.4 ± 0.18 **
Arginine	30.1 ± 0.7 *	32.6 ± 0.20 **
Tryptophan	8.6 ± 0.18 *	6.8 ± 0.15 **

mean values with one asterisk * differ significantly ($\alpha = 0.05$) from average values with two asterisks **.

3.6. Caloric Value of Low-Carbohydrate Bread with Optimal WSF

The chemical composition of the resulting bread (Table 4) was changed by the introduction of WSF into the low-carb bread recipe. We found that the bread with WSF had more protein (0.74 g/100 g d.m.) and more fiber (3 g/100 g d.m.) than the bread without WSF. The base flour mixture had a lower protein content than the added WSF, which led to

an increase in protein content in the bread. It also contained a large amount of fiber, which came from a large share of the coating in the watermelon seeds. Simultaneously, there was a decrease in fat and available carbohydrate content from 4.29 g to 2.86 g/100 g DM and from 12.4 g to 8.7 g/100 g DM, respectively. However, the ash content did not change and was slightly above the level of 5 g/100 g DM in both bread samples. In other studies in which high-protein flours were added to wheat bread, the amount of nutrients likewise grew without affecting the sensory properties [42,43].

Table 4. Chemical composition of low-carbohydrate bread enriched with 5% watermelon seed flour.

Chemical Components (g/100 g d.m.)	Addition of WSF (%)	
	0	5
Protein	33.49 ± 0.19 ^{a*}	34.23 ± 0.24 ^b
Fat	4.29 ± 0.03 ^b	2.86 ± 0.07 ^a
Ash	5.09 ± 0.02 ^a	5.22 ± 0.04 ^a
Total fibre	37.12 ± 0.06 ^a	40.18 ± 0.10 ^b
Available carbohydrate	12.4 ± 0.38 ^a	8.7 ± 0.28 ^b
Caloric value (kcal/100 g)	297.21 ^b	277.62 ^a

* values in the same row marked superscript letters ^{a,b} are significantly ($\alpha = 0.05$) different.

4. Conclusions

These studies have shown that watermelon seed flour could be used to enrich low-carb, high-protein bread. Sensory analysis revealed that low-carbohydrate and high-protein bread can be enriched with WSF by up to a 5% additional amount. Compared to the control bread, the bread with a 5% WSF content had more protein, less fat, more fiber, less carbohydrates, and a lower caloric value. This enriched bread contained 34.2 g of protein, 2.9 g of fat, 40.2 g of fiber, 8.7 g of carbohydrates, and 277.6 kcal per 100 g (d.m.). Regulation (EC) No 1924/2006 says that food is high in protein if at least 20% of the food's energy is made up of protein. The obtained bread with 5% WSF content has a protein content of 34.2, which provides 136.9 kcal, which is much more than 20% of the total energy of the bread. A low-carbohydrate bread is considered a product in which the carbohydrate content has been reduced by at least 30% compared to a similar product. Traditional wheat bread has a carbohydrate content of 69.5% d.m. Consequently, bread enriched with 5% WSF can be considered to be high in protein and low in carbohydrates.

The results of the sensory evaluation indicate that future scientific research should consider the possibility of introducing an addition to bread or using a specific technological procedure that will affect the slightly bitter taste in the case of a higher addition of watermelon seed flour. This action would further enrich the bread's protein profile to the benefit of its consumers. More in-depth analyses of the antioxidant activity and digestibility of bread are needed. It is imperative to conduct both in vitro and in vivo experiments in order to ascertain the complete health advantages of consuming this particular type of bread.

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