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# Enhancing Gluten-Free Biscuits: a Quality Assessment with Medicinal Plant Additions

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We recommend writing about the purpose of the research at the beginning. This study investigates nutritional composition (dry matter, ash, fat, reducing sugars), antioxidant activity (using the DPPH method), total polyphenol content, and sensory parameters of gluten-free biscuits with a 5% addition of medicinal plants (*Origanum vulgare* L., *Tilia platyphyllos* Scop., *Agrimonia eupatoria* L., and *Thymus serpyllum* L.) compared to control variant without herbs. The dry matter content ranged from 95.42 to 96.81%. The highest ash content was detected in the sample with the addition of oregano (2.01%), while the lowest was in the control sample (1.53%). The fat content in the monitored samples ranged from 27.48% (sample with oregano) to 29.06% (control sample). The reducing sugar content ranged from 18.93 mg $GE.g^{-1}$ (control sample) to 25.96 mg $GE.g^{-1}$ (sample with oregano). The total polyphenol content ranged from 1.09 mg GAE.100 $g^{-1}$ (control sample) to 3.35 mg GAE.100 $g^{-1}$ (sample with oregano). The antioxidant activity was highest in the variant with wild thyme (1.62 mg TEAC.100 $g^{-1}$) and lowest in the control sample (1.44 mg TEAC.100 $g^{-1}$). The sensory evaluation confirmed that gluten-free biscuits with adding herbs, especially lime-tree and oregano, had very good taste, aroma, and overall acceptability compared to the control sample.

**Keywords:** celiac disease, bakery products, antioxidants, sensory properties, *Origanum vulgare*, *Tilia platyphyllos*, *Agrimonia eupatoria*, *Thymus serpyllum*

## Introduction

Celiac disease is an immune-mediated systemic disorder characterized by gluten intolerance, which results in damage to the small intestine through villous atrophy. This condition is recognized as a significant global health issue, affecting approximately 1% of the population worldwide (Di Cairano et al., 2018). Historically, the gluten content in cereal grains was minimal, and the early varieties of oats, wheat, and rye were vastly different from contemporary strains. Advances in agricultural breeding have led to an increase in gluten levels, as higher gluten content enhances the baking qualities of bread and pastries.

The link between gluten and celiac disease was first identified by English pediatrician Dr. Samuel J. Gee in the 17th century, who emphasized the necessity

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of a gluten-free diet for affected individuals. In 1952, Dr. Dicke and his team established gluten as the causative agent of celiac disease. Gluten, a protein found in grains such as wheat, barley, rye, spelt, and kamut, is responsible for triggering the disease (Caio et al., 2019). The primary treatment for celiac disease is adherence to a strict gluten-free diet; however, this diet can be costly, complicated, and socially limiting. Research indicates that many individuals struggle to maintain their gluten-free diets, often turning to natural alternatives like millet, corn, rice, and sorghum (Zriouel et al., 2020). Commercial gluten-free products frequently lack appealing texture, flavor, aroma, and nutritional value compared to their gluten-containing counterparts. Suitable gluten-free foods include those made from corn, rice, amaranth, and chestnuts, as opposed to traditional grains like wheat, rye, and oats. Biscuits, a popular category of baked goods, are typically made from wheat flour and are characterized by low moisture and high sugar content (Xu et al., 2020). They serve as a convenient food option for celiac patients, appreciated across various demographics. Gluten-free biscuits are often simpler to produce than gluten-free bread since gluten is less critical for the structure of biscuits. Consequently, a wider range of flours can be utilized (Di Cairano et al., 2018). When creating gluten-free biscuits, wheat flour must be substituted with alternative ingredients, leading to a higher hardness compared to traditional wheat biscuits (Mancebo et al., 2015). Gluten-free baked goods tend to have lower protein, fiber, and mineral content, along with a higher glycemic index. To enhance the nutritional profile of these products, health-promoting ingredients can be incorporated. For instance, the mineral deficiency in gluten-free recipes can be addressed by adding nutrient-rich components such as amaranth, buckwheat, or flaxseed (Stantiall and Servent, 2017).

Food enrichment involves the addition of one or more nutrients that are either insufficient or absent in food products, aiming to enhance their nutritional properties. As consumer awareness regarding health and nutrition continues to grow, there has been a marked increase in research focused on investigating the functional, nutritional, and sensory qualities of foods. The primary goal of food production is to ensure that people lead healthy and fulfilling lives through the provision of safe and nutritionally rich food options (Cascone et al., 2024). In recent years, a shift in lifestyle preferences toward healthier and more balanced diets has further stimulated advancements in the functional food market. This increased demand for foods that not only satisfy hunger but also contribute positively to health has spurred innovation and development in food enrichment practices. As a result, the food industry is increasingly exploring ways to integrate essential nutrients into everyday foods, thereby improving their overall quality and appeal to health-conscious consumers (Zeng et al., 2024).

This study aimed to develop gluten-free biscuits with 5% of *Origanum vulgare* L., *Tilia platyphyllos* Scop., *Thymus serpyllum* L., and *Agrimonia eupatoria* L. These types of medicinal plants are popular in Slovakian folk medicine, where they are commonly used as tea. This research aims to demonstrate how they can also be utilized in the production of cereal products.

## Material and Methodology

### Materials

All ingredients (amaranth flour, chestnut flour, powdered sugar, milk powder, liquid milk, margarine, and vanilla) were sourced from local markets in Nitra, Slovakia. Samples of medicinal plants: oregano (*Origanum vulgare*), lime tree (*Tilia platyphyllos*), wild thyme (*Thymus serpyllum*), and agrimony (*Agrimonia eupatoria*) used in the production of the biscuits were collected during their flowering period from the locality of Podhorany near Nitra (Slovakia) at an altitude of 175 m above sea level. The drying process of the plants took place at room temperature without direct sunlight. In the period between drying and the analyses carried out the samples were stored in paper and cloth bags, which were kept free from access to sunlight. Before the application on biscuits the medicinal herbs were milled into powder (Sencor Scg 1050wh, Japan). All used chemicals were analytical grade and purchased from CentralChem (Bratislava, Slovakia).

#### Preparation of Biscuits

The making gluten-free biscuit process was carried out in domestic conditions using an old family recipe. A total of five different types of gluten-free biscuits were produced: control biscuits, biscuits with 5% wild thyme, biscuits with 5% lime-tree flower, biscuits with 5% agrimony, and biscuits with 5% oregano.

The raw materials were weighed according to the recipe, which involved sifting together chestnut and amaranth flour, milk powder, powdered sugar, and the chosen medicinal plant. Vanilla was then added to the mixture. After thoroughly mixing the dry ingredients with the liquid milk, chopped margarine


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was incorporated into the dough. The dough underwent efficient kneading on a work surface until it formed a compact and homogenous mass. Due to its crumbliness, the dough required a longer kneading time. Once kneaded, the dough was rolled out with a rolling pin to a desired thickness of approximately 4–5 mm. To prevent sticking, the work surface was sprinkled with cornstarch during the rolling process. Evenly sized round shapes were then cut out from the rolled dough and placed on a baking sheet.

The entire production process took approximately 60 minutes, which included 30 minutes for weighing the ingredients and preparing the dough. The biscuits were then baked at 200 °C (ETA 178790000, Czech Republic) for 10 minutes, following a preheating period of 10 minutes to reach the desired temperature. After baking, the samples were left on the baking tray lined with baking paper to cool for approximately 20 minutes.

## Methods

### Proximate Composition

#### Dry Matter, Ash, and Fat Content

AACC method 08-01 used to determine the dry matter and ash content (AACC, 1996). According to manufacturer guidelines, the Ancom XT15 Fat Extractor (USA) was used to measure the amount of fat in the sample.

#### Reducing Sugars Content

The reducing sugars content was determined spectrophotometrically (Jenway 6320D, UV VIS, UK) by dinitrosalicylic colorimetric method according to the procedures described by Wang (2005). Glucose (10–100 mg.l$^{-1}$; $R^2$ = 0.998) was used as a standard.

### Antioxidant Characteristics

#### DPPH – Free Radical Scavenging Activity

According to the steps outlined by Sanchéz-Moreno et al. (1998), the 2,2-difenyl-1-picrylhydrazyl (DPPH) assay used to measure the samples' capacity to scavenge free radicals using a spectrophotometer (Jenway 6320D, UV VIS, UK). Trolox (10–100 mg.l$^{-1}$; $R^2$ = 0.989) was used as a standard.

#### Total Polyphenol Content

The total polyphenol content of samples determined spectrophotometrically (Jenway 6320D, UV VIS, UK) using modified Folin-Ciocalteu method by Singleton et al. (1965). Gallic acid (25–300 mg.l$^{-1}$; $R^2$ = 0.999) was used as a standard.

### Statistical Analysis

The results are expressed as mean values of 3 replications ± standard deviation (SD). Data were analyzed with the ANOVA test and differences between means were compared through the Duncan test ($p$ <0.05).

### Sensory Evaluation

A sensory panel of 40 evaluators – 20 women and 20 men, aged 21 to 65 – determined the organoleptic properties of prepared biscuits. The panelists were asked to assess the overall acceptance, taste, smell, and overall appearance, aftertaste. A 7-point hedonic scale was used to rate the samples, with values ranging from 7 (like very much) to 1 (strongly dislike).

## Results and Discussion

### Dry Matter, Ash, Reducing Sugars and Fat Content

The highest dry matter content was found in the sample with the addition of agrimony and in the control sample (Table 1). The sample with the lowest dry matter content was the variant with oregano, which had a dry matter content of 95.43% and a water content of 4.58%. Determining dry matter allows for a better and easier understanding of the chemical composition. According to Nakov et al. (2018), this concept includes the quantity of all additives that make up the biscuits, excluding water. Generally, biscuits have a very low moisture content, which is advantageous from a microbial perspective. Consequently, they can be stored for a long time if kept under suitable conditions (environmental conditions and packaging material) (Morreale et al., 2018). A similar study by Ushakova et al. (2020) produced gluten-free biscuits made from buckwheat, coconut, corn flour, and coconut oil. Chemical and physical analyses showed that these biscuits had a lower dry matter content of 66.9% and a higher moisture content of 33.1%, indicating that this type of biscuit cannot be stored for more than one month. In contrast, our study found that the moisture content was very low, allowing these types of biscuits to be stored in good condition for up to three months. The best storage conditions for biscuits involve using airtight containers to prevent moisture from entering. This is crucial, as low-moisture biscuits can become stale if exposed to air. It is also necessary to store them in a cool, dry place away from direct sunlight, as heat and humidity can compromise their quality (Barberis et al., 2019).

The control sample without medicinal plants had the highest fat content, followed by biscuits with lime tree flowers at 28.47% (Table 1). This high level of fat content was noted in the study by Siger et al. (2021), where the fat levels ranged from 1.08 to 2.02%. *Thymus serpyllum* contains thymol and carvacrol as key components of its phenolic essential oil. The results of tests carried out demonstrated that the fat from wild thyme contains 3.95 mg of thymol per gram of oil (Gul et al., 2019). Meanwhile, oregano oil contains substantial amounts of carvacrol, which is recognized as one of the most effective plant extracts against pathogens. The presence of a hydroxyl group in the structure of the phenolic compounds contributes to their antimicrobial activity. The relative positioning of these natural components is crucial, especially when compared to other plant phenolics, which helps explain the superior antimicrobial activity of carvacrol (Zinoviadou et al., 2009).

Detailed research by Culetu et al. (2021) examined how fat affects gluten-free dough. The study investigated six fat-based compounds: butter, margarine, lard, refined palm oil with stearin, refined palm oil, and hydrogenated palm oil, each with varying solid fat contents, to evaluate their gluten-free properties in dough and biscuits. Refined palm stearin oil exhibited the highest solid fat content, while dough made with refined palm oil was found to be the finest. The hardness of the gluten-free dough influenced the breaking strength of the biscuits; it was found that the hardest dough was produced with hydrogenated palm oil compared to the other samples. Biscuits made with lard displayed the darkest color, while those with hydrogenated palm oil were the lightest. This demonstrates that solid fat content is a crucial parameter affecting the textural, rheological, and thermal characteristics of the product. Cho et al. (2018) showed that *Agrimonia eupatoria* can protect against liver damage by reducing total lipid levels. However, some studies comparing the nutritional composition of gluten-free products to conventional foods found no significant differences. Notably, gluten-free biscuits and pasta tend to have a higher saturated fat content than their conventional counterparts. For pasta, this difference, although small, was statistically significant at 0.1 $g.100\ g^{-1}$ (Cornicelli et al., 2018).

One of the main ingredients in biscuit production is sugar, which contributes to the structure of the biscuits through the recrystallization of sugar and the formation of amorphous glass during the cooling process. Sugar has a high calorific value of 3.87 calories per gram, compared to honey at 3.04 calories per gram and fructose at 2.81 calories per gram (Lin et al., 2010). The highest reducing sugar content (Table 1) was observed in the oregano sample, with 25.96 $mg\ GE.g^{-1}$, followed by the lime tree flower sample at 23.54 $mg\ GE.g^{-1}$. The high reducing sugar content in the biscuit prepared with lime tree flower may be attributed to the presence of sucrose, fructose, and glucose, as confirmed by Koch and Stevenson (2017) using gas chromatography. Similarly, a linear polysaccharide called chitosan is found in wild thyme (Talon et al., 2017). A study by Huzio et al. (2020) identified three free sugars in wild thyme: D-galactose (0.28 $mg.g^{-1}$), D-fructose (12.90 $mg.g^{-1}$), and D-glucose (15.02 $mg.g^{-1}$). Consistent with this research, gluten-free products are generally smaller in volume due to the absence of a gluten network, resulting in less elasticity and a firmer, harder texture compared to wheat products (Brites et al., 2018; Timothy et al., 2018). To mitigate these issues, hydrocolloids such as hydroxypropyl methylcellulose, carboxymethyl cellulose, pectin, xanthan, and k-carrageenan can be used. These hydrocolloids are known for their ability to mimic gluten's viscoelastic properties in bakery products, slow down starch retrogradation, and enhance loaf volume, crumb elasticity, and porosity (Tsatsaragkou et al., 2016; Masmoudi et al., 2020).

**Table 1** Proximate composition of prepared biscuits

| **Parameter** | **Biscuits** | | | | |
|---|---|---|---|---|---|
| | **control** | **5% lime tree** | **5% oregano** | **5% agrimony** | **5% wild thyme** |
| **Dry matter (%)** | 96.13 ±0.01$^{a}$ | 95.78 ±0.01$^{ab}$ | 95.43 ±0.03$^{b}$ | 96.81 ±0.05$^{a}$ | 95.99 ±0.03$^{ab}$ |
| **Ash (%)** | 1.53 ±0.03$^{b}$ | 1.95 ±0.07$^{a}$ | 2.01 ±0.04$^{a}$ | 2.00 ±0.07$^{a}$ | 1.67 ±0.05$^{b}$ |
| **Fat (%)** | 29.06 ±0.07$^{a}$ | 28.47 ±0.03$^{b}$ | 27.48 ±0.02$^{cd}$ | 27.85 ±0.05$^{c}$ | 28.37 ±0.03$^{b}$ |
| **Reducing sugars (mg GE.g$^{-1}$)** | 18.93 ±0.09$^{e}$ | 33.54 ±0.05$^{a}$ | 25.96 ±0.06$^{b}$ | 19.41 ±0.08$^{d}$ | 21.35 ±0.06$^{c}$ |

Notes: Results expressed as mean ±SD on a dry basis ($n$ = 3). Different superscript letters within identical rows significantly differ ($p < 0.05$); GE – glucose equivalent

In the gluten-free biscuit samples analyzed, the variant with oregano contained a high ash content of 2.01%, followed closely by the stickle-wort variant at 2.00%. The control sample exhibited an ash content of only 1.53% (Table 1). An analysis of common oregano revealed that all mineral constituents were present in significantly varying amounts. Macronutrients such as calcium, potassium, and magnesium were observed in concentrations of several grams per kilogram of the dried plant material. In contrast, trace elements such as zinc, iron, and copper were found in concentrations ranging from hundreds of μg.kg$^{-1}$ to mg.kg$^{-1}$. Factors affecting the mineral content of plants are species-specific, influenced by genetic and environmental conditions. Notably, 2 grams of dried oregano provides 4.2% of the recommended dietary intake for manganese and 4.4% for calcium (Karamać et al., 2019). The mineral content of gluten-free products made from amaranth, buckwheat, millet, oats, and teff (including bread, biscuits, flour, flakes, pasta, and other products) was assessed by Rybicka and Gliszczyńska-Świgło (2017) for eight different minerals: magnesium (Mg), calcium (Ca), potassium (K), copper (Cu), sodium (Na), manganese (Mn), iron (Fe), and zinc (Zn). In 100 g of these products, the mineral content varied as follows: K 17–1,417 mg, Ca 0.01–237 mg, Cu 0.01–1 mg, Na 0.01–1,512 mg, Mg 7–223 mg, Fe 0.3–19 mg, Mn 0.01–4.0 mg, Zn 0.2–3.1 mg. The suitability of amaranth and chestnut flour as raw materials to produce gluten-free products was highlighted by Hager et al. (2012) due to their rich nutritional properties. The mineral content of chestnut flour, as analyzed, was as follows: K 854 mg 100$^{-1}$ and Mn 3.7 mg 100$^{-1}$. For amaranth flour, the values were 205 Mg of mg 100$^{-1}$, Mn 2.1–4.0 mg 100$^{-1}$ g, and Zn 2.5–3.1 mg 100$^{-1}$. A similar study by Sarker et al. (2020) indicated that amaranth is an excellent raw material with a high mineral content, particularly noted as a good source of Fe, Ca, and Mg. One hundred grams of amaranth contains 120 mg of Ca, 223 mg of Mg, 433 mg of K, 5.7 mg of Cu, 3.1 mg of Zn, and 5.7 mg of Fe. It is important to note that this data pertains to raw materials rather than commercially available products.

## Antioxidant Activity (DDPH) and Total Polyphenol Content

The highest antioxidant activity (Table 2) was observed in the sample with the addition of wild thyme, while the control sample, which did not include any medicinal herbs, exhibited the lowest antioxidant content (1.44 mg TEAC.100 g$^{-1}$). Gonçalves et al. (2020) investigated the antioxidant properties of aromatic plants commonly used in traditional medicine and food. Among the plants studied, oregano demonstrated the strongest DPPH scavenging ability ($IC_{50}$ 4.65 ±0.12 μg.ml$^{-1}$) and exhibited the highest reducing power. In their analysis of lime tree components contributing to antioxidant activity, the researchers identified several key compounds, including astragalin, hyperoxide, chlorogenic acid, quercetin, tiliroside, and caffeic acid, with caffeic acid making the most significant contribution to the overall antioxidant activity. The samples of big-leaf lime, both from field and commercial sources, showed radical scavenging capabilities, with no significant differences noted between the two sources (Pavlović et al., 2020). Furthermore, when gluten-free biscuits were made using chestnut flour (Paciulli et al., 2018), they exhibited a slightly darker color and higher oxidative stability due to the antioxidants present in chestnut. The incorporation of chestnut flour resulted in improved organoleptic and technological quality. A substitution level of 500 g.kg$^{-1}$ of chestnut flour was found to be the most viable compromise between quality and stability during storage.

The polyphenol content of the tested samples was highest in the variant with the addition of oregano, which had a concentration of 3.35 mg GAE.100 g$^{-1}$. In comparison, a study conducted by Paśko et al. (2019) reported the polyphenol content of amaranth flour to be 0.96 mg GAE.g$^{-1}$ dry matter. Amaranth seeds contain several phenolic acids, including gallic acid, *p*-hydroxybenzoic acid, *p*-coumaric acid, vanillic acid, cinnamicacid,andcaffeicacid.AccordingtoGonçalvesetal. (2020), oregano exhibited the highest phenolic content, with an extract yielding 1,597.20 ±24.10 μmol GAE.g$^{-1}$.

**Table 2** Antioxidant activity and total polyphenols in tested samples

| Parameter | Biscuits | | | | |
|---|---|---|---|---|---|
| | control | 5% lime tree | 5% oregano | 5% agrimony | 5% wild thyme |
| **Polyphenol (mg GAE.100 g$^{-1}$)** | 1.09 ±0.01$^{d}$ | 2.45 ±0.07$^{bc}$ | 3.35.2 ±0.13$^{a}$ | 2.61 ±0.08$^{b}$ | 2.23 ±0.07$^{c}$ |
| **DPPH (mg TEAC.100 g$^{-1}$)** | 1.44 ±0.01$^{d}$ | 1.49 ±0.02$^{c}$ | 1.57 ±0.03$^{b}$ | 1.58 ±0.02$^{b}$ | 1.62 ±0.05$^{a}$ |

Notes: Results expressed as mean ±SD on a dry basis ($n$ = 3). Different superscript letters within identical rows significantly differ ($p<0.05$); GAE – gallic acid equivalent; TEAC – trolox equivalent antioxidant capacity

Cittan et al. (2018) reported that the polyphenol values in their samples of big-leaf lime ranged from 2.78 to 24.32 mg GAE.g$^{-1}$ (on a dry basis). In contrast, the big-leaf lime sample analyzed in this study had a polyphenol content of 2.45 mg GAE.100 g$^{-1}$ dry weight. Shafi et al. (2016) compared the ingredient content and properties of chestnut flour and standard wheat flour in biscuit production. They found that the mineral content, composition, functional properties, and antioxidant properties of chestnut flour were comparable to those of wheat flour. However, chestnut flour exhibited a higher polyphenolic content of 4.25 g GAE.100 g$^{-1}$, along with flavonoids at 1.92 g QE.100 g$^{-1}$, and higher levels of minerals such as Mg, K, Cu, and Zn compared to standard wheat flour. Notably, chestnut flour biscuits demonstrated better antioxidant activity, indicating a higher stability of polyphenols compared to those made with wheat flour.

## Sensory Characteristics of Biscuits

In terms and conditions, research analyses are essential for effectively evaluating consumer responses to reformulated and new products. The interest of consumers in food products can be studied from a perceptual, affective, and conceptual perspective. Perception relates to the sensory properties that consumers perceive, while affective tests assess the level of pleasure that the product provides to the consumer. Conceptual representation refers to the framework used to characterize the product based on consumer opinions (Vidal et al., 2019). The sensory evaluation of manufactured gluten-free biscuits, enhanced with medicinal plants, was conducted using a hedonic scale ranging from 1 to 7 points. Respondents assigned points to specific parameters on the hedonic scale based on their subjective opinions regarding the perceived organoleptic characteristics of the biscuits (Figure 1).

When evaluating the overall appearance, the evaluator noted that the samples containing wild thyme and lime trees had a distinct shade of green (Figure 2).

This color difference may explain why respondents assigned these samples higher scores compared to the control sample, which received the lowest score of 5.19. In a study by Lamacchia et al. (2014), gluten-free products were compared with traditional wheat products, with the latter being considered the "gold standard" for commercial quality. However, gluten-free products are often more expensive and are perceived to be inferior in quality, particularly in terms of taste and texture. For gluten-free biscuits with the addition of medicinal herbs, an unexpected foreign smell was noted. There was no visible difference in the samples regarding this parameter, but the most acceptable samples were those made with oregano and thyme, praised for their spicy aroma. The control sample garnered the least acceptance due to the lack of aroma from medicinal plants, unlike the others. Interestingly, the lime-tree biscuits had an earthy smell, while


a) b)

**Figure 1** Formulations of gluten-free biscuits with medicinal plants
a – 1 – oregano, 2 – agrimony, 3 – lime tree, 4 – wild thyme, 5 – control). Dough developed for gluten-free biscuits with the addition of medicinal plants; b – final product after baking arranged for the sensory test, 1 – oregano, 2 – agrimony, 3 – lime tree, 4 – wild thyme, 5 – control
Photo: Iveta Esseová

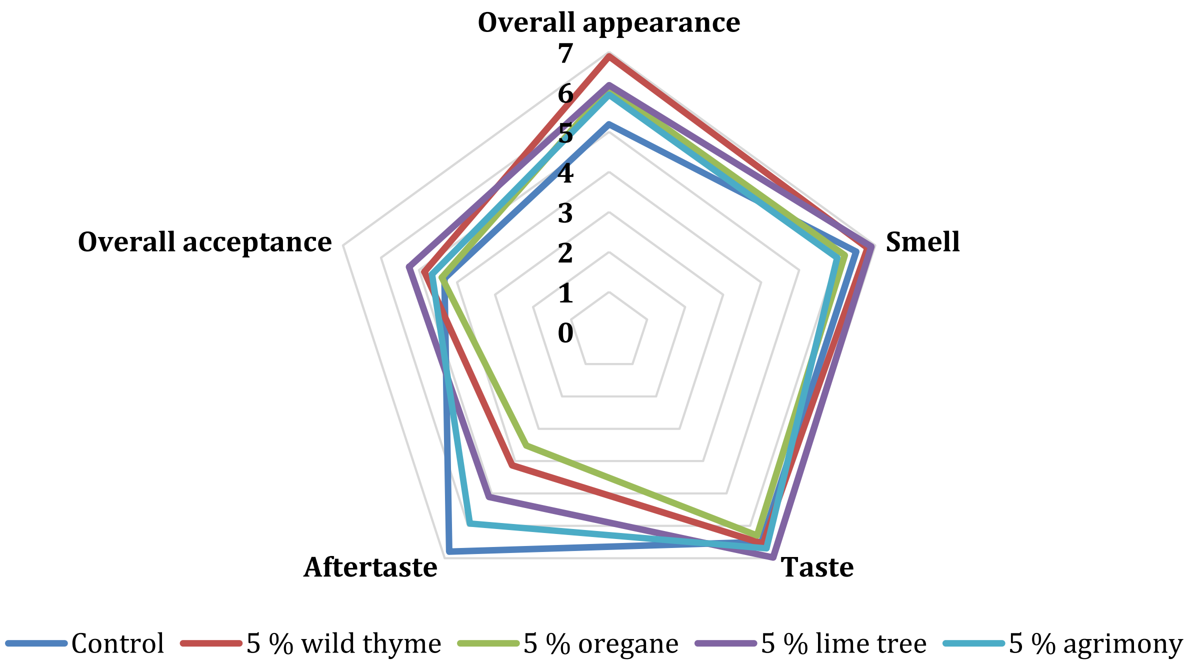


**Figure 2** Results of sensory evaluation of biscuits (sum of all evaluators)

the agrimony biscuits were noted to smell like potato. Significant variations in taste scores were observed, with the control sample receiving the lowest score. The sample with lime-tree flowers scored the highest at 6.98, followed closely by agrimony (6.7), wild thyme (6.55), oregano (6.5), and control (6.3). For comparative analysis, the aftertaste was also evaluated, ranging from the lowest score for agrimony to 6.9 for lime tree. Respondents noted a slight spiciness in the samples with oregano and thyme. The evaluation of foreign taste elicited varied responses, heavily influenced by individual biases and perceptions. For instance, two respondents reported the absence of any foreign taste in the five samples, while others detected a pleasant citrus flavor in the lime biscuits. Overall, the acceptability of gluten-free biscuits with the addition of medicinal plants was generally positive. As shown in Figure 2, the best-rated biscuits were those made with lime tree flower, wild thyme, and oregano.

## Conclusion

The development of gluten-free biscuits incorporating four different varieties of medicinal plants has opened new avenues in creating functional foods tailored for individuals with celiac disease. This study aimed to analyze the nutritional and sensory properties of these biscuits in comparison to conventional varieties, highlighting their potential benefits for health-conscious consumers. The formulated gluten-free biscuits were evaluated for various parameters, including dry matter content, antioxidant activity, mineral content, and sensory attributes. Notably, biscuits made with stickle-wort demonstrated the highest dry matter and antioxidant activity. However, despite these positive attributes, they were the least preferred in sensory evaluations, indicating a discrepancy between nutritional benefits and consumer acceptance – a critical factor for commercial viability. Among the medicinal plants used, oregano stood out with the highest mineral content at 2.01%, underscoring the potential of these plants to enrich gluten-free diets, which often lack essential minerals. The functional biscuits maintained a comparable total fat content to traditional biscuits, yet the presence of unsaturated fatty acids in the medicinal plant formulations could enhance their overall nutritional profile. Moreover, the addition of medicinal herbs imparted unique organoleptic properties to the biscuits, characterized by a pleasant spicy aroma and distinctive flavor. This differentiation not only appeals to celiac patients but also attracts health-conscious consumers seeking nutritious alternatives. In conclusion, the study highlights the promise of gluten-free biscuits enriched with medicinal plants as functional foods. They offer a viable option for individuals with dietary restrictions while catering to a broader audience interested in healthy eating. Future research could explore optimizing sensory qualities to enhance consumer acceptance alongside nutritional benefits.

### Conflict of Interest

The authors have no conflicts of interest to declare.

### Ethical Statement

This article doesn't contain any studies that require an ethical statement.

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