CHEMICAL CHARACTERISTICS OF COOKIES MADE FROM FLOUR FROM DIFFERENT WHEAT VARIETY

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Abstract: Cookies are widely consumed across all age groups, owing to their relatively simple technological production process, broad market availability, convenience for direct consumption, and favorable microbiological stability, which ensures an extended shelf life. Wheat flour represents the principal raw material in cookie manufacturing. The aim of this study was to evaluate changes in the chemical composition of cookies resulting from the substitution of commercially available wheat flour with flours derived from different wheat varieties. To fulfill this objective, five types of cookies were produced: cookies prepared with commercially available wheat flour type 400 (control, C), and cookies produced from flours obtained by milling common wheat (*Triticum aestivum*) varieties Adelaide (A), Bisanzio (B), and AGB-28 (AGB), as well as durum wheat (*Triticum durum*) variety Cobato (D). The selected wheat varieties were cultivated in the experimental fields of KOAL Seeds Sh.p.k. (Republic of Kosovo). Cookie production was carried out under industrial conditions at the manufacturing facility of the cookie factory „BE Commerce – Vushtrri" (Republic of Kosovo), in accordance with the company's standardized technological formulation. The basic raw materials used in the production process included: commercial wheat flour type 400, flours from common wheat *Triticum aestivum* (varieties Adelaide, Bisanzio, and AGB-28) and durum wheat *Triticum durum* (variety Cobato), in combination with sucrose, margarine, salt, glucose, sodium bicarbonate, milk powder, flavoring, and water. The following parameters were analyzed in the produced cookies: moisture content (AOAC 925.09), ash and mineral profile (AOAC 930.05; AOAC 984.27; AOAC 2015.01), proteins (AOAC 960.52), fats (AOAC 963.15), total carbohydrates (by calculation), and total dietary fiber (AOAC 985.29). The conducted analysis showed that in the examined samples, the moisture content ranged from 3.47% (cookies produced from the Bisanzio variety) to 4.36% (cookies produced from the Adelaide variety); ash content from 0.50% (cookies produced from the Cobato variety) to 0.66% (control cookies); fat content from 15.63% (cookies produced from the Bisanzio variety) to 19.60% (control cookies); protein content from 4.58% (cookies produced from the Adelaide variety) to 6.52% (cookies produced from the Cobato variety); total dietary fiber content from 0.53% (control cookies) to 5.75% (cookies produced from the Adelaide variety); and total carbohydrate content from 69.83% (control cookies) to 74.31% (cookies produced from the AGB-28 variety). Regarding the mineral composition the cookies produced from the Adelaide variety stood out as the richest source of essential minerals, exhibiting the highest values for calcium (Ca), zinc (Zn), manganese (Mn), sodium (Na), magnesium (Mg), and potassium (K). The use of different wheat varieties allows for variations in the content of essential macro- and micronutrients in cookies.
Keywords: Wheat varieties, cookies, chemical composition.

1. INTRODUCTION

Cereals are an essential part of the human diet. These crops cover half of the total harvested area in the world, representing about 736 million hectares, and reach a total production of 2,996 million tons (Yamini et al., 2025). They include various grain crops, such as wheat, rye, maize, oats, rice, and barley, and account for two-thirds of the total global food intake (Borrelli & Ficco, 2025). Wheat, maize, and rice play a key role, contributing approximately 90% of the total cereal production (Yamini et al., 2025).

Wheat is a cereal crop belonging to the Poaceae family (order Poales). It serves as a primary source of nutrients for approximately 40% of the global population. Wheat is the most widely cultivated cereal crop in the world, with over

218 million hectares under cultivation. This is attributed to its versatility and adaptability to diverse climatic conditions, the convenience of grain storage, the ease of processing into flour, and its high caloric and nutritional value. Accounting for about 20% of the daily calorie and protein intake, wheat is a vital component of the human diet and ranks as the second most significant food crop in developing countries, following only rice (Iqbal et al., 2022; Sharma & Sharma, 2025). Wheat grains contain carbohydrates ranging from 55% to 78%, 14% protein, 2% fat, and 2.5% minerals. They are a significant source of B-complex vitamins and essential minerals such as selenium, zinc, magnesium, and iron (Iqbal et al., 2022).

All wheat species belong to the genus Triticum and are classified as diploid, tetraploid, or hexaploid according to the number of chromosome pairs in their genome. Common wheat (*Triticum aestivum* L.) is a representative of hexaploid wheat, while durum wheat (*Triticum durum*) is the most commercially important tetraploid species (Dimitrios, 2024). Hexaploid *T. aestivum* is known as bread wheat, accounting for about 95% of total wheat production, while durum wheat, known as pasta wheat, accounts for the remaining 5% (Sharma & Sharma, 2025). Flours obtained from bread wheat varieties are widely utilized in the production of bread and other bakery products, while durum wheat flours possess technological properties that make them particularly suitable for manufacturing high-quality pasta (Ciudad-Mulero et al., 2021).

Common wheat is classified into hard and soft wheat, depending on the hardness of the grain (Iqbal et al., 2022). Wheat flour is obtained by milling mature wheat grains (Zhang, 2020). Products made from soft wheat flour from common wheat include a wide range of items, such as cakes, donuts, crackers, cookies, biscuits, and pie crusts. A common characteristic of soft wheat flour products is that most of them are chemically leavened with baking powder or baking soda, while hard wheat products are usually leavened with yeast (Finnie & Atwell, 2016).

Cookies, whose basic formulation is based on an optimal ratio of flour, fat, and sugar, occupy a significant place in the market due to their convenience as ready-to-eat products. Their wide acceptance among all age groups is due to their affordability, variety, ease of storage, convenience for transportation, and long shelf life (Krajewska & Dziki, 2023). Soft wheat flour is considered more suitable for biscuit and cookie production due to its lower water-holding capacity compared to hard wheat flour. When hard wheat flour is used in the formulation, cookies with firmer and tougher structures are usually obtained (Finnie & Atwell, 2016).

The quality of wheat flour depends on several factors, such as variety, harvest time, agronomic conditions, growing region, post-harvest processing, and storage conditions. Variations in the composition and type of flour cause changes in the characteristics of the final products (Ramzan & Sharif, 2023). Given the aforementioned, the aim of this research was to evaluate the changes in the chemical composition of cookies resulting from the replacement of commercially available wheat flour with flours obtained from different wheat varieties.

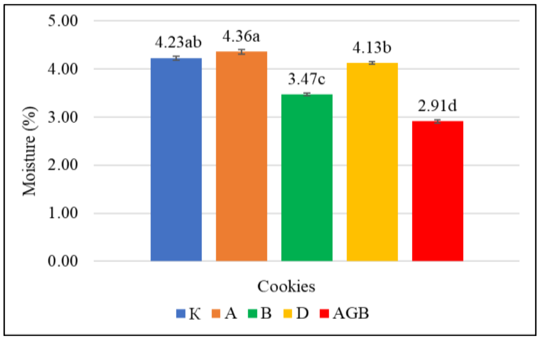
2. MATERIALS AND METHODS

The study investigated five types of cookies: a control sample (K) produced from commercial wheat flour (Type 400) and four cookie samples prepared from flours obtained by milling three varieties of common wheat (Adelaide, Bisanzio, and AGB-28) and one variety of durum wheat (Cobato). The wheat varieties were cultivated in the experimental fields of the company KOAL Seeds Sh.p.k. (Republic of Kosovo). All other raw materials required for cookie production, except the varietal flours, were supplied by the cookie factory BE Commerce – Vushtrri (Republic of Kosovo). Cookie production was carried out under industrial conditions at the facilities of BE Commerce – Vushtrri, following the factory's standardized formulation and technological procedure. The manufacturing process included several stages: weighing of raw materials; homogenization of flour, sugar, margarine, baking soda, salt, and water for 5 minutes; separate homogenization of glucose, milk powder, and flavoring for 2 minutes; final combined homogenization of all ingredients for 2 minutes; dough shaping and placement into baking trays; baking at 250 °C for 10 minutes; cooling to room temperature; and packaging of the finished products. The chemical composition of the produced cookies was determined through standard analytical methods. Moisture content was analyzed according to AOAC method 925.09, while ash content and mineral profile were determined using AOAC methods 930.05, 984.27, and 2015.01. Protein content was determined using AOAC method 960.52, fat content using AOAC method 963.15, and total dietary fiber according to AOAC method 985.29. Total carbohydrate content was calculated by difference, following the approach described by Najjar et al. (2022). All analyses were performed in triplicate, and results were expressed as mean values ± standard deviation (SD). Statistical analysis was conducted using Microsoft Office Excel and the XLSTAT 2019 statistical software package. Analysis of variance (ANOVA) followed by Fisher's least significant difference (LSD) test was applied to determine significant differences among samples at a confidence level of 95% ($p < 0.05$).

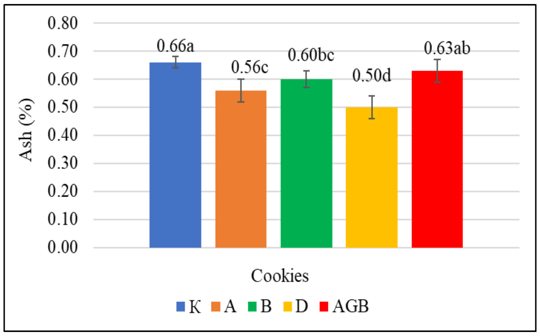
3. RESULTS AND DISCUSSIONS

The results obtained from the chemical analyses of the produced cookie samples, along with the determined statistical significance, are presented both graphically and in tabular form. All reported values represent the mean of three measurements ± standard deviation (SD). Mean values marked with different letters indicate statistically significant differences at the level of $p < 0.05$.
The results for the moisture and ash contents of the produced cookies are presented in Graph 1 and Graph 2.

Graph 1. Moisture content



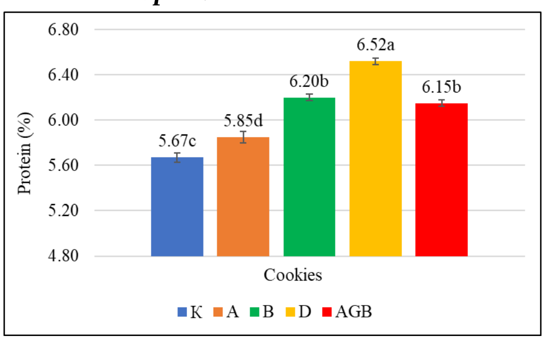
Graph 2. Ash content



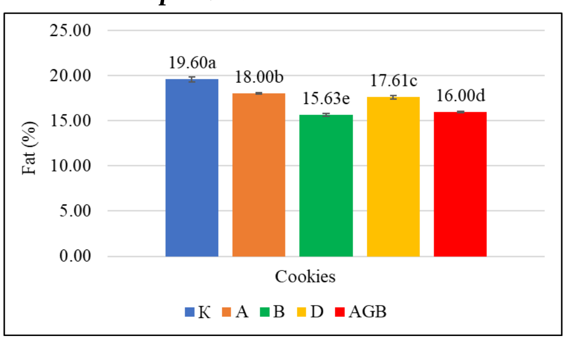
* Control sample (K), Adelaide (A), Bisanzio (B), Cobato (D), AGB-28 (AGB).
Source: Authors' research

Based on the obtained data, the moisture content of the analyzed cookie samples ranged from 2.91 ± 0.03% in cookies produced from the AGB-28 (AGB) variety to 4.36 ± 0.04% in cookies produced from the Adelaide (A) variety. A statistically significantly lower moisture content ($p < 0.05$), compared with the control sample (4.23 ± 0.05%), was observed in cookies produced from the Bisanzio (B), Cobato (D), and AGB-28 (AGB) varieties. Comparable results have been reported in previous studies. For instance, Najjar et al. (2022) reported moisture contents of 3.25% and 2.87% in cookies produced from white and whole wheat flour, respectively. Similarly, Ogundele and Hiam (2024) reported a moisture content of 3.96% in cookies produced from common wheat (*Triticum aestivum* L.), which is consistent with the results obtained in the present study. The relatively low moisture content observed in the analyzed samples suggests the potential for an extended shelf life of the cookies. In contrast, even lower moisture content values (1.2% and 1.3%) in cookies produced from commercial wheat flour were reported by Sadaf et al. (2022).
The results obtained for the ash content of the produced cookies are shown in Graph 2. From the presented results, it can be observed that the control cookies (K) have a statistically significantly higher ash content (0.66 ± 0.02%) than cookies A (0.56 ± 0.04%), B (0.60 ± 0.03%), and D (0.50 ± 0.04%). Additionally, cookies K have a higher ash content than the AGB cookies (0.63 ± 0.04%), although this difference is not statistically significant ($p > 0.05$). The obtained values are lower than the available literature data, according to which the ash content in wheat flour cookies ranges from 1.03% to 1.69% (Sadaf et al., 2022; Najjar et al., 2022; Ogundele & Hiam, 2024).
The protein and fat contents of the produced cookie samples are presented in Graph 3 and Graph 4.

Graph 3. Protein content



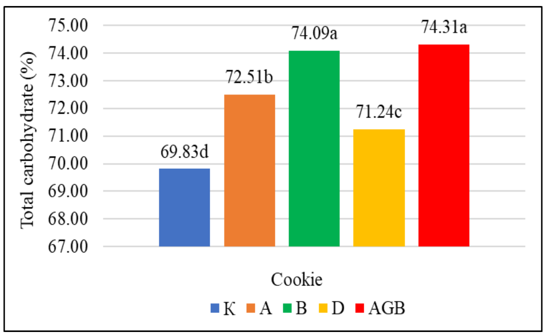
Graph 4. Fat content



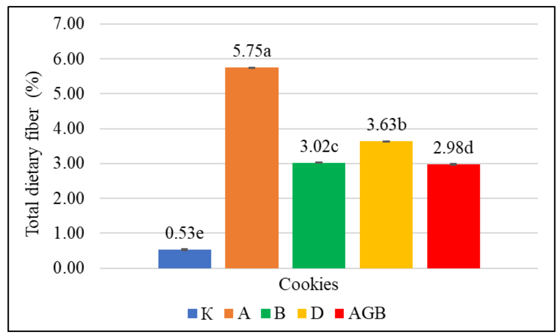
* Control sample (K), Adelaide (A), Bisanzio (B), Cobato (D), AGB-28 (AGB).
Source: Authors' research

As shown in Graph 3, the cookies produced from the three common wheat varieties (Adelaide, Bisanzio, and AGB-28), as well as those produced from the durum wheat variety Cobato, exhibited statistically significantly higher ($p < 0.05$) protein contents compared with the control sample (K). Specifically, the protein contents were 5.85 ± 0.05%, 6.20 ± 0.03%, 6.15 ± 0.03%, and 6.52 ± 0.03% for Adelaide, Bisanzio, AGB-28, and Cobato, respectively, whereas the control sample contained 5.67 ± 0.04% protein. Among the tested samples, cookies produced from the Cobato variety demonstrated the highest protein content. Higher protein content values in cookies have been reported in previous studies. For instance, Kuchtová et al. (2018) observed elevated protein levels in cookies produced from fine wheat flour (Type 650 Extra), while Ogundele and Hiam (2024) also reported higher protein contents in wheat-based cookies.
The results obtained for the fat content show statistically significant differences ($p < 0.05$) among the produced cookies (Graph 4). The highest fat content was observed in cookies K (19.60 ± 0.03%), while the lowest fat content was found in cookies B (15.63 ± 0.02%). Najjar et al. (2022) reported that the fat content of cookies produced from white and whole wheat flour was 19.34% and 20.26%, respectively, which is approximately the same as in the control cookies (K).
Graph 5 and Graph 4 present the obtained results for the total carbohydrate and total dietary fiber content in the produced cookies.

Graph 5. Total carbohydrate content



Graph 6. Total dietary fiber content



* Control sample (K), Adelaide (A), Bisanzio (B), Cobato (D), AGB-28 (AGB).
Source: Authors' research

The presented results show that the total carbohydrate content ranged from 69.83% ± 0.37% (control cookies) to 74.31% ± 0.12% (AGB-28 cookies), while the total dietary fiber content ranged from 0.53 ± 0.02% (control cookies) to 5.75 ± 0.01% (A cookies). Cookies produced from commercially available wheat flour (K) were characterized by a statistically significantly ($p < 0.05$) lower content of total carbohydrates (69.83%) and total dietary fiber (0.53%) compared to the cookies produced from the varietal wheats. The highest total carbohydrate content was observed in the AGB cookies (74.31%), whereas the highest total dietary fiber content was found in the A cookies (5.75%). The obtained results are in agreement with the findings reported by Kuchtová et al. (2018) and Sadaf et al. (2022). In contrast, Ogundele & Hiam (2024) reported lower values for total carbohydrate content (51.82%) but higher values for total dietary fiber content (8.89%) in cookies produced from common wheat, compared to our results.
The results of the mineral composition of the produced cookies are presented in Table 1.

Table 1. Mineral composition of the produced cookies

Sample	**Mineral composition (mg/kg)**							
	Zn	**Fe**	**Cu**	**Mn**	**Ca**	**K**	**Mg**	**Na**
Control	3.17	4.21	/	3.19	673.00	1534.00	193.50	1314.90
Adelaide (A)	8.42	17.80	2.97	9.53	907.00	1858.20	370.10	2038.10
Bisanzio (B)	6.75	18.90	2.99	9.27	641.50	1782.00	342.40	2031.00
AGB-28 (AGB)	8.26	17.10	3.09	9.30	636.30	1823.20	347.60	2020.70
Durum (D)	8.08	17.60	2.43	8.94	941.00	1748.00	359.80	1869.70

Source: Authors' research

From the presented results, it can be observed that with regard to the content of micro- and macrominerals, the cookies produced from the Adelaide variety stand out with the highest values for Zn (8.42 mg/kg), Mn (9.53 mg/kg), Ca (907.00 mg/kg), K (1858.20 mg/kg), Mg (370.10 mg/kg), and Na (2038.10 mg/kg). Compared to the cookies produced from the various wheat varieties, the control cookies are characterized by a lower content of micro- and macrominerals, while copper was not detected. Ojinnaka et al. (2019) reported that wheat biscuits contain 4.46 mg/100 g Fe, 360.50 mg/100 g K, 137.50 mg/100 g Mg, and 3.21 mg/100 g Na. Dossa et al. (2025), in determining the mineral composition of wheat flour cookies, found that among the microminerals, Fe was present at 7.139 mg/kg, Mn at 1.663 mg/kg, Zn at 22.041 mg/kg, and Cu at 1.549 mg/kg. Among the macrominerals, Na was present at 90.450 mg/kg, K at 1393.983 mg/kg, and Mg at 418 mg/kg, while Ca was present at 476.896 mg/kg.

4. CONCLUSIONS

The present study investigated the influence of different wheat varieties on the chemical composition of cookies by replacing commercially available Type 400 wheat flour with flours obtained from selected wheat cultivars. Specifically, cookies were produced from three varieties of common wheat (*Triticum aestivum* L.)—Adelaide, Bisanzio, and AGB-28—and one variety of durum wheat (*Triticum durum* Desf.)—Cobato, and their chemical characteristics were compared with those of a control sample prepared from commercial flour. The results of the chemical analyses demonstrated that the substitution of commercial wheat flour with varietal flours significantly affected the chemical composition of the produced cookies. Statistically significant differences ($p < 0.05$) were observed among the samples for several of the analyzed parameters, confirming that the wheat variety represents an important factor influencing the nutritional and compositional properties of the final product. Variations in moisture, protein, fat, ash, and other components can be attributed to the inherent compositional differences among the wheat varieties used for flour production. These findings highlight the role of raw material selection in determining the quality and nutritional characteristics of bakery products. In particular, cookies produced from varietal flours exhibited notable differences in protein and other nutrient contents compared with the control sample, suggesting that the use of specific wheat cultivars can contribute to improving or modifying the nutritional profile of cookies. Such variability provides opportunities for the development of bakery products with tailored nutritional characteristics, depending on the technological and nutritional objectives of production. Furthermore, the results indicate that the utilization and potential commercialization of flours derived from different wheat varieties could enable the production of cookies with diversified macro- and micronutrient compositions. This approach may support the development of bakery products with enhanced nutritional value and improved functional properties. The strategic selection of wheat varieties therefore represents a promising pathway for product innovation in the bakery industry, particularly in the context of increasing consumer demand for nutritionally improved and functional food products. Overall, the findings of this study contribute to a better understanding of the relationship between wheat variety and the chemical composition of cookies. They also provide a scientific basis for the further exploration of varietal wheat flours in the formulation of bakery products with improved quality, nutritional value, and potential functional food applications. Future research may focus on evaluating additional quality parameters, such as packaging methods and storage stability, in order to further support the practical application of these flours in cookie production.

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