



NUTRITIONAL AND PHYTOCHEMICAL CHARACTERIZATION OF GLUTEN-FREE BREAD BASED ON TAPIOCA FLOUR, ALMOND FLOUR AND APRICOT KERNEL FLOUR (*PRUNUS ARMENIACA L.*)

Anamaria Frențiu¹, Marina-Florina Gociu¹, Andreea Inoveanu¹, Mariana-Atena Poiană¹, Daniela Stoin^{1,*}

University of Life Sciences "King Mihai I" from Timisoara, Faculty of Food Engineering, Timisoara, Calea Aradului, nr. 119, Roumania, 300645

*e-mail: gociumarinaflorina@yahoo.com; danielastoin@usvt.ro

Abstract: The objective of the present study was to investigate the effect of substituting tapioca flour (TF) with increasing proportions of apricot kernel flour (AKF) in combination with almond flour (AF), on the nutritional and phytochemical characteristics of gluten-free bread. The formulations were prepared using tapioca flour (TF), almond flour (AF), apricot kernel flour (AKF), salt, eggs, olive oil, yeast, sugar, almond milk, water, xanthan gum, and apple vinegar. Four bread variants were developed according to the following ratios: Control (PM: 0% AKF : 28% AF : 72% TF), P1 (2% AKF : 28% AF : 70% TF), P2 (4% AKF : 28% AF : 68% TF), and P3 (6% AKF : 28% AF : 66% TF). Significant differences were observed in the proximate composition and phytochemical profile as the proportion of AKF increased. Protein content increased from 9.4% in the control sample to 11.2% in P3, while total lipid content rose from 8.6 to 12.1%, reflecting the high concentration of unsaturated fatty acids in AKF and AF. Mineral levels (particularly potassium, magnesium, phosphorus, and iron) were also higher in enriched samples, ranging between 1.66% and 1.78%. The total phenolic content increased significantly from 34.2 mg GAE/100 g in the control to 58.5 mg GAE/100 g in the P3 sample, accompanied by enhanced antioxidant activity determined through the DPPH radical scavenging assay. Sensory analysis indicated that the bread samples with moderate levels of AKF substitution (P1–P2) exhibited the best balance between nutritional enhancement and sensory acceptability, maintaining desirable texture, volume, and flavor. The incorporation of apricot kernel flour, alongside tapioca and almond flours, significantly improved the nutritional and functional profile of gluten-free bread.

Keywords: gluten-free bread, tapioca flour, almond flour, apricot kernel flour, functional product

• Introduction

Gluten-free bread often suffers from low nutritional quality and poor texture due to the absence of gluten, which provides structure and elasticity. The incorporation of alternative flours, such as apricot kernel flour (AKF), tapioca flour (TF), and almond flour (AF), offers an opportunity to enhance both the nutritional and functional properties of gluten-free bread. Apricot kernel flour is rich in protein, fiber, and bioactive compounds, while almond flour contributes healthy fats, proteins, and micronutrients. Tapioca flour provides starch that improves dough consistency and crumb structure. By combining these flours, it is possible to develop gluten-free bread with improved nutritional value, sensory characteristics, and functional properties, while also promoting the valorization of plant-based by-products.

• Material and method

- Ingredients:** AKF, TF, AF, eggs, olive oil, milk, yeast, xanthan gum, apple cider vinegar, and salt were obtained from local specialized stores in Timișoara, Romania.
- Production of gluten-free bread samples:** Control and experimental breads, prepared with varying substitution levels of TF with AKF, were produced following AACC International Method 10-50.05, with slight modifications.
- Sensory evaluation of gluten-free bread samples:** A panel of 20 trained panelists evaluated the bread samples using a 9-point hedonic scale.
- The proximate composition, total phenolic content (TPC), and antioxidant activity (AA) of the gluten-free bread samples** were evaluated using standard laboratory procedures.

• Results and discussion

The bread formulations were prepared using tapioca, almond, and apricot kernel flours, with varying levels of apricot kernel flour (0–6%). Increasing AKF content improved the nutritional and functional profile: protein rose from 9.4% to 11.2%, lipids from 8.6% to 12.1%, and ash ranged 1.66–1.78%. Total phenolic content increased from 34.2 to 58.5 mg GAE/100 g, accompanied by enhanced antioxidant activity. Sensory analysis showed that moderate AKF substitution (2–4%) provided the best balance between nutrition and sensory acceptability, maintaining texture, volume, and flavor. Incorporating apricot kernel flour alongside tapioca and almond flours represents a promising strategy for producing nutrient-enriched, functional gluten-free bread.



Figure 1. The gluten-free bread samples supplemented with AKF

Table 1. Proximate composition of gluten-free bread samples

Proximate composition (%)	Gluten-free bread samples			
	PM	P1	P2	P3
Moisture	32.24± 0.41	32.52± 0.09	32.90± 0.09	33.42± 0.13
Fat	6.83 ± 0.11	8.60 ± 0.03	10.44 ± 0.11	12.10 ± 0.06
Protein	5.94 ± 0.22	9.40 ± 0.09	10.62 ± 0.04	11.20 ± 0.03
Crude fibre	3.55 ± 0.07	4.63 ± 0.24	4.92 ± 0.06	5.42 ± 0.33
Ash	1.66 ± 0.08	1.71 ± 0.23	1.76 ± 0.44	1.78 ± 0.03
Carbohydrates	49.78± 0.32	43.14± 0.25	39.36± 0.04	36.08± 0.09
Energy value (kcal/100 g)	284.35± 0.24	287.56± 0.04	293.88± 0.12	298.02± 0.22

Table 2. Sensory evaluation of gluten-free bread samples

Sensory evaluation	Gluten-free bread samples			
	PM	P1	P2	P3
Color	7.42 ± 0.07	8.06 ± 0.17	7.76 ± 0.07	7.62 ± 0.06
Appearance	7.55 ± 0.24	8.18 ± 0.04	7.82 ± 0.22	7.56 ± 0.41
Odor	7.18 ± 0.44	8.65 ± 0.30	7.67 ± 0.35	7.44 ± 0.06
Flavor	7.05 ± 0.07	8.46 ± 0.14	8.20 ± 0.24	7.94 ± 0.09
Overall acceptance	7.12 ± 0.06	8.52 ± 0.34	8.26 ± 0.09	8.07 ± 0.02

Conclusions

Increasing the proportion of apricot kernel flour (AKF) in gluten-free bread improved its nutritional and functional profile. Protein and lipid contents increased, minerals were higher, and total phenolic content and antioxidant activity were enhanced. Moderate AKF substitutions (P1–P2) maintained good sensory attributes, including texture, volume, and flavor. Incorporating AKF with tapioca and almond flours offers a promising strategy for producing nutrient-enriched, functional, and sustainable gluten-free bread.