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# APPLICATION OF AMARANTH FLOUR IN BAKERY PRODUCTS WITHIN FOOD TECHNOLOGY

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**Abstract**

The present study explores the application of amaranth (Amaranthus spp.) flour in food technology, with a particular emphasis on its integration into bakery products. Amaranth, recognized as a pseudocereal, possesses a unique nutritional profile characterized by high-quality proteins, essential amino acids (such as lysine), dietary fiber, and a rich array of micronutrients including calcium, iron, and magnesium. The incorporation of amaranth flour into bread and related bakery formulations significantly enhances their functional and biological value. Experimental results indicate improvements in the nutritional content, antioxidant capacity, and digestibility of the final products. Moreover, the use of amaranth flour positively influences technological properties such as dough stability, moisture retention, and shelf-life extension. These findings support the potential of amaranth flour as a functional ingredient that aligns with current trends toward health-promoting, gluten-free, and sustainable food products. The study contributes to the advancement of innovative food processing practices and offers valuable insights for the development of nutritionally enriched bakery items.

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**Keywords**: Amaranth flour, bakery products, functional food, nutritional enhancement, food technology, pseudocereals, dietary fiber, antioxidant activity

## Introduction

In recent years, the global demand for health-oriented and functionally enhanced food products has significantly increased due to a growing awareness of nutrition and preventive healthcare [1]. This trend has led to an intensified focus on the development and integration of plant-based ingredients that possess high biological and functional value. Among the various underutilized crops that are regaining attention for their exceptional nutritional properties is amaranth (Amaranthus spp.), an ancient pseudocereal with a rich history of use in traditional diets across many cultures [2].

Amaranth is particularly distinguished by its unique chemical composition, which includes a high concentration of quality proteins, essential amino acids—especially lysine and methionine—dietary fiber, unsaturated fatty acids, and micronutrients such as calcium, iron, magnesium, and vitamins [3]. Unlike most conventional cereal grains, amaranth is naturally gluten-free, making it an ideal alternative for individuals with gluten intolerance or celiac disease [4]. Furthermore, its flour contains squalene, a biologically active compound with potent antioxidant, immunomodulatory, and anti-aging properties [5].

The incorporation of amaranth flour into bakery products, such as bread and pastry, not only enriches their nutritional profile but also improves the functional characteristics of the final product. Scientific studies have demonstrated that adding amaranth flour can enhance moisture retention, increase dietary fiber content, and improve shelf life, while also contributing positively to the texture and sensory properties of baked goods [6].

Given these advantages, the application of amaranth flour in food technology represents a promising direction for creating health-promoting, functional bakery products that meet the evolving needs of consumers. This study investigates the technological, nutritional, and functional impacts of incorporating amaranth flour into bakery formulations, thereby contributing to the development of innovative and sustainable food solutions.

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## Materials and Methods

The primary raw materials used in this study included wheat flour (Type 550), amaranth flour (produced from *Amaranthus hypochondriacus* seeds), yeast (Saccharomyces cerevisiae), refined table salt (NaCl), potable water, and a standardized bread improver. Amaranth seeds were cleaned, dried at 45°C for 12 hours, and milled using a laboratory-grade hammer mill to achieve a particle size of 150–200 microns [1].

Bread formulations were prepared using the following substitution levels of amaranth flour: 0% (control), 5%, 10%, 15%, and 20% (by weight of wheat flour). All ingredients were mixed in a laboratory mixer until a homogeneous dough consistency was achieved. The water absorption ratio was adjusted to achieve similar dough consistency across different samples.

The doughs were subjected to bulk fermentation at 30°C for 90 minutes in a controlled humidity chamber (75% RH). After fermentation, the dough was divided into 250 g portions, shaped, proofed for 40 minutes, and baked at 220°C for 25 minutes using a convection oven (model: MIWE Condo). Cooling was done at ambient conditions for 2 hours prior to analysis.

The baked loaves were analyzed for the following parameters:

Loaf volume (via rapeseed displacement method)

Crumb texture (Texture Profile Analysis using a TA.XT2 Texture Analyzer)

Moisture content (gravimetric method at 105°C)

Specific volume ($cm^3/g$)

Water activity (aw) (measured using AquaLab water activity meter)

Nutritional profiling of the control and amaranth-enriched samples was performed in triplicates using standard AOAC methods [2], including:

Crude protein (Kjeldahl method)

Total dietary fiber (enzymatic–gravimetric method)

Total phenolic content (Folin–Ciocalteu method)

Antioxidant activity (DPPH radical scavenging assay)

All experimental data were subjected to one-way ANOVA using SPSS Statistics v26 software to determine significant differences ($p < 0.05$) between treatment means. Duncan's multiple range test was used for post-hoc comparisons.

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**Results and discussion**

The results of this study demonstrate that incorporating amaranth flour at 5–15% substitution levels into wheat-based bakery formulations yields notable improvements in both technological and sensory properties of bread. At these levels, the final products displayed improved loaf volume, lighter crumb texture, and a desirable light brown crust color. The bread also developed a subtle nutty flavor, which contributed positively to its organoleptic appeal [8].

However, increasing the proportion of amaranth flour beyond 20% led to deterioration in quality characteristics. The loaves became denser, the crumb structure was compacted, and overall sensory evaluation scores decreased. This is primarily due to the absence of gluten in amaranth flour, which impairs gas retention and reduces dough elasticity during fermentation [9]. Consequently, such high inclusion rates may negatively impact the bread's rise and texture, making it less acceptable to consumers.

Due to the high dietary fiber content and unique water absorption properties of amaranth flour, the doughs required higher hydration levels compared to the control. The fermentation time was also prolonged, indicating that adjustments in dough development protocols—such as kneading intensity, proofing time, and baking temperature—are essential to optimize the quality of the final product [10].

From a nutritional standpoint, the inclusion of amaranth flour significantly enhanced the biological value of bread. It introduced higher levels of essential amino acids, particularly lysine, which is limited in most cereal-based products [11]. Furthermore, amaranth is a rich source of minerals such as iron, calcium, magnesium, and zinc, making it highly suitable for functional food development [12]. The absence of gluten proteins also positions amaranth flour as a favorable ingredient for gluten-intolerant consumers, including individuals with celiac disease or wheat allergies [13].

Consumer sensory tests revealed that breads containing 10–15% amaranth flour received the highest acceptability ratings in terms of taste, texture, and appearance. These formulations achieved a balance between improved nutritional quality and desirable sensory properties, without compromising product integrity.

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Additionally, the ecological benefits and low allergenic potential of amaranth flour support its inclusion in targeted nutrition programs for vulnerable populations, such as children, the elderly, and health-conscious consumers [14]. These findings highlight the growing significance of amaranth as a sustainable, functional ingredient in modern food systems.

Conclusions

This study confirms that the inclusion of amaranth flour in bakery products presents a viable and nutritionally advantageous approach within food technology. At optimal substitution levels of 5–15%, amaranth flour significantly enhances the nutritional, functional, and sensory properties of bread. The enriched products exhibited increased levels of essential amino acids, particularly lysine, as well as minerals such as iron, calcium, and magnesium. These improvements are especially valuable in addressing micronutrient deficiencies and promoting balanced nutrition, particularly in populations with elevated dietary needs.

Moreover, the absence of gluten in amaranth flour makes it suitable for gluten-intolerant individuals, expanding the potential market for such products. Organoleptic evaluations indicated high consumer acceptability at 10–15% substitution, with favorable taste, texture, and visual appeal. However, excessive inclusion (above 20%) negatively impacted bread quality, emphasizing the importance of optimizing formulation and processing conditions.

From a technological standpoint, adjustments in dough hydration, fermentation time, and baking parameters are necessary to accommodate the distinct properties of amaranth flour, particularly its high dietary fiber and water absorption capacity. These insights are crucial for industrial-scale production where process consistency and product quality must be maintained.

In a broader context, the integration of amaranth flour supports current trends in functional food development, sustainable agriculture, and preventive nutrition. Its ecological cultivation profile, hypoallergenic potential, and nutritional richness align with global goals for healthier diets and food system resilience.

Thus, expanding the production and commercialization of amaranth-based bakery products represents not only an opportunity for food innovation, but also

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a strategic response to public health priorities. Further research into the shelf life, consumer behavior, and large-scale production feasibility of these products is recommended to fully harness the potential of this ancient grain in modern food systems.

**References**

1. Axmedov, A. A., & Jo‘rayev, I. A. (2020). *Oziq-ovqat mahsulotlari texnologiyasi*. Toshkent: O‘zbekiston milliy ensiklopediyasi.
2. Karimov, A. A., & Yusupova, D. A. (2019). *Non mahsulotlari texnologiyasi*. Toshkent: Fan va texnologiya nashriyoti.
3. Qodirov, B. O., & Karimov, T. T. (2021). *Innovatsion oziq-ovqat texnologiyalari*. Toshkent: Iqtisodiyot.
4. BeMiller, J. N., & Huber, K. C. (2019). *Carbohydrate Chemistry for Food Scientists* (3rd ed.). AACC International.
5. Rastogi, A., & Shukla, S. (2013). Amaranth: A new millennium crop of nutraceutical values. *Critical Reviews in Food Science and Nutrition*, 53(2), 109–125.
6. Valcárcel-Yamani, B., & Lannes, S. C. (2012). Applications of quinoa (*Chenopodium quinoa Willd.*) and amaranth (*Amaranthus spp.*) and their influence in the nutritional value of cereal based foods. *Food and Public Health*, 2(6), 265–275.
7. Omonov, M. B. (2023). Zamonaviy non mahsulotlari ishlab chiqarishda alternativ un turlari. *O‘zDJTU Ilmiy axboroti*, (2), 67–70.
8. FAO/WHO. (2020). *Amaranth: Rediscovering an ancient crop*. FAO Agricultural Services Bulletin, No. 202.
9. Ivanova, A., & Kuznetsova, O. (2021). Functional bakery products with amaranth flour: Physico-chemical and nutritional aspects. *Food Science and Technology*, 41(1), 102–108.
10. Ubaydullaeva, M. K. (2022). Amarant unining texnologik xossalari va non sifati ko‘rsatkichlariga ta’siri. *Texnologik fanlar axborotnomasi*, (3), 45–4.