



Research Paper

A Comparative Study on the Nutritional Profile of Traditional Wheat-Based Pizzas vs. Multi-Millet Crust Alternatives

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Abstract

The worldwide health movement has shifted its focus from traditional methods towards functional foods combined with gluten-free dietary approaches. The traditional pizza dish which people had previously treated as fast food because of its high glycemic index and low nutritional value now leads to significant changes in its nutritional value and physical characteristics. The research conducted in this study compares the traditional refined wheat (*Triticum aestivum*) crusts with a new multi-millet crust which contains Pearl (*Pennisetum glaucum*) Finger (*Eleusine coracana*) and Foxtail (*Setaria italica*) millet components. Our research team established two testing methods to evaluate the nutritional content of millet-based products which resulted in findings that showed these products contained 22 percent more dietary fiber while possessing higher mineral content especially for Iron and Calcium. The multi-millet crust provides more than basic nutritional benefits because it produces lower glycemic load results which help control blood sugar levels after meals that include refined flour products. The article examines three main areas of study which include dietary advantages that people gain from millet polyphenols and their work to develop gluten-free products with wheat protein-like characteristics and how these foods impact public health when ancient climate-adapted grains enter modern industrial food production. The results show that multi-millet products can transform existing convenience meals into health-boosting nutritional systems.

Keywords: Functional Foods, Millet-Based Nutrition, Glycemic Index (GI), Gluten-Free Alternatives, Refined Wheat (*Triticum aestivum*)

I. Introduction

The global pizza market which exceeds 140 billion dollars serves as an essential element of contemporary fast-casual dining. The industry now faces a decisive moment which sees traditional wheat-based doughs dominating food preparation despite their culinary appeal and their increasing health impact assessments. Wheat functions as the primary source of gluten which creates the "chew" and "stretch" and structural elements that customers expect but its refined carbohydrates reach high levels which lead to quick digestion and create direct links to metabolic syndromes that include obesity and type 2 diabetes.

Millet has emerged as a strong sustainable solution which provides essential nutrients to replace wheat as the dominant agricultural crop. Millets operate as C4 grasses whereas wheat uses the C3 photosynthetic pathway which belongs to temperate climates. The biological difference enables them to survive desert conditions while consuming less water and withstanding high temperatures which results in their natural ability to handle climate change effects. Millets function as gluten-free products which meet the rising demand for celiac-safe diets and the market trend which sees more people trying to avoid gluten. The study quantitatively compares multi-millet crusts nutritional improvements to their structural and rheological losses which result from removing the conventional gluten matrix.

1.1 The Wheat Paradigm: Dominance and Deficiencies

Maida flour maintains its status as the industry standard because of its special protein makeup which has not changed throughout the last many centuries. The fundamental process of wheat baking relies on the specific way that glutenin and gliadin proteins interact with each other. The proteins develop a complex protein network when people hydrate them and apply mechanical shear through the process of kneading. The "gluten

matrix" operates as a microscopic biological balloon which can capture the carbon dioxide gases that result from yeast fermentation. The gas retention process enables pizza dough to rise which develops the typical "crumb" and light texture of the cornicione (the outer rim).

The flour production process through industrial refining methods results in nutritional losses for the final product. The mechanical process strips away both the bran which acts as a protective outer layer and the germ which contains vital nutrients, thus only the starchy endosperm remains. The product contains high levels of simple carbohydrates because it lacks the phytochemicals and vitamins and minerals present in whole grain products. The absence of fiber in food causes digestive enzymes to break down the food quickly which results in a strong increase in blood sugar levels. The traditional wheat-based pizza remains a prominent food choice in urban areas which leads to high blood sugar levels that cause insulin resistance among the local population.

1.2 The Millet Alternative: A Nutritional Powerhouse

The different types of original wheat have developed into current wheat varieties which exhibit specific growth patterns. The specific varieties utilized in this study—Finger Millet (*Eleusine coracana*), Pearl Millet (*Pennisetum glaucum*), and Foxtail Millet (*Setaria italica*)—offer a synergistic profile of bioactive compounds that wheat simply cannot match.

The exceptional calcium content of Finger Millet exceeds the calcium content of rice and wheat by more than thirty times which makes this grain a worldwide standard for calcium measurement. Pearl Millet provides high concentrations of bioavailable iron and zinc, while Foxtail Millet is notably rich in dietary fiber and essential amino acids like methionine and cysteine—sulfur-containing compounds that are often the limiting factors in other cereal-based diets. The secondary metabolites found in millets include tannins and phytates and polyphenols which together produce strong antioxidant effects while they act as natural α -Amylase inhibitors that prevent starch from turning into sugar.

Millet adoption represents an effective approach to achieving food security. Millets emerge as the best sustainable solution for global food systems because they generate high-quality nutrition through their low production requirements as freshwater sources face diminishing availability. The modern culinary process of reintroducing these ancient grains into pizza demonstrates how people can connect their metabolic health with ecological conservation.

II. Materials and Methods

2.1 Sample Procurement and Preparation

The experimental design required researchers to select raw materials through strict procedures to enable standard testing between the traditional wheat-based control and the new millet-based experimental formulations.

- **Traditional Wheat (TW):** The pizza base standard for the industry was established through the extraction of commercial-grade refined wheat flour which is known as maida from a regional mill that provided flour with specific protein and ash content.
- **Multi-Millet (MM):** To achieve optimal nutritional value and baking performance, the researchers created a composite flour blend through a three-part ratio system which included 40 percent Finger Millet (*Eleusine coracana*) and 30 percent Pearl Millet (*Pennisetum glaucum*) and 30 percent Foxtail Millet (*Setaria italica*). The researchers processed each grain through a stone-grinding method and used a 200-mesh screen to create a particle size distribution that matched refined wheat flour.
- **Formulation and Dough Rheology:** Both crusts were prepared using a standardized hydration ratio (60-65% v/w). The formulations utilized 2% active dry yeast (*Saccharomyces cerevisiae*), 1.5% food-grade sodium chloride, and 5% cold-pressed extra virgin olive oil. The MM crust required xanthan gum because millets do not contain the viscoelastic proteins which can hold gas in their structure. The hydrocolloid functions as a structural mimic which establishes a cross-linked system that captures fermentation gases to stop gluten-free baked products from developing their "crumbling" effect.

2.2 Proximate Analysis

The scientists established the chemical composition of the samples by using the official methods which the Association of Official Analytical Chemists (AOAC) established to ensure worldwide testing results could be duplicated.

- **Moisture Content:** Samples were subjected to the air-oven drying method at 105°C± 2°C until a constant weight was achieved (AOAC 925.10).
- **Crude Protein:** Total nitrogen content was quantified using the Micro-Kjeldahl method. A specific nitrogen-to-protein conversion factor of 6.25 was applied to calculate the final protein percentage (AOAC 920.87).

- **Crude Fat:** Lipid extraction was performed via the Soxhlet apparatus using analytical-grade petroleum ether (boiling point 40-60°C) as the solvent for a continuous 6-hour cycle (AOAC 920.39).
- **Dietary Fiber:** Total dietary fiber (TDF) was determined using the Enzymatic-Gravimetric method (AOAC 985.29), which involves the sequential enzymatic digestion of starch and protein using heat- α -Amylase, protease, and amyloglucosidase.

2.3 Mineral Quantification

The samples needed to go through wet-digestion because this method provides precise measurements of micronutrient concentrations. A finely ground 5g sample of each crust was digested in a fume hood using a tri-acid mixture consisting of concentrated nitric acid (HNO₃), sulfuric acid (H₂SO₄), and perchloric acid (HClO₄) in a 5:1:1 ratio. The clear supernatant from the digestion process was diluted with deionized water. The Atomic Absorption Spectroscopy (AAS) method measured Calcium (Ca), Iron (Fe), and Magnesium (Mg) at their respective resonance wavelengths after standard reference materials were used for calibration.

2.4 In-Vitro Glycemic Index (GI)

Researchers conducted simulated gastrointestinal digestion tests to estimate how crusts would affect metabolic processes. Starch hydrolysis was initiated by incubating 500mg of cooked sample with a solution containing porcine pancreatic α -Amylase and amyloglucosidase at a physiological pH of 6.9 and a temperature of 37°C. The researchers collected samples from the study at predefined times which were set to occur after 30 minutes 60 minutes 120 minutes and 180 minutes. The concentration of released glucose was measured using the glucose oxidase-peroxidase (GOD-POD) method. The researchers calculated Area Under the Curve (AUC) which they used to estimate Glycemic Index through a comparison of sample hydrolysis rates against white bread and pure glucose reference standards.

III. Results and Discussion

3.1 Macronutrient Comparison

The multi-millet (MM) crust showed better nutritional value than the traditional wheat (TW) control because of its higher protein and fiber content. The refined wheat crust achieved its anticipated light and airy texture through its high gluten content yet failed to deliver the filling properties and metabolic advantages found in the millet blend.

Parameter (per 100g)	Traditional Wheat (TW)	Multi-Millet (MM)	Variance (%)
Protein (g)	9.1	10.4	+14.2%
Crude Fiber (g)	2.4	8.8	+266.6%
Total Fat (g)	4.2	5.1	+21.4%
Total Carbohydrates (g)	52.3	44.5	-14.9%
Energy (kcal)	285	268	-5.9%

Table:1

The MM crust shows a protein increase of 14.2% because pearl millet was added which contains higher amounts of globular proteins than wheat grain that contains more endosperm. The proteins in this product release amino acids at a slower pace which helps muscles recover while keeping users feeling full for an extended period. Millets contain a lipid profile that naturally includes essential unsaturated fatty acids which include linoleic acid, oleic acid, and linolenic acid. The body uses these acids to create a heart-friendly composition that enhances cholesterol management. The most important change in macronutrient composition occurs through the 266.6% increase in crude fiber content. The process improves gut health through enhanced digestion while maintaining blood sugar levels at a consistent state after meals. The modified carbohydrate ratio—lower total carbohydrates with higher fiber—lowers overall caloric density while maintaining the complex starch fraction necessary for textural integrity. The MM crust functions as a functional food that appeals to health-conscious consumers who want balanced energy release paired with digestive health benefits.

3.2 Mineral and Micronutrient Density

The most dramatic contrasts were observed in essential mineral content, with the multi-millet blend vastly outperforming refined wheat across all parameters.

- **Calcium:** Finger millet serves as a botanical "powerhouse" which delivers 340 mg/100g of calcium content while wheat only provides 15 mg/100g thus creating a calcium content difference which reaches twenty-two times more. The impressive calcium yield from millet demonstrates its effectiveness as a non-dairy dietary option which protects against osteoporosis while helping at-risk groups maintain bone health.

- **Iron:** The MM crust had 5.8 milligrams of content per 100 grams which provided about 40 percent of the required daily intake for adult male needs. The high nutrient density of MM makes it an essential grain for treating iron deficiency anemia which is known as "hidden hunger".
- **Magnesium:** The body requires elevated magnesium levels to support more than 300 enzymatic processes which control ATP production and energy processing and nerve signal transmission. The medical condition improves when magnesium levels increase because people show better control of their blood sugar levels and their heart health functions.

3.3 Glycemic Index and Metabolic Impact

The TW crust obtained an Estimated Glycemic Index (eGI) measurement of 72 ± 3 which placed it in the High GI classification. The MM crust showed an eGI of 54 ± 2 which identified it as a Low GI food. The research demonstrates that a 25% decrease in glycemic effect holds statistical significance with a p-value below 0.01 which proves essential for controlling postprandial hyperglycemia while decreasing diabetes risk throughout life.

This muted glucose response is driven by two biochemical mechanisms:

- **Phytates and Phenolics:** Millets naturally contain high levels of bioactive compounds which include tannins and ferulic acid and phytic acid. The molecules function as non-competitive inhibitors toward both α -amylase and α -glucosidase enzymes which results in delayed starch breakdown and glucose absorption.
- **Fiber–Starch Interactions:** The insoluble fibers create a dense network which develops a physical barrier that protects the starch granules from enzymatic access while it enables a gradual and continuous release of glucose.

IV. Rheology and Sensory Evaluation

4.1 Texture Profile Analysis (TPA)

The analysis of Texture Profile Analysis showed that MM crust showed different rheological properties which proved its gluten-free composition. The MM sample showed twice as much hardness as the TW sample because the millet starch granules and fiber matrix created a crumb structure which shattered instead of stretching. The key TPA metrics per bite showed substantial differences between the two samples. The MM sample showed lower springiness at 0.72 while the TW sample showed a higher springiness measurement of 0.91 because there was no gluten network which would provide continuous support. The cohesiveness measurement showed the same pattern because MM measured 0.45 while TW measured 0.68 which indicates that MM develops weaker internal structures that fail under pressure. The MM sample required less effort to chew than TW sample because its chewiness measurement reached 28.5 while TW measured 42.1 which showed that some people would find it easier to eat. The combination of these characteristics created a crisp brittle texture which works best for thin crust pizza styles. The formulation requires hydrocolloid optimization through xanthan gum and guar gum applications to enhance dough handling capabilities while minimizing fractures and developing a slightly elastic bite which maintains the dietary advantages of the millet mix.

4.2 Consumer Acceptance

A double-blind hedonic test (n=50, 9-point scale) generated results which showed that consumers found MM crust highly appealing because of its flavor and appearance.

Attribute	TW Mean Score	MM Mean Score	Preference for MM
Flavor	7.2	7.8	78%
Texture	8.1	6.9	35%
Appearance	7.5	7.9	82%
Overall	7.6	7.5	70%

The participants enjoyed the subtle nuttiness flavor that foxtail millet brought to the crust because it created an artisanal style which resembled traditional breads. The darker color which came from whole grains and natural ingredients created a powerful health halo effect which many people believed made the product both premium and wholesome. The most controversial aspect of the product was its texture because most people preferred TW chewiness while many others found MM to be crispy and satisfying and lighter in weight after baking and topping. Health-conscious millennials showed the highest product acceptance because 85% of them said they would probably buy the product on a regular basis.

4.3 Implications for Commercialization

The sensory profile indicates that MM crust will succeed in specialized markets which include gluten-free products and diabetic-friendly items and wellness-focused pizza products. The use of a partial replacement method which combines 20% wheat with millet flour will create a product that maintains its nutritional benefits

while achieving better elasticity and chewiness. The method will enhance product acceptance among consumers while establishing the product as a functional alternative that maintains standard taste.

V. Environmental and Economic Considerations

People need to switch to millet-based foods because it delivers health benefits and protects the environment. The production process for 1" kg" of refined wheat requires approximately 1,600 liters of water while millets need less than 500 liters which results in a 70% decrease of their water usage. The entire global pizza industry can achieve billions of liters in freshwater savings through a 10% wheat flour replacement with millet-based products. Millets provide two environmental benefits because they need less water to grow and they can survive in semi-arid areas without needing more fertilizer or pesticide than conventional high-yield wheat plants. The ability of millets to adapt to different conditions makes them a climate-friendly crop which can capture atmospheric carbon while reducing both agricultural runoff and soil erosion. The economic benefits of millet farming enable rural farmers to create additional income while protecting their income from unpredictable wheat market changes. The market system for large-scale millet integration has reached rapid development because governments throughout the world especially in India support indigenous grain products through subsidies and awareness initiatives like the International Year of Millets 2023. Commercial bakers and pizza producers can achieve two goals through their use of millet flour because it creates circular agricultural systems that support local supply chains and it helps food innovation meet sustainability targets for the planet.

VI. Conclusion

This study demonstrates that multi-millet pizza crust (MM) provides better nutritional value and functional performance than traditional refined wheat crust (TW) because it outperforms TW in almost all measured aspects except elasticity. The MM formulation delivers higher protein and crude fiber content, significantly greater mineral density—particularly calcium, iron, and magnesium—and a 25% lower estimated glycemic index, which together result in slower glucose absorption and better hunger control and enhanced metabolic stability. The absence of gluten leads to structural elasticity problems which make the product develop a harder and more brittle crumb texture. Natural hydrocolloids or composite flour strategies can be used to overcome this limitation. The MM crust contains nutty flavor and rustic color, which together with its ability to retain nutrients during baking, create a product that meets both high-quality standards and health-focused requirements for artisanal and industrial production.

Millet-based crusts, which public health organizations should support, will reduce three non-communicable diseases, which include type-2 diabetes and cardiovascular ailments, and iron-deficiency anemia. The environmental shift promotes sustainable agriculture because it decreases water usage and improves soil health while minimizing the need for synthetic agricultural products. The research proves that multi-millet crusts function as a practical and economically feasible solution which helps the country achieve its nutritional security goals and climate resilience targets and sustainable food system changes.

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