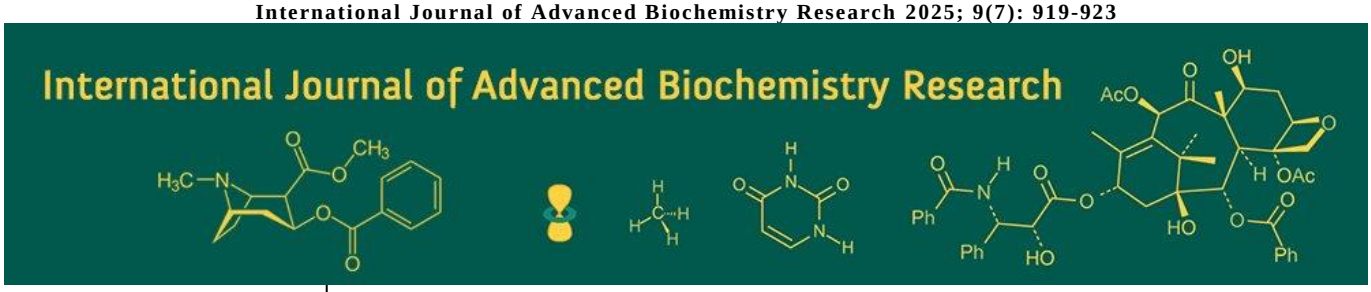

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Baldev Singh
Research Scholar, Department of Food Science and Nutrition, CCAS, MPUAT, Udaipur, Rajasthan, India

Dr. Renu Mogra
Professor and Head, Department of FSN, CCAS, MPUAT, Udaipur, Rajasthan, India

Nandini Wadhwani
Research Scholar, Department of Food Science and Nutrition, CCAS, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Baldev Singh
Research Scholar, Department of Food Science and Nutrition, CCAS, MPUAT, Udaipur, Rajasthan, India

Preparation and standardization of millet based protein rich flour and instant mixes of value added products

Baldev Singh, Renu Mogra and Nandini Wadhwani

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Abstract
With over 10,000 years of cultivation and domestication, millets are a significant component of the grain family. Recent studies have shown that millets are currently the most nutrient-dense and healthful food. In many households, large quantities of these millets are consumed, which helps to lower food insecurity. With their distinct nutritional compositions, quinoa (*Chenopodium quinoa*) and amaranth (*Amaranthus spp*.) are great suppliers of macronutrients and energy. They provide protein, lipids rich in unsaturated fatty acids, and high-quality dietary fiber. They are known as pseudo cereals. The gluten-free grains quinoa and amaranth are both rich in vitamins, minerals, and other biological components. Quinoa and amaranth have higher protein contents than other millets, with 13.1 and 14.5 g per 100 g, respectively. It provides a complete amount of plant-based protein, is suitable for gluten-free diets, and is abundant in vital vitamins and minerals. In order to create value-added products (muffins, pizza base, idli, and handvo) and their instant mixes, the aforementioned study intends to create a protein-rich flour employing millets amaranth (25%) and quinoa (25%), along with additional components (Bengali gram flour 20% and soy flour 30%). The purpose of this study is to help "adolescent boys and girls" meet their daily protein needs. Due to their quick development, greater muscle mass, and improved athletic ability. During this stage of life, there is a strong need for protein. Protein is necessary for the development and repair of tissues, including muscles, bones, skin, and organs. Adolescents who consume adequate protein are protected against muscular atrophy or stunted growth, and they also support appropriate physical development, cell growth, enzyme and hormone production, immune function, and energy supply. Customers may use the protein-rich flour as an extra protein source in their diet. The physical properties of the protein-rich flour made from millet and the quick mixes were examined. Solubility ranged from 11.3% to 13.1%, wettability was 25 to 29 seconds, hydration capacity was 1.6 to 1.9 ml/g, hydration index was 1.3 to 1.5, bulk densities ranged from 0.71 to 0.75 g/ml, swelling capacity was 2.1 to 2.3 ml/g, and swelling index values were 1.2 to 1.4 ml/g. The maximum protein content was found in protein-rich flour (20.8±1.04%), followed by idli mix (20.5±1.09%), muffins (20.5±1.03%), handvo (20.4±1.03%), and pizza base (20.6±1.06%), according to the proximate results. The high protein content is caused by both soy flour and quinoa, which are known for having rich amino acid profiles. The main sources of the fat content, which ranged from 5.2% to 5.4%, were amaranth and soy. Throughout the storage term, the moisture content remained below 10%, indicating excellent shelf stability. As a gauge of mineral composition, the ash content ranged from 2.1% to 2.4%. The crude fibre content was raised from 3.0% to 3.4%, increasing the amount of dietary fibre consumed. The calorie content ranged from 365 to 370 kcal/100 g. The study's conclusion affirms that these nutrient-dense ingredients can be combined to make fast mixes that are health-conscious. The goods demonstrated positive outcomes in terms of shelf life, consumer acceptance, and nutritional quality. Therefore, they can be effectively promoted as functional convenience meals in the present food market setting, supporting public health goals of enhancing food security and nutritional well-being.

Keywords: Millets, amaranth, quinoa, protein rich flour, value added products, instanst mixes, muffins, pizza base, idli, handvo

1. Introduction
Delicious soups, desserts, drinks, sauces, porridges, and souffles are just a few of the many foods that can be made with grains like quinoa and amaranth. Millets can also be used to make fermented and germinated items. The grains are malted to make beer and germinated to make sprouts.

The fermented beverage made from quinoa and amaranth seeds is called "chichi" (Bhattarai *et al.*, 2018) [3]. Quinoa is frequently used to make kispina, a gritty bread. They can also be utilised to manufacture starchy materials, flour, and protein concentrates. Amaranth grains can be rolled or popped and used to make muesli, breads, and granola bars. In many recipes, including pasta, puddings, cakes, biscuits, muffins, crackers, dumplings, and pancakes, grain can be crushed and used in place of flour. Proteins from other cereal grains are thought to be incapable of making dough. Blends of wheat flour and other grains are then used to manufacture bread products. Amaranth and quinoa are currently feasible food alternatives due to their high protein content (Haber *et al.*, 2017) [11].

To enhance the nutritional content of wheat-based goods, pseudocereal can be used to a certain degree. However, because of the high fibre content and the diluting effect on gluten, adding large amounts presents technological hurdles. Restoring the functionality of gluten when wheat is completely substituted is difficult and requires the addition of certain ingredients or adjustments to the production parameters. This study focuses on the seed properties, chemical composition, and technological features of commercially available pseudocereals (buckwheat, quinoa, and amaranth) in order to achieve a more successful and efficient use of them. The characteristics of the pseudocereal WMFs are examined in relation to their chemical makeup and seed properties, and they are compared among the numerous kinds. (Bock *et al.*, 2021) [7]

Utilising composite flour has the added advantage of raising the nutritional value of baked products like biscuits, especially when cereals are combined with legumes or tubers. Rice, quinoa, amaranth, and tuber flour blends (taro, sweet potato, and potato) can also be used to enhance the use of non-wheat flour (gluten-free flours) in baked goods like biscuits. (Salem and others, 2019) While quinoa and amaranth are grown in South America, mostly in Peru and Bolivia, buckwheat originated in Central Asia and was later introduced to Central and Eastern Europe (FAO, 2013).

Tryptophan and methionine are abundant in these protein-rich cereal and pseudocereal fractions, but the amount of other essential amino acids (such lysine) may be low. An amino acid deficiency in food formulation can be compensated for by adding additional components, such as legumes (such as lentil or lupin), which naturally contain larger levels of lysine.

Convenience foods are those that offer the user convenience by needing little to no processing or preparation prior to eating. Recent consumer shifts brought about by increased urbanisation, the industrialisation of "working women," and other reasons have led to the emergence of ready-to-eat foods (RTE) and fast mixes.

Traditional cuisines are now the most popular among customers. Many cereals based on traditional meals have been processed to provide quick mixes including instant UPMA mix, IDLI mix, and dosa mix. Even if local quick food products have long been produced at home, the current boom in the diversity of instant food products has made consumers more willing to use the products that are available in the market in convenient packaging at a reasonable price.

2 Materials and Methods

This study was conducted at the Department of FSN, CCAS, MPUAT Udaipur Rajasthan.

2.1 Formulation of millet based protein rich flour

Quinoa and amaranth were the two millets chosen for this investigation. The local market in Udaipur, Rajasthan, provided the raw materials needed for this study, including soybean, amaranth, quinoa, and Bengal gramme flour. In the lab, raw soybeans were processed to create flour that was high in protein. In the lab, millet-based protein-rich flour was used to standardize food preparation for items including muffins, pizza base, idli and handvo.

2.2 Sensory evaluation of developed products

With the assistance of a panel of judges, the sensory qualities of the products were evaluated using a nine-hedonic rating scale, which ranges from 1 (dislike extremely) to 9 (like extremely).

2.3 Preparation of instant mixes of developed products

In the lab, instant mixes of established items (such as muffins, pizza base, idli, and handvo) were made and standardized.

2.4 Quality evaluation

Physical characteristics of protein-rich flour and instant mixes, including bulk density, swelling capacity and swelling index, solubility capacity, wettability, hydration capacity, and hydration index, were examined using the proper standard techniques.

2.4.1 Nutritional analysis: AOAC-standardized techniques were used to analyse proximate analysis such as moisture, crude protein, crude fat, crude fibre, and total ash. The difference approach was used to estimate the amount of carbohydrates, and the energy content was calculated.

Standard techniques are used for the estimation of minerals (iron and calcium).

Phytate, an anti-nutritional factor, was computed following the proper standard procedure.

Instant mix was made in large quantities, sealed in HDPE bags, and kept at room temperature for 60 days in order to assess its shelf life.

2.5 Shelf life assessment of protein rich flour and instant mixes

2.5.1 Moisture content analysis: Moisture content is measured of protein rich flour and instant mix on oth day, 30th day, 45th day and 60th day.

2.5.2 Microbial evaluation: Microbiological analysis is the best method for evaluating quality. For this, the total viable count (TVC) was looked at. At intervals of 0, 30, 45, and 60 days, assessments were conducted.

2.5.3 Peroxide value: The samples' peroxide value was ascertained by applying the AOAC (2000) procedure.

2.5.4 Sensory evaluation: On the 0th, 30th, 45th, and 60th days of storage, a sensory evaluation of the flour and mixes was conducted. The quality was evaluated using a hedonic rating scale.

2.6 Statistical analysis

According to the study's findings, appropriate statistical techniques were applied to the data analysis. Each sample was analysed three times, and the data in the tables were

expressed using the mean ± standard deviation (SD). The significance criterion for differences was set at $p<0.05$.

3. Results and DISCUSSION

A deliberate step to address the micronutrient and protein deficiencies that are prevalent in various populations is the development of shelf-stable and nutritionally improved protein-rich flour blends. For this study, a protein-rich flour was made using a balanced blend of amaranth flour (25g), quinoa flour (25g), besan (20 g), and soy flour (30 g). This foundation mixture was used to create instant mixes for idli, handvo, pizza base, and muffins. Several physicochemical, nutritional, microbiological, and sensory tests were performed on the blends during a 60-day storage period. The findings show that the created formulations are appropriate in terms of nutritional sufficiency, storage stability, and sensory acceptability.

3.1 Physical Properties

The physical characteristics of the protein-rich flour and its derivative instant mixes have a major impact on the handling, packing, reconstitution behaviour, and customer acceptability of the final products. The samples were easy to pack and carry because their bulk densities ranged from 0.71 to 0.75 g/ml. Swelling capacity (2.1 to 2.3 ml/g) and swelling index values (1.2 to 1.4 ml/g) are indicators of good water absorption ability and are crucial for rehydrating instant mixtures. Solubility ranged from 11.3% to 13.1%, indicating the presence of soluble proteins and carbohydrates; wettability ranged from 25 to 29 seconds; hydration capacity ranged from 1.6 to 1.9 ml/g; and hydration index ranged from 1.3 to 1.5. The hydration capacity and hydration index of the flour considerably strengthened its potential to absorb water, ensuring soft and uniform textures in the final reconstituted goods. These characteristics are particularly important for products like idli and handvo, where batter consistency is essential to the quality of the finished product.

3.2 Proximate Composition

The proximate composition of the protein-rich flour and its rapid mixes showed their better nutritious content. Pizza base (20.6±1.06%), muffins (20.5±1.03%), handvo (20.4±1.03%), and idli mix (20.5±1.09%) were the next highest protein-containing foods. The high protein content is caused by both soy flour and quinoa, which are known for having rich amino acid profiles. The main sources of the fat content, which ranged from 5.2% to 5.4%, were amaranth and soy. Throughout the storage term, the moisture content remained below 10%, indicating excellent shelf stability. As a gauge of mineral composition, the ash content ranged from 2.1% to 2.4%. The crude fibre content was raised from 3.0% to 3.4%, increasing the amount of dietary fibre consumed. The energy value, which ranged from 365 to 370 kcal/100 g, showed that there was enough carbohydrate to meet energy needs.

3.3 Mineral Content

The mineral analysis of the flour and mixes revealed high levels of calcium and iron, which are essential for strong bones and preventing anaemia. While the calcium value fluctuated between 138 and 145 mg/100 g, the iron concentration ranged between 8.0 and 8.6 mg/100 g. These figures demonstrate the effectiveness of amaranth and quinoa, which are naturally high in these nutrients. Despite the presence of phytates (150-200±2-4 mg/100 g), which are known to hinder the absorption of minerals, the mineral levels remained within favourable ranges. Phytate levels had no appreciable impact on bioavailability because they were mild.

3.4 Moisture content during storage

From the first to the sixty-first day of storage, the moisture content of every instant mix rose gradually. Muffin mix increased from 9.1% to 9.9%, pizza base mix from 9.3% to 10.1%, idli mix from 9.1% to 9.8%, protein-rich flour from 9.5% to 10.2%, and handvo mix from 9.0% to 9.9%. This steady rise suggests that moisture is gradually absorbed over time, most likely as a result of package permeability and ambient humidity. It draws attention to the necessity of packaging that can withstand moisture in order to maintain product quality while being stored.

3.5 Peroxide Value

The peroxide value, which is a measure of lipid oxidation, remained nil, or undetectable, for all mixes on the 0th day, confirming the product's freshness and indicating no early signs of rancidity. Over time, exposure to oxygen and ambient temperature caused peroxide levels to progressively increase. The greatest value was 3.2±0.05 to 3.7±0.02 meq/kg on the 60th day, while the values in protein-rich flour ranged from 1.6±0.03 to 2.0±0.02 meq/kg fat on the 30th day. All values remained far below the critical rancidity criterion of 10 meq/kg during the course of the storage period, indicating that the items retained their chemical stability. The critical difference (CD) and standard error (SE) values, which rose over time to represent these findings, validated their reliability.

3.6 Microbial Analysis

Microbial stability was assessed using the total viable count and the pour plating method. The microbial counts on the 0th day were zero and ranged from 2.1×10^3 to 2.4×10^3 CFU/g on the 30th day, indicating hygienic preparation. Counts increased gradually to 3.1×10^3 to 3.6×10^3 CFU/g by the 45th day, and then to 4.8×10^3 to 5.4×10^3 CFU/g by the 60th day. Meanwhile, every measurement remained below the safe ingesting threshold of 10^4 CFU/g. SE and CD values confirmed statistically significant changes over time while staying within microbiologically safe ranges. These results validate the microbiological safety and shelf stability of the proposed blends at room temperature.

3.7 Sensory Evaluation

On the 0th, 30th, 45th, and 60th day, sensory attributes such as appearance, texture, taste, fragrance, and overall acceptability were evaluated using a 9-point hedonic scale. The high ratings (above 8) that all commodities received on the 0th day for all measures demonstrated the initial acceptability of the product. Over the course of storage, there were minor declines in flavour and aroma, particularly by day 60. However, all samples continued to receive scores above 7, suggesting that consumers continue to find them acceptable. Muffins and handvo had the most constant sensory attributes, followed by pizza foundation and high-protein flour. The idli mix's softness and aroma declined even further, probably due to characteristics associated with fermentation.

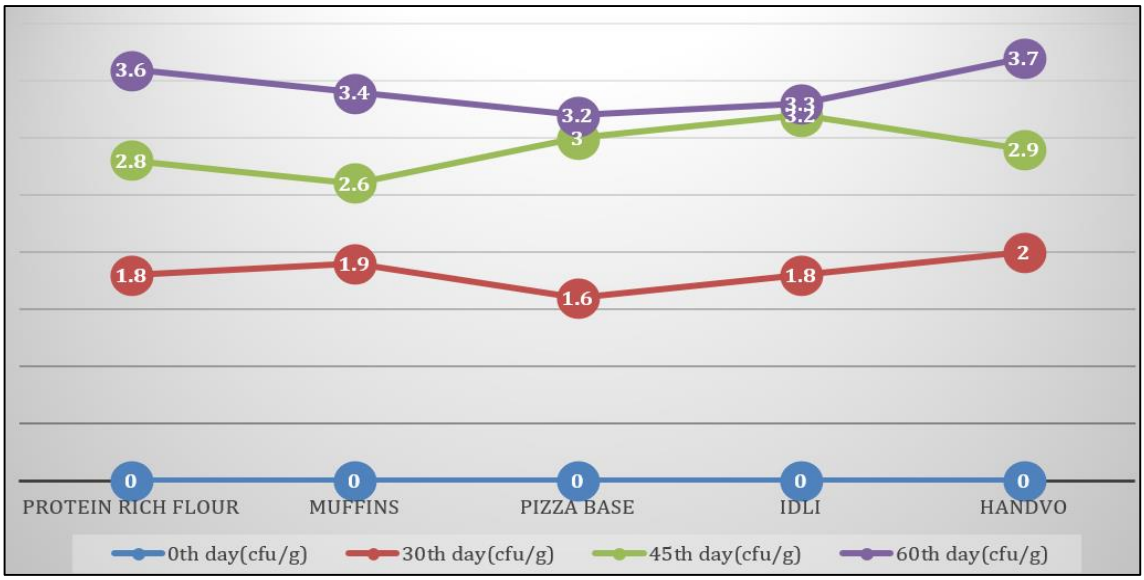

Fig 1: Microbial analysis of protein rich flour and instant mixes

4. Conclusion

The findings clearly demonstrate that the protein-rich flour and its quick mixes are functionally viable, pleasant, and nutritionally adequate, and that they may be stored for up to 60 days under ambient conditions. Together, legumes and pseudocereals offer a complete nutritional profile that includes essential minerals, high protein, and dietary fibre. The goods successfully withstood lipid oxidation and microbiological deterioration over time, while also retaining their intended sensory attributes. These results support the notion that these quick mixes could be utilised as wholesome, ready-to-cook options in both urban and rural settings, improving dietary diversity and nutritional security.

The current study emphasises the value and practicality of include functional ingredients such soy flour, quinoa, amaranth, and besan in quick mixes. These foods were chosen because of their superior nutritional profiles and practical attributes. All of the essential amino acids, particularly lysine, which is lacking in other cereals, are present in the high-quality protein found in pseudocereals like quinoa and amaranth. They also provide high amounts of calcium, iron, and dietary fibre. Besan (Bengal gramme flour), a traditional legume flour, has remarkable emulsifying properties that enhance texture and is rich in protein, fibre, and folate. Soy flour, a well-known legume product, is notable for its high protein content and isoflavones, which are health-promoting antioxidants.

Handvo, idli, pizza base, and muffins are the four types of fast mixes that were made using the composite flour that was created by precisely combining these four elements. Due to changing consumer habits, time constraints, and the growing need for quick yet nutritious food items, the concept of instant mixes is gaining popularity in the modern food market. Because instant mixes not only offer quick preparation but also ensure consistency in taste and quality, they are suitable for a wide range of consumers, including families, students, and working professionals.

Outstanding physical properties, such as bulk density, hydration capacity, and solubility—all crucial for preparation and reconstitution—were displayed by the instant mixes made in this study. Due to their high levels of protein, calcium, iron, fiber, and energy, all of the products satisfied the criteria for functional and fortified foods. The peroxide readings and microbe counts remained within safe limits for the entire 60-day storage period, demonstrating the products' oxidative and microbiological stability.

The health benefits of these drugs are well-established. Amaranth and quinoa support cardiovascular, digestive, and muscle growth. Besan lowers blood sugar levels and increases satiety due to its low glycemic index. Soy flour helps maintain hormonal balance and reduces the risk of chronic diseases like heart disease and some types of cancer. The composite mixes function as a source of nourishment and a way to avoid sickness because of the synergistic advantages that various flours offer.

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