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Traditional Processing Methods for Millets: Enhancing Nutritional Value and Health Benefits by Reducing Anti-Nutritional Factors

Sourabh Ajit Chougala[1], Ramappa[2] and Vishwaradhya M Biradar [3]

[1]Ph.D. Scholar (Agril.Engg.) Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur-584101

[2]Ph.D. Scholar (Agril.Engg.) Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT,Udaipur, Rajastan-313001

3Ph.D. Scholar (Agril.Engg.) Department of Processing and Food Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur-584101

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*Corresponding Author

Abha Nutan Kujur*

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INTRODUCTION

Millets are ancient grains, widely cultivated and consumed in regions like India and Africa for thousands of years. They belong to the *Poaceae* family and are considered a staple food in many traditional diets due to their adaptability to arid climates and poor soils. Common varieties of millets include finger millet (*Eleusine coracana*), pearl millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor*), and foxtail millet (*Setaria italica*). These grains are not only resilient but also nutritionally dense, making them a vital component of food security in many developing countries.

Millets are rich in macronutrients such as carbohydrates, proteins, and fats, and are excellent sources of micronutrients like calcium, iron, magnesium, and B-vitamins. Additionally, they contain a high level of dietary fiber, making them beneficial for digestive health. The nutritional profile of millets makes them a valuable alternative to more commonly consumed cereals like rice and wheat, especially in addressing malnutrition and food security in resource-limited regions.

Anti-Nutritional Factors in Millets

Despite their nutritional benefits, millets also contain various anti-nutritional factors (ANFs) that can interfere with the absorption and utilization of nutrients. These include phytates, tannins, oxalates, and saponins, which are naturally occurring compounds that can bind to essential minerals, reducing their bioavailability. Phytates, for instance, form complexes with minerals like calcium, iron, and zinc, inhibiting their absorption in the gastrointestinal tract. Tannins, on the other hand, can precipitate proteins and interfere with enzymatic activity, leading to reduced protein digestibility.

The presence of these ANFs in millets poses a challenge for nutrition, particularly in populations that rely heavily on these grains as a staple food. However, traditional processing methods have been developed to mitigate the effects of these compounds, thereby enhancing the nutritional value of millets.

Traditional Methods for Reducing Anti-Nutritional Factors

Traditional processing methods are crucial in enhancing the nutritional value of millets by reducing the content of anti-nutritional factors (ANFs). These methods have been practiced for generations and are effective in making millets more suitable for consumption.

- **Soaking:** Soaking millets in water for a specific duration helps in leaching out water-soluble anti-nutritional factors like tannins and saponins. The soaking process also activates endogenous enzymes that break down phytates, thus improving the bioavailability of minerals. For example, soaking finger millet for 12 hours has been shown to reduce phytate content significantly, enhancing mineral absorption.
- **Fermentation:** Fermentation is a traditional process widely used in the preparation of millet-based foods such as idli and dosa in India. During fermentation, lactic acid bacteria produce organic acids that lower the pH, leading to the hydrolysis of phytates. This process also enhances the availability of amino acids and improves protein digestibility. Fermented millet products are particularly rich in nutrients and easier to digest.
- **Germination/Sprouting:** Germination involves soaking the grains and allowing them to sprout. This process activates enzymes such as phytase, which breaks down phytates and other anti-nutritional factors. Sprouted millets have higher levels of vitamins, especially B-vitamins, and improved protein and mineral bioavailability. The process also reduces tannin content, improving the overall nutritional quality of the grains.
- **Malting:** Malting is another traditional method where millets are soaked, germinated, and then dried. This process not only reduces ANFs but also enhances the nutritional quality by increasing the content of soluble sugars, amino acids, and vitamins. Malted millets are often used in the preparation of beverages and weaning foods due to their enhanced nutritional properties.
- **Cooking Methods:** Traditional cooking techniques such as boiling and roasting are effective in reducing the content of heat-labile anti-nutritional factors like oxalates and saponins. Roasting, in particular, is known to reduce tannin levels significantly, thereby improving the palatability and nutritional value of millets.
- **Decortication:** Decortication involves the removal of the outer layer or bran of the millet grains. Since most of the anti-nutritional factors are concentrated in the outer layers, this process significantly reduces their content. However, it is important to note that decortication may also reduce the fiber content of the grains.
- **Parboiling:** Parboiling is a process where millets are soaked, steamed, and then dried. This method is effective in reducing phytates and improving the cooking quality of millets. Parboiled millets also have a longer shelf life and improved texture, making them more versatile in various culinary applications.

Comparative Analysis

The effectiveness of traditional methods in reducing anti-nutritional factors (ANFs) in millets varies significantly depending on the process used. Understanding these differences is crucial for optimizing the nutritional benefits of millets in both traditional and modern diets.

Soaking is one of the simplest methods, primarily effective in reducing water-soluble ANFs such as phytates and tannins. Studies have shown that soaking can reduce phytate content by up to 50%, thereby improving mineral bioavailability. However, its impact on other ANFs like oxalates and saponins is limited. Fermentation is more effective than soaking, as it not only reduces phytates but also degrades tannins and improves protein digestibility. The acidic environment created during fermentation activates endogenous enzymes that break down complex ANFs into simpler, more absorbable forms. Fermentation has been found to improve the bioavailability of iron and zinc, making it a

highly effective method for enhancing the nutritional quality of millets. Germination/Sprouting further enhances the nutritional profile of millets by significantly reducing phytate levels and increasing the content of bioactive compounds like vitamins and antioxidants. Sprouting has been shown to decrease tannin content, thereby improving protein digestibility and mineral availability.

Compared to soaking and fermentation, germination offers a more comprehensive reduction in ANFs while simultaneously boosting the nutritional value. Malting is similar to germination but includes additional drying steps, making it more effective in reducing ANFs like phytates and increasing the availability of amino acids and sugars. Malted millets have a superior nutritional profile, particularly in terms of protein and mineral content. Malting also enhances the sensory properties of millets, making them more palatable and suitable for various food products. Cooking Methods such as boiling and roasting are effective in reducing heat-labile ANFs like oxalates and saponins. However, these methods have limited impact on phytates and tannins unless combined with other processes like soaking or fermentation. Boiling, for instance, can reduce oxalate content by up to 80%, but its effect on phytates is minimal. Roasting, on the other hand, is particularly effective in reducing tannin content and improving the taste and digestibility of millets.

Decortication is highly effective in reducing ANFs because it removes the outer layers of millet grains where these compounds are concentrated. However, this process also removes a significant portion of dietary fiber and some micronutrients, making it less ideal for those seeking the full nutritional benefits of whole grains. Parboiling has been shown to effectively reduce phytate content and improve the texture and cooking quality of millets. While parboiling does not completely eliminate ANFs, it significantly reduces their levels and enhances the overall nutritional profile.

Enhanced Health Benefits

The traditional processing methods used to reduce anti-nutritional factors (ANFs) in millets not only make these grains more nutritious but also enhance their health benefits. The improvement in nutrient bioavailability and the reduction of harmful compounds result in millets becoming powerful functional foods that can help manage and prevent various health conditions.

1. **Improved Nutritional Value:** The reduction of ANFs through methods like germination, fermentation, and malting leads to an increase in the bioavailability of essential minerals such as iron, calcium, and zinc. This is particularly important in regions where micronutrient deficiencies are prevalent. For example, sprouted millets have higher levels of bioavailable iron and zinc, which are critical for combating anemia and supporting immune function. Additionally, the breakdown of phytates and tannins during these processes enhances protein digestibility and amino acid availability, further improving the overall nutritional profile of millets (Rao and Deosthale , 1988).
2. **Managing Lifestyle Diseases:** Processed millets are increasingly recognized for their role in managing lifestyle-related diseases such as diabetes and cardiovascular disorders. Millets are rich in dietary fiber, particularly insoluble fiber, which aids in regulating blood sugar levels by slowing down carbohydrate absorption. The presence of resistant starch, which is enhanced through processes like parboiling and fermentation, also contributes to a lower glycemic index (GI), making millets an ideal food for diabetes management. Moreover, the increased availability of bioactive compounds, such as antioxidants and phenolics, after traditional processing, helps in reducing oxidative stress and inflammation, thereby supporting heart health.
3. **Contribution to Gut Health:** The fermentation of millets leads to the production of beneficial compounds like lactic acid and short-chain fatty acids (SCFAs), which have prebiotic effects. These compounds promote the growth of healthy

gut microbiota, improving digestion and enhancing immune function. Fermented millet foods, such as dosa and idli, are not only easier to digest but also contribute to a balanced gut environment, which is crucial for overall health. The increased dietary fiber content after processing also supports regular bowel movements and helps in the prevention of digestive disorders like constipation and irritable bowel syndrome (IBS).

4. **Enhanced Immune Function:** The improved nutrient profile of processed millets supports the immune system by providing essential vitamins, minerals, and bioactive compounds that are necessary for maintaining immune health. The increased bioavailability of zinc, in particular, is crucial for immune function, as zinc plays a key role in the development and function of immune cells. Additionally, the presence of antioxidants in processed millets helps in neutralizing free radicals, thereby reducing the risk of chronic diseases and supporting overall immune resilience.

CONCLUSION

Millets, often regarded as ancient grains, have emerged as a crucial component in modern diets due to their rich nutritional profile and health benefits. Traditional processing methods, including soaking, fermentation, germination, malting, cooking, decortication, and parboiling, play a significant role in enhancing the nutritional value of millets by reducing anti-nutritional factors (ANFs) and improving the bioavailability of essential nutrients.

Soaking and fermentation effectively reduce water-soluble ANFs such as phytates and tannins, improving the mineral bioavailability of millets and making them more nutritious. Germination and malting further enhance this effect by significantly reducing phytates and increasing the levels of essential vitamins and amino acids. Cooking methods like boiling and roasting also contribute to reducing heat-labile ANFs, although they are less comprehensive compared to fermentation and germination. Decortication and parboiling provide additional benefits by removing or reducing specific ANFs while improving cooking quality and extending shelf life.

These traditional methods not only make millets more nutritious but also enhance their health benefits. Processed millets have been shown to improve protein digestibility, manage blood sugar levels effectively, support cardiovascular health, and contribute to gut health through prebiotic effects. The increased availability of essential nutrients such as iron, zinc, and antioxidants helps in addressing nutritional deficiencies and supports overall health.

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