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PENGARUH PERKECAMBAHAN TERHADAP SIFAT FUNGSIONAL JEWAWUT: TINJAUAN KOMPREHENSIF

The Effect of Germination in Functional Properties of Pearl Millet: A Comprehensive Review

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ABSTRAK

Jewawut, tanaman sereal yang tahan banting dan bergizi, memainkan peran penting dalam memastikan ketahanan pangan di daerah kering dan semi-kering di seluruh dunia. Meskipun penting, penelitian mengenai perubahan fisikokimia dan sifat fungsional Jewawut selama perkecambahan masih terbatas. Penelitian ini bertujuan untuk meninjau dan mensintesis literatur yang ada secara sistematis untuk menjembatani kesenjangan pengetahuan ini dan memberikan wawasan tentang potensi Jewawut mutiara yang dikecambahkan dalam pengembangan pangan fungsional. Kami berhipotesis bahwa perkecambahan secara signifikan meningkatkan sifat fungsional Jewawut dengan mengubah karakteristik fisikokimianya. Penelitian sebelumnya telah mendokumentasikan berbagai transformasi biokimia dan struktural pada Jewawut selama perkecambahan, termasuk perubahan aktivitas enzim, komposisi nutrisi, dan senyawa bioaktif. Namun, analisis komprehensif tentang bagaimana perubahan ini secara khusus memengaruhi sifat fungsional Jewawut masih kurang. Dengan menyelidiki transformasi ini, kita dapat mengoptimalkan penggunaan Jewawut dalam mengembangkan makanan fungsional yang memenuhi kebutuhan konsumen yang sadar akan kesehatan dan memenuhi kebutuhan diet atau masalah kesehatan tertentu. Penelitian ini akan berkontribusi pada pemahaman yang lebih baik tentang potensi nutrisi dan fungsional dari millet mutiara yang berkecambah, yang pada akhirnya mengarah pada produk makanan inovatif dan peningkatan ketahanan pangan di daerah di mana Jewawut merupakan tanaman pokok.

Kata kunci: Makanan fungsional, Kulit biji, Fermentasi

ABSTRACT

Pearl millet, a resilient and nutritious cereal crop, plays a crucial role in ensuring food security in arid and semi-arid regions worldwide. Despite its importance, there is limited research on the physicochemical changes and functional properties of pearl millet during germination. This study aims to systematically review and synthesize existing literature to bridge this knowledge gap and provide insights into the potential of germinated pearl millet in functional food development. We hypothesize that germination significantly

enhances the functional properties of pearl millet by altering its physicochemical characteristics. Previous studies have documented various biochemical and structural transformations in pearl millet during germination, including changes in enzyme activity, nutrient composition, and bioactive compounds. However, a comprehensive analysis of how these changes specifically influence the functional properties of pearl millet is lacking. By investigating these transformations, we can optimize the use of pearl millet in developing functional foods that cater to health-conscious consumers and address specific dietary needs or health concerns. This research will contribute to a better understanding of the nutritional and functional potential of germinated pearl millet, ultimately leading to innovative food products and improved food security in regions where pearl millet is a staple crop.
***Keywords**: Functional food, Fruit peels, Fermentation*

PENDAHULUAN

Pearl millet is a staple cereal crop in many arid and semi-arid regions of the world, known for its resilience and nutritional value. Pearl millet's adaptability to harsh environmental conditions makes it a crucial food source for millions of people in Africa and Asia. Its high protein content and essential micronutrients contribute to improved food security and nutrition in these regions. Additionally, pearl millet has gained attention in recent years for its potential in sustainable agriculture and climate change adaptation strategies. Foxtail millet is a cereal crop that has a complex nutritional content, including significant amounts of protein, fiber, minerals and phytochemical compounds. Despite the presence of anti-nutritional compounds such as phytic acid and tannins, proper processing methods can effectively reduce the presence of these substances to negligible levels, as evidenced in the study of Sharma *et al* (2018). In the context of food security and its potential health benefits, millets have now attracted serious attention from a wide range of professionals, including food scientists, food technologists and nutritionists. This has led to an increase in research focused on developing processing techniques to make millets a widely accepted modern food ingredient, as suggested in the publication Saleh *et al* (2013).

Understanding the physicochemical changes and functional properties of pearl millet during germination can provide insights into its potential health benefits and applications in food products. Pearl millet's unique characteristics make it an ideal candidate for further research and development in the food industry. Germination, a natural process that enhances the bioavailability of nutrients, could potentially unlock even more health benefits from this already nutritious grain. By studying the changes

that occur during germination, researchers may discover new ways to improve the nutritional profile and functional properties of pearl millet-based foods, leading to innovative products that address specific dietary needs or health concerns. However, there is limited research specifically addressing the detailed physicochemical transformations and functional property changes in pearl millet during the germination process. Investigating these changes can provide valuable insights into optimizing germination conditions to maximize the nutritional and functional benefits of pearl millet. The objective of this study is to analyze and characterize the physicochemical changes and functional properties of pearl millet throughout different stages of germination.

HASIL

Germination is a significant process that enhances the nutritional quality of pearl millet (*Pennisetum glaucum*), a staple food for millions in arid and semi-arid regions. The germination process initiates biochemical changes that can improve the bioavailability of essential nutrients while simultaneously reducing the levels of anti-nutritional factors. Studies have shown that germination can lead to a decrease in compounds such as phytic acid, tannins, and oxalic acid, which are known to inhibit nutrient absorption n (Ekta dan Chauhan 2017; Bhuvaneshwari *et al.* 2020; Jalgaonkar *et al.* 2022). Specifically, Bhuvaneshwari et al. highlight that soaking and sprouting millet grains can enhance mineral bioavailability and reduce anti-nutritional factors significantly, thereby improving the overall nutritive value of the seeds (Bhuvaneshwari *et al.* 2020).

Figure 1. Soaking and Germination of Pearl Millet (12h and 24h)
(Bhuvaneshwari *et al.* 2020).

PEMBAHASAN

Moreover, the germination process has been observed to alter the proximate composition of pearl millet, leading to increased protein content and improved digestibility. For instance, research indicates that germination enhances the extractability and bio-accessibility of minerals like calcium, iron, and zinc, which are crucial for human health (Ekta dan Chauhan 2017; Gwekwe 2024). This is corroborated by findings from Tumwine et al., who emphasize that germination activates endogenous enzymes that modify the grain's constituents, resulting in improved nutritional quality and functional properties (Tumwine *et al* 2018).

Additionally, the reduction of anti-nutritional factors during germination is critical for enhancing the bioavailability of these nutrients, making them more accessible for absorption in the human digestive system(Rana dan Dahiya 2021; Kulthe *et al* 2022). The impact of germination on the nutritional profile of pearl millet is also reflected in its functional properties. The process has been shown to increase the levels of soluble sugars and free amino acids, which can enhance the sensorym qualities of millet-based products (Tumwine *et al* 2018; Gowda *et al* 2022). Furthermore, the reduction in viscosity during porridge preparation, attributed to starch degradation, indicates that germination not only improves nutritional quality but also affects the cooking and textural properties of millet (Tumwine *et al* 2018).

This is particularly important for food applications, as it can lead to the development of more palatable and digestible food products. In summary, germination serves as a powerful tool to enhance the nutritional quality of pearl millet by increasing the bioavailability of essential nutrients and reducing anti-nutritional factors. This process not only improves the nutritional profile but also enhances the functional properties of pearl millet, making it a more valuable food source for populations that rely on it as a staple. The integration of germination into food processing practices could therefore play a significant role in addressing nutritional deficiencies in regions where pearl millet is a primary food source. Germination significantly affects the functional properties of pearl millet (Pennisetum glaucum), leading to enhancements in nutritional quality, digestibility, and overall usability in food applications. The germination process activates various biochemical pathways that result in the modification of the grain's composition, thereby improving its functional characteristics. The research investigated

the impact of germination, steaming, and microwave treatment on the phenolic composition, antioxidant activity, and enzyme inhibition properties of whole grain barnyard, foxtail, and proso millets. HPLC analysis identified vanillic and ferulic acids as the predominant phenolic acids and kaempferol as the main flavonoid in unprocessed millets. The content of specific phenolics was changed after the different processing treatments ."

One of the primary effects of germination is the increase in bioaccessible minerals, particularly iron and calcium. Research indicates that germination enhances the extractability of these minerals, making them more available for absorption in the human body. For instance, Suma and Urooj found that germination for 72 hours significantly increased the HCl extractability of iron and calcium in pearl millet, which is crucial for improving mineral bioavailability (Suma dan Urooj 2011). This is further supported by findings from Ekta and Chauhan, who reported that germination increased the in vitro extractability and bio-accessibility of minerals while simultaneously reducing anti-nutritional factors such as phytic acid and oxalic acid (Ekta dan Chauhan 2017). The reduction of these anti-nutritional factors during germination is essential as they can inhibit mineral absorption, thus enhancing the overall nutritional profile of pearl millet.

In addition to improving mineral bioavailability, germination also affects the functional properties of pearl millet by increasing the levels of soluble sugars and proteins. The activation of enzymes such as amylases during germination leads to the breakdown of starch into simpler sugars, which enhances the sweetness and digestibility of the grain (Badau *et al* 2005). This enzymatic activity not only increases the total soluble sugars but also improves the in vitro starch digestibility, making pearl millet a more attractive option for food products (Badau *et al* 2005). Moreover, the protein content and its digestibility are positively influenced by germination, as noted by Badau et al., who highlighted that germination leads to an increase in free alpha-amino nitrogen, which is indicative of improved protein quality (Badau *et al* 2006).

The functional properties of pearl millet are also enhanced through changes in its physical characteristics during germination. For example, the process can lead to modifications in the flour's pasting properties, which are critical for applications in food processing. Obadina et al. observed that malting, which involves germination,

significantly altered the physicochemical properties of pearl millet flour, affecting its pasting behavior and making it more suitable for various culinary applications (Obadina *et al* 2017). Additionally, the reduction in total phenolic content during germination, as reported by Embashu and Nantanga, indicates that the grain becomes less astringent and more palatable, which is beneficial consumer acceptance (Embashu dan Nantanga 2019).

Furthermore, the germination of pearl millet has been linked to improved antioxidant properties. Bhuvaneshwari *et al* (2020). noted that germination not only reduces anti-nutritional factors but also enhances the antioxidant capacity of millet grains, which can contribute to better health outcomes (Bhuvaneshwari *et al* 2020). This increase in antioxidant activity is particularly relevant as it may help in combating oxidative stress in consumers.

Superior antioxidants were obtained from barley seeds, one of which profiled phenolics in various grain varieties using advanced analytical methods such as HPLC and HPLC/MS. Interestingly, all the grain varieties studied showed strong ability in counteracting different types of free radicals, including DPPH, hydroxyl, peroxyl, and superoxide. The study also revealed that processing processes such as husking and cooking have different effects on total phenolic content and antioxidant capacity, with variations depending on the specific characteristics of each grain variety (Chandrasekara *et al* 2012), The results of Chandrasekara *et al* (2012), showed that both soluble and bound fractions of millet grains are rich sources of phenolic compounds with antioxidant, metal chelating, and reducing power. In different research, the increase in phenolics also occurred in a number of grains that received germination treatment (Cevallos *et a*l 2010), soaking and germination also correlated with an increase in high antioxidant activity (Jian *et al* 2009). the results of research by Pushparaj *et al* (2014) reported correlation coefficient data indicating that DPPH radical capture activity and reducing power tests in millet were largely due to the presence of flavonoid content.

In conclusion, germination plays a crucial role in enhancing the functional properties of pearl millet by improving mineral bioavailability, increasing digestibility, and modifying physical and chemical characteristics. These changes not only elevate the nutritional quality of pearl millet but also expand its potential applications in food products, making it a valuable crop for addressing nutritional deficiencies in various populations.

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