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Germination and Fermentation are Effective to Reduce The Antinutritive Factors of Millet: A-Review

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ABSTRACT

Millet (*Pennisetum glaucum*) is an important grain that has many health benefits, rich in minerals and phytochemicals, of which there are 70 varieties around the world, unlike other grains, Millet can grow in arid environments especially due to climate change, making It has the potential to become a global food crop. Millet has always been known as a poor crop. Recently, researchers are interested in benefiting from the high nutritional values of millet when compared to other major grains such as wheat and rice, which is a good source of dietary fiber and rich in calcium. Millet contains about 283 mg phosphorous% and 3.9 mg of iron also contains important amino acids such as isoleucine (4.4 g), leucine (9.5 g), methionine (3.1 g) and phenylalanine (5.2 g). Also, millet contains B vitamins, especially niacin, B 6 and folic acid, unfortunately, because it contains some anti-nutritional factors, millet has long been not used for nutrition, and now, after knowing many methods of processing that can be used to improve the nutritional value and bioavailability access to these grains has become of interest to researchers, and thus, this review focuses on the effect of germination and fermentation on reducing anti-nutritional factors in millet.

Keywords: Millet, germination, fermentation, antinutritive factors, nutrition

INTRODUCTION

Due to the prevalence of food insecurity in developing countries, there is a growing need to produce nutritious, affordable and palatable food for the population. In this regard, Millet is crucial because of its abundance on the continent and good nutritional composition.

Millet is utilized as a dietary medicine, according to Singh *et al.* (2016). They said that millet has very high nutritional advantages when compared to other cereals like wheat and rice. As millet is utilized as a meal and to generate nutritious food, it is also a great source of carbs, protein, iron, and calcium, as well as dietary fiber, antioxidants, and anti-nutrients. Millet includes antinutrients such as tannins, phytates, polyphenols, and trypsin inhibitors. Polyphenols are referred to be "lifespan necessities" due to their crucial role in maintaining the body's functioning and wellness throughout life. Although they have no known direct involvement in nutrition, they do contain some health qualities such as antiestrogenic, anti-carcinogenic, anti-mutagenic, anti-inflammatory, antiviral, and platelet aggregation inhibitory action that may be useful in limiting and avoiding disease occurrence. Millet-containing meals may have an antioxidant impact, which can assist to maintain health and reduce the risk of aging and metabolic disease.

In Saudi Arabia, Millet is taken into consideration one of the promising grain crops withinside the south of the Kingdom of Saudi Arabia, mainly withinside the Jizan region, because the increase of millet has little water need, tolerates drought, and grows higher in dry sandy soils. In this region, the farmers of these areas use its seeds as food and its leaves as fodder. Millet farming is a priority for leaders in the Kingdom of Saudi Arabia, as the Ministry of Environment, Water and Agriculture received great support from Salman bin Abdulaziz – may God protect him – for the beneficiaries of the Sustainable Rural Development Program. One of the objectives of this program is to increase millet production to 7.2 thousand tonnes by the end of 2026 (Ministry of Environment, Water and Agriculture, Saudi Arabia, 2020).

Millet is traditionally transformed into a variety of products through fermentation and germination. Over time, however, a paradigm shift occurred, resulting in new commercial products. In conclusion, this review highlights the importance of germination and fermentation as an effective method to control anti-nutritional factors found in millet.

Importance of Germination Process in increasing amount of Bioactive Compounds

Germination is part of the malting process, including soaking, germination and drying, and can increase the grain's Total Phenolic Compounds (TPC) and enhance the grain's nutritional value by reducing anti-nutrients such as phytates, tannins, and oxalic acid. Sprouted millet contains many bioactive compounds, such as vitamins, delta-aminobutyric acid (GABA), and phenolic compounds, which can be synthesized or refined de novo during germination. Several elements of millet are biologically active, and these biologically active compounds are called

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phytochemicals. The most abundant phytochemicals are phenolic compounds, which are present in all plant organs and are an important part of human nutrition. A unique set of free phenolic compounds, their glycosides and esters, and their insoluble bound counterparts linked to polysaccharides are present in the cell walls of cereals and millets (Shahidi and Chandrasekara, 2013).

Different types of Millet

Various types of millet appeared in Fig. (1) like Proso millet, crab millet, Kodo millet, pearl millet, foxtail millet and small millet are used commercially in the manufacture of biscuits, bread, muffins, pancakes and biscuits (Kaur *et al*., 2014).

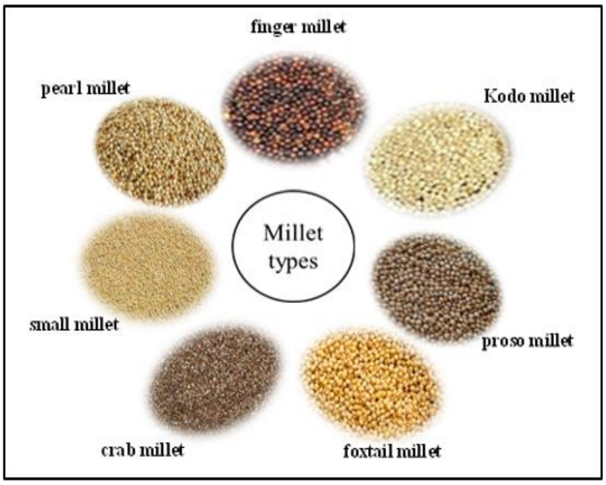

Figure 1. Various types of millet used in food manufacture

Finger Millet (*Eleusine coracana*)

Millet is a major food source for most people in the arid tropics and its fiber content is higher than rice and comparable to wheat (Reddy *et al*., 2008).

There are approximately 5–8 g of protein in each 100 g of finger millet, 65–75 g of carbohydrates and 15–20 g of dietary fiber per 100 g. Additionally, it contains 2.5-3.5 grams/100 grams of minerals, with the highest calcium content (344 mg) and potassium content (408 mg), compared to all other types of millet (Radchuk *et al*., 2012; Gupta *et al*., 2017).

Finger millet is superior to other food crops as it is drought and pest resistant, requires little irrigation and other agricultural inputs, yet produces desirable yields (Udeh et al., 2018). Despite the benefits of MF, the application of MF to processed foods is still insufficient due to the low rate of use of ready-to-eat, lack of public awareness, lack of research on cereals and the lack of food development. Novel foods (Shahidi and Chandrasekara, 2013).

A global food crop can be developed from pearl millet (Taylor, 2016). Throughout Asia and Africa, it grows in arid and semi-arid areas. The ability to grow in arid and semi-arid environments gives it a competitive advantage in a changing climate. In Asia, its biggest market in India, while in West Africa it is Nigeria, Niger, and Mali. Several African countries, including Zimbabwe, Mozambique, and Namibia, produce millet locally (Taylor, 2016). It is considered one of the lowest glycemic Index grains (Annor et al., 2017) and may treat Type-2 diabetes.

Antinutritional factors in Millet

Like other coarse cereals, Millets contain antinutrient factors (phytic acid, tannins, and enzyme inhibitors). preventing them from providing sufficient nutrition.

Natural phytic acid, also known as phytate, occurs naturally in plant organs. According to El Maki *et al*. (2007), these grains had a phytate content of approximately 825.7 mg/100 g. It has been reported that phytate inhibits the activity of enzymes critical to protein breakdown digestive system (Kies et al., 2006). When high concentrations of cereals are consumed, phytates have been shown to interfere with mineral bioavailability in general and may negatively impact newborns, pregnant or lactating women (Al Hasan *et al*., 2016).

Because of the negative charge of phytic acid it attracts and binds calcium, zinc, iron, and magnesium that have positive charges, thus forming less bioavailable complexes. Additionally, phytates are effective at chelating ions, which can lead to mineral deficiency disorders in animals and humans (Grases *et al*., 2017).

Although, Tannins which are found in different parts of plants are very small compounds (Timotheo and Lauer, 2018), an increase in their complexes with protein, results in reduced protein digestibility and amino acid depletion (Raes *et al*., 2014), further impairs protein digestibility. Nature has two types of tannins: hydrolyzable and condensed. Concentrated tannins are abundant in peanuts and millets (Shahidi andChandrasekara, 2013). Ruminants immediately break down hydrolyzable tannins in their digestive systems. A number of compounds found in these breakdown products were reported to be toxic. A significant amount of enzymes in the digestion process are inhibited by tannins when they are consumed (Joye, 2019).

With enzymes, Shunmugapriya *et al*. (2020) attempted to reduce millet's antinutritional properties. A method of enzyme extraction was used to prepare millet milk from different types of Millet. In their study, milk from millet was extracted and treated with amylase then it was pasteurized (75 °C/ 15 min.). They found that millet milk was able to meet the requirements of plant milk in terms of viscosity. According to their analysis, finger millet milk had a protein content ranging from 1.38 to 1.12 g and high total polyphenols content (about 205.72 mg/100 ml), whereas farm millet milk had a high total flavonoid content (96.25 mg/100 ml). According to their findings, enzyme treatment significantly reduced levels of antinutritional factors (phytic acid, tannin, and trypsin inhibitor activity) in millet milk. It showed a high level of enzymatically digestible protein (69.28 to 85.57 %) and starch (69.75 ± 0.56 to 63.36 ± 0.12 mg maltose/g). Industrial production of millet milk products was recommended.

Effect of germination on antinutritional factors in millet

A simple conventional food processing process called sprouting can improve the nutrient availability of whole grains (Subba Rao and Muralikrishna 2002; Hejazi *et al*. 2016). This process significantly increases the hydrolysates of the body, which increases the bioavailability of vitamins, carbohydrates, minerals and proteins (Heazi *et al*., 2016). Germination time and temperature are two important factors to consider during the germination process. These two factors have a significant impact on the nutritional growth of cereals (Narukawa *et al*. 2012; Sawantetal. 2012). In addition, germinated grains are known to be one of the most effective ways to reduce antinutrients (Nakht *et al*., 2018). After germination, phytase is activated, further reducing phytate and phytate levels. Sprouted foods often have different physical structures, nutritional content, and biochemical activities. In particular, sprouting reduces the concentration of antinutrients such as tannins and phytic acid, thereby increasing the bioavailability of minerals in the body and improving the nutritional value of foods (Oghbaei and Prakash, 2016). Singh *et al*. (2017) also found that germination reduced antinutrient content most when compared to soaking, fermentation, and milling. Phytate content of millet was found to decrease with increasing germination time in a study by Abioye *et al*. (2018). Sorghum has been found to have lower tannin content due to leakage of the malting medium (Singh *et al*., 2015). During this period, there was an increase in polyphenol oxidase activity and several other catabolic enzymes

Effect of fermentation on antinutrients in millet

Throughout history, people have used fermentation technology as one of the ways to store food and beverages before reaching refrigeration methods. Consuming food and beverages during the fermentation process is a very healthy eating habit because the changes in the fermentation process of food and beverages themselves act as sugars and starches to promote what you want, helps solve many health problems in the body, especially those of the digestive system (Șanlier *et al*, 2019).

Also, grains such as millet are essential for human nutrition. Combining grains with other methods produces a better nutritional profile and a better amino acid profile. The main reason for the low bioavailability of coarse grains is the presence of anti-nutrients and inhibitors. Tannins and phytic acids are also known to interfere with enzymatic activity in amylolysis and proteolysis (Peyer *et al*. 2016). Several methods and a combination of methods can be used to reduce the level of antinutrients. In general, fermentation is the most important and common process that significantly reduces the antinutrient content and thus increases the overall nutritional value of coarse grains and other food grains. Fermentation of grains is a simple and economical way of preserving food. In indigenous communities in most developing countries, grain fermentation is a traditional and regular practice (Blandino *et al*. 2003).

Fermentation increases the metabolic activity of certain microorganisms in food by multiplying them. Raw products become more digestible by fermenting, which improves their nutritional value as well. Fermentation leads the foods and beverages to become more appealing to the senses and also become more functional (Blandino *et al.* 2003). Children, adults, and the elderly would all benefit from this type of food or feed. This type of mixed meal is available to many vegetarians in developing countries.

The whole grain properties of cereal grains can provide probiotic, prebiotic, and fiber benefits (Lamsal and Fabius, 2009). It has been suggested by several researchers that probiotic microorganism can be engineered into products with whole properties that are functional and can be found in grains. When food processing conditions change, probiotics remain viable and stable (Peyer *et al*., 2016). As a result, probiotics have the ability to tolerate high salt concent, pH values, and oxygen activities (ArroyoLopez *et al*., 2008 Bonatsu *et al*., 2015).

Many researchers reported that fermenting coarse grains and sorghum with probiotics results in significant antinutrient levels. Fermentation with various probiotics further reduced antinutrient levels (Sindhu and Khetarpaul, 2001). It was found that millet fermentation (12 and 24 hours) reduces some antinutrients especially, phytic acid and tannins (Culibaly *et al*., 2011). Previously, cornmeal was fermented in a consortium of lactic acid bacteria (LAB) at 12-hour intervals to study the effect of fermentation on antinutritional activity and as a result, a significant decrease in antinutrients was observed in fermented cornmeal with increasing fermentation time (Chibuike Ogodo *et al*., 2014).

In addition, fermentation with single strains of *Lactobacillus plantarum* and *Lactobacillus casei* exhibited a tendency for phytic acid to be decreased by about 64% and 66%, respectively. while when their combination was used for fermentation of food mixtures, phytic acid was completely removed (Sindhu and Kheterpaul, 2001). As a result of termination by another mixed culture (S. Boulardi and L. Plantarum), Polyphenol content decreased by about 31% but no trypsin inhibitory activity was found in both single or sequential fermentation (Sindhu and Kheterpaul, 2001).

CONCLUSION

In recent years, focus of research has shifted to identifying biologically active ingredients in food that can optimize physical and mental health and reduce the risk of disease. In addition, there is growing interest in incorporating natural food additives and health-promoting substances into the diet to meet the demand for foods with additional health benefits. Meanwhile, the search for innovative interventions in traditional food recipes promises to address local and regional nutritional issues. This includes a fusion of traditional foods with locally available ingredients for nutritional value and fortification. One of the most important grains and foods with health benefits, Millet (*Pennisetum glaucum*) is rich in minerals and phytochemicals that contain several antinutrients, except that they can be enhanced with various treatments. it is included. Methods such as germination and fermentation.

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يساعد الإنبات والتخمير في تقليل العوامل المضادة للتغذية في حبوب الدخن: دراسة مرجعية

عزه بنت عبد الله بن عبد الرحمن الوهيبي[1] ، أسمهان أزهري علي[1,2] و سالي سمير صقر[1,3]*

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يعتبر الدخن (*Pennisetum glaucum*) من الحبوب المهمة التي لها العديد من الفوائد الصحية، الغنية بالمعادن والمواد الكيميائية النباتية، والتي تصل أصنافهاإلى 70 صنفًا حول العالم ، و على عكس الحبوب الأخرى ، يمكن أن ينمو الدخن في البيئات القاحلةخاصة بسبب التغير في المناخ، مما يجعل لديها القدرة على أن تصبح محصولًا غذائيًا عالميًا، و لطالما عُرف الدخن بأنه محصول الفقير، و في الآونة الأخيرة، يهتم الباحثون بالاستفادة من القيم الغذائية العالية للدخن عند مقارنتها بالحبوب الرئيسية الأخرى مثل القمح والأرز، وهي مصدر جيد للألياف الغذائية وغنية بالكالسيوم، ويحتوي الدخن على حوالي 283 ملجم فوسفور٪ و 3.9 ملجم حديد ويحتوي أيضًا على أحماض أمينية مهمة مثل إيزولوسين (4.4 جم) وليوسين (9.5 جم) وميثيونين (3.1 جم) وفينيل ألانين (5.2 جم) ، و يحتوي الدخن أيضًا على فيتامينات ب ، وخاصة النياسين ، ب 6 وحمض الفوليك، و لسوء الحظ، فنظرًا لاحتوائه على بعض العوامل المضادة للتغذية، ظل الدخن لفترات طويله غير مستخدم للتغذيه، و حاليا، و بعد معرفة العديد من طرق المعالجه و التي يمكن استخدامها لتحسين القيمة الغذائية والتوافر البيولوجي لهذه الحبوب فقد أصبحت حبوب الدخن محل اهتمام الباحثين، وبالتالي، تركز هذه المراجعة على تأثير الإنبات والتخمير على تقليل العوامل المضادة للتغذية في حبوب الدخن.