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Cereal-Based Fermented Beverages: A Review of Their Production, Properties, and Potential Health Benefits

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ABSTRACT: Cereal-based fermented beverages have been consumed for centuries in various parts of the world. They are produced by the fermentation of cereals such as barley, rice, and maize, and can be consumed as a beverage or used in cooking. This review paper provides an overview of the production, properties, and potential health benefits of cereal-based fermented beverages

Keywords: Cereals, Fermented drinks, health benefits

I. INTRODUCTION

The basic food of the planet is cereal. Fermentation is used to process a significant amount of the cereals produced worldwide before consumption. This is due in large part to fermentation's enhancement of appetising aroma and texture as well as its improvement of shelf life and digestibility. Cereals present a number of nutritional challenges, including the swelling of their starch upon cooking, the limited amount and amino acid profile of their protein fraction, the limited bioavailability of their mineral content due to relatively low mineral levels, the presence of phytic acid and other antinutritional factors that reduce their bioavailability to 5-15%, and many others(Nout, 2009).Cereals generate more than 60% of the world's food output and are cultivated on more than 73% of the world's harvested land. They provide nutritional fibre, proteins, energy, minerals, and vitamins essential to human health. Cereals or their components may be used as fermentable substrates for the growth of probiotic microorganisms, particularly lactobacilli and bifidobacteria, or as dietary fibre to promote a number of advantageous physiological effects in functional food compositions. Due to the presence of some types of nondigestible carbohydrates, it can also function as a prebiotic or as encapsulating materials for probiotics to increase their stability(Charalampopoulos et al., 2002).Whole grain is now one of the most popular options for delivering probiotics. This is mostly due to the benefits of both probiotics and whole grains, such as non-digestible carbohydrates, soluble fibre, phytochemicals, and other bioactive components, that consumers receive from products formulated with probiotics and whole grains(Marquart & Cohen, 2005)Other micronutrients included in whole-grain cereals include vitamin E, folates, phenolic acids, zinc, iron, selenium, copper, manganese, carotenoids, betaine, choline, sulphur amino acids, phytic acid, lignins, lignans, and alkylresorcinol's, all of which have the potential to act as antioxidants. One of the main phytochemicals found in cereals, dietary fibre, can be split into two groups according on how well it dissolves in water. The non-starchy polysaccharides pentosans (arabinoxylan) and beta glucans make up the majority of the water-soluble portion (soluble fibre). Humans' serum cholesterol, postprandial blood glucose, and insulin levels have been shown to decrease with soluble fibre consumption(Edge et al., 2005).

Cereal-based fermented beverages have been enjoyed by various cultures throughout history. These beverages are created through the fermentation of cereal grains, such as barley, rice, corn, and wheat, which yields a range of flavours and textures. Fermentation is a natural process that involves the conversion of sugars into alcohol and carbon dioxide by yeast or bacteria.One well-known example of a cereal-based fermented beverage is beer, which has a long history dating back thousands of years. Beer is typically made from malted barley, water, hops, and yeast. The fermentation process transforms the sugars in the malted barley into alcohol, resulting in a carbonated beverage with varying levels of bitterness and flavor complexity.

Cereals as a source of nutrients:

Rice

Rice has a higher protein quality than both wheat and corn, but only slightly less than oats. Additionally, rice protein is hypoallergenic and has a significant amount of lysine. As a result, it might serve as a viable element for baby food

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formulations and provide diversity for food-allergic kids' restricted diets(Chandi & Sogi, 2007). The amino acid profile of rice protein was superior to casein and soy protein isolate in satisfying the needs of children between the ages of 2 and 5.

Wheat

Cereals made with whole wheat and wheat bran are a significant source of dietary antioxidants. The most promising wheat phenolic acids for health benefits are those that are free and esterified(Baublis et al., 2000).Wheat has antioxidants that are mostly concentrated in the bran layers, with red wheat often having higher levels than white wheat in terms of antioxidant content(KIM et al., 2006).

Maize

One of the major grains in Asia is maize (Zea mays). Its kernels are the biggest. Due to its size and hardness, decortication by abrasion is possible, and fine grinding is necessary to produce cooked goods with a smooth texture(Nout, 2009).

Barley

Barley was more of a staple grain for our ancestors than it is today. The Neolithic culture's emergence and growth were greatly influenced by barley. Semolina, whole-dehulled grain, and flour are all forms of barley that are used. Barley products are used to prepare a wide range of foods, such as bread, couscous, and soups (Amri et al., 2005). The primary ingredient in barley is -glucan, which is also a significant source of soluble fibre linked to hypercholesterolemia, hypoglycemia, and a decreased risk of chemically caused colon cancer in experimental mice.

Sorghum

Sorghum is a staple crop in Asia's semiarid regions and is an important source of both proteins and carbs for those who live there. Sorghum is frequently used as sustenance for humans, but the technology for turning the grains into edible goods is still insufficient (Lazaro & Favier, 2000).

Millet

In the Indian subcontinent, finger millet, also known as ragi (Eleusine coracana), is a crucial staple grain for traditional consumers and those from lower socioeconomic classes(Das et al., 2012).The potential for its use by non-traditional millet consumers is suggested by some of the health advantages of regular consumption of millet meals, such as the hypocholesterolemic, hypoglycaemic, and antiulcerative properties. Since the millet's anti-nutritional components, such as polyphenols and phytates, are primarily concentrated in the seed coat and aleurone layers(Raes et al., 2014),decortication reduces their levels and hence increases the nutrients' bioavailability.

Oats

Oats have recently drawn scientific and commercial interest, primarily because of their high amount of -glucan and other substances with antioxidant potential(Yrjö Mälkki et al., 2004). At a daily dietary level of 10 g oat -glucan, the health benefits of -glucan as related to cholesterol reduction, improved gastrointestinal function, and glucose metabolism would be attained(Y. Mälkki & Virtanen, 2001). Oat soluble fibres play crucial roles in the digestive system and are crucial for maintaining a healthy colon wall and colonic environment because they can be fermented by "good bacteria" (pro-biotic microorganisms), which have pre-biotic effects. These soluble and insoluble oat fibres work together to balance each other out.Prebiotics made of soluble fibre are becoming more and more significant as functional foods that support good health(Macfarlane, 2010). Polysaccharides (such beta glucans, arabinoxylans, and plant gums) and oligosaccharides (like fructo-oligosaccharides) make up the majority of soluble fibres.

Production of cereal-based beverages

The production of cereal-based fermented drinks involves several steps, including milling, mashing, and fermentation. The cereals are first milled to produce a flour or meal, which is then mixed with water and heated to create a mash. The mash is then fermented using microorganisms such as yeast or lactic acid bacteria, which convert the carbohydrates in the cereal into alcohol and organic acids.Processing steps for many cereal-based beverages include cleaning/washing, steeping in water, drying, grinding, sieving, and fermentation. In the unit operation, germination is a crucial stage that requires more focus since, during this phase, the hydrolytic enzymes modify the endosperm. Additionally, some vitamins are created, and minerals have a higher bioavailability. To avoid a disproportionate growth of microorganisms and to remove the CO2 produced during soaking, the soak water must be changed once or twice. It is crucial to mix or turn the grains during germination to

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ensure adequate aeration, which will promote greater germination.

Production process for cereal-based beverages:

Raw Material Selection: High-quality grains are selected, considering factors such as taste, texture, and nutritional content. Common choices include rice, oats, barley, and corn.

Cleaning and Sorting: The grains are thoroughly cleaned to remove impurities and foreign particles. Sorting may also be done to eliminate damaged or discoloured grains.

Milling: The grains are milled to break them into smaller particles, resulting in increased surface area for efficient extraction during subsequent steps.

Cooking: The milled grains are cooked in water to soften them and facilitate the release of their flavors and nutrients. The cooking time and temperature depend on the specific grain being used.

Enzyme Treatment (Optional): In some cases, enzymes may be added to the cooked grains to enhance the breakdown of starches and proteins, leading to improved flavor and digestibility.

Straining and Separation: The cooked grains are strained or filtered to separate the liquid portion from the solid residue. This liquid extract forms the base of the cereal-based beverage.

Flavouring and Sweetening: Flavourings such as vanilla, cocoa, or fruit extracts may be added to enhance the taste of the beverage. Sweeteners like sugar, honey, or artificial sweeteners are incorporated to achieve the desired level of sweetness.

Pasteurization: To ensure product safety and extend shelf life, the beverage is pasteurized by heating it to a specific temperature for a certain duration, effectively killing any harmful bacteria.

Packaging: The final product is packaged in bottles, cartons, or other suitable containers, ensuring proper sealing and labelling for distribution and sale.

According to (Taylor, 2017)the dehulling or decortication process of grains was traditionally carried out by hand using a pestle and mortar or with a simple stone quern type mill, which has two horizontal mill stones; however, hammer mills are now more frequently used. There are still some places that employ manual milling procedures in addition to mechanical decortication and milling.Traditional millet-based fermented beverages have been documented in numerous nations; the majority of these beverages are made in rural areas, with a few exceptions(Chao et al., 2013).Despite the awareness of the malting process and the value of consuming sprouted millet, the malting procedure is still very prevalent in many developing nations. Soaking, germination, and drying were the three essential steps in the traditional malting process. The quality of the malt or its derived products varied greatly depending on the time and state parameters of each unit operation(Chiba et al., 2012).The malt is traditionally ground using a grinding technique. In the past, millet malt was employed in both beverage preparation and infant feeding. The total amount of Codex Alimentarius-recommended limits for aerobic germs, coliforms, yeast, and filamentous fungi in malt produced using the conventional method is higher.Similar to millets, under specific environmental conditions, millets are susceptible to mycotoxin formation by fungal development. In addition to endangering consumer health, mycotoxin poses a serious risk to malt quality (Kaur et al., 2014).However, the risk from the pathogens is somewhat decreased by products that heavily ferment lactic acid bacteria and by cooking.In the food processing industry, fermentation is the anaerobic process of employing bacteria or yeast to break down carbohydrates into organic acids or alcohol. Perishable food quality, nutritional value, and organoleptic qualities can all be enhanced by the bioprocess of fermentation. As stated by (Kantachote et al., 2017)it alters the amount of carbohydrates in foods, produces amino acids, enhances the availability of B-group vitamins, breaks down antinutrients, and consequently boosts the availability of iron, zinc, and calcium.Fermentation is a processing method that dates back to ancient times. This method depends on the production of metabolites by microbial metabolism, which can prevent the growth and survival of undesired microflora in food (Shahidi & Chandrasekara, 2013). A more affordable and practical method of preserving food is fermentation, which inhibits many pathogens by raising the acidity and lowering the pH of the substrate (Kotásková et al., 2016). Fermentation in food processing is a method of detoxifying, reducing cooking times and fuel consumption, according to (Kotásková et al., 2016).

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Table 1. Different types of Cereals based fermented beverages

Beverage	Main Cereal	Microorganism	Country of origin	Nature of use
Beer	Barley	Yeast	Various	Alcoholic beverage
Sake	Rice	Saccharomyces's sake	Japan	Alcoholic clear drink
Merissa	Sorghum and millet	Saccharomyces	Sudan	Alcoholic drink
Khaomak	Rice	Rhizopus, Mucor	Thailand	Alcoholic sweet beverage
Chongju	Rice	Saccharomyces cerevisiae	Korea	Alcoholic clear drink
Kachasu	Maize	Yeasts	Zimbabwe	Alcoholic beverage
Boza	Wheat, millet, maize and other cereals	Lactobacillus, Saccharomyces cerevisiae, Leuconostoc	Albania, Turkey, Bulgaria,	Thick, sweet, slightly sour beverage

Properties

Cereal-based fermented beverages typically have an alcohol content ranging from 3% to 20% or higher, depending on factors such as the fermentation time, yeast strains used, and brewing techniques. The choice of cereal, malting process, yeast strains, and fermentation conditions contribute to the flavour profile of these beverages. Beer can have a wide range of flavours, including malty, hoppy, fruity, or spicy notes. Sake, on the other hand, has a distinctive rice-based flavour with umami and floral characteristics.Carbonation levels can vary in cereal-based fermented beverages. While some beers and sake may be carbonated naturally during fermentation, others are artificially carbonated during packaging.The choice of cereal and malting process can influence the colour of the final beverage. Beers can range from pale yellow to deep amber or even black, while sake is typically clear and colourless.Cereal-based fermented beverages can contain various nutrients derived from the grains used. They may provide carbohydrates, proteins, B vitamins, minerals like potassium and magnesium, and antioxidants.The alcohol content, pH level, and pasteurization methods can affect the shelf life of cereal-based fermented beverages. Beers are generally stable for several months to a few years, while sake can have a longer shelf life due to its higher alcohol content and pasteurization.

The critical role that foods and beverages play in the prevention and treatment of disease is currently being acknowledged more and more. Due to the additional health benefits that functional products offer above and beyond their fundamental nutritional purposes, their production and use have accordingly expanded significantly. Beverages are one of these products that has been acknowledged as a significant category of active functional foods; they exhibit a number of crucial qualities, including being practical and able to satisfy consumer demands for container contents, size, shape, and appearance, as well as being simple to distribute and store for refrigeration. Additionally, they are a fantastic way to give vitamins, minerals, antioxidants, -3 fatty acids, dietary fibre, prebiotics, and probiotics, as well as other nutrients and bioactive substances.The idea of foods that are good for your health is not new: Hippocrates, who lived 2400 years ago, once stated, "Let food be thy medicine and medicine be thy food." The idea that eating may satisfy nutritional needs and still play a helpful impact in the mitigation of some diseases has been backed by research advancements over the last couple of decades(Otles & Cagindi, 2012). Different notions have arisen to more accurately identify these foods in light of the advantages marketed by particular foods or food additives. The US Foundation for Innovation in Medicine first used the term "nutraceuticals" in 1989 to describe any item that is a food or component of a food that has medical or health advantages, including the prevention and treatment of disease.

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Potential health benefits of cereals

Cereals, such as whole grains, provide several potential health benefits

Reduced risk of chronic diseases: Whole grain cereals have been associated with a lower risk of chronic conditions, including heart disease, stroke, type 2 diabetes, and certain cancers. The fiber, antioxidants, vitamins, minerals, and phytochemicals present in whole grains contribute to these protective effects(Aune et al., 2016)

Improved digestive health: Cereals rich in dietary fiber, such as bran cereals, can promote regular bowel movements and prevent constipation. They also support a healthy gut microbiome by providing nourishment to beneficial gut bacteria(Slavin, 2013).

Nutrient-rich profile: Cereals fortified with vitamins and minerals, such as iron, folate, and B vitamins, can help meet daily nutrient requirements. This is particularly relevant for populations at risk of nutrient deficiencies, such as pregnant women and vegetarians(Sanz-Penella et al., 2012),(Rosa-Sibakov et al., 2015).

Cereal-based fermented beverages, such as kombucha, kefir, and traditional African beverages like mahewu and amazake, have several potential health benefits. Some of these benefits include:

Probiotics: Fermented beverages are rich in probiotics, which are beneficial bacteria that promote a healthy gut microbiota. Probiotics can improve digestion, enhance nutrient absorption, and support a strong immune system.

Improved digestion: Fermentation breaks down complex carbohydrates in cereals, making them easier to digest. This can be especially beneficial for individuals with digestive issues or intolerances.

Increased nutrient availability: Fermentation can enhance the bioavailability of certain nutrients present in cereals, such as minerals and vitamins. This means that the body can better absorb and utilize these nutrients.

Detoxification: Fermented beverages contain organic acids, such as acetic acid, which can help detoxify the body by supporting liver function and aiding in the elimination of toxins.

Potential anti-inflammatory effects: Some fermented beverages have been found to have anti-inflammatory properties, which can help reduce inflammation in the body and may have a positive impact on conditions like arthritis.

Potential blood sugar regulation: Certain fermented beverages made from cereals have shown potential in regulating blood sugar levels, which can be beneficial for individuals with diabetes or those at risk of developing the condition.

Hydration: Cereal-based fermented beverages are often hydrating due to their high-water content, making them a refreshing and nutritious alternative to sugary drinks.

II. CONCLUSION:

Cereal-based fermented drinks are a diverse group of beverages that have been consumed for centuries in various parts of the world.cereal-based fermented beverages offer a range of benefits and are gaining popularity among consumers. These beverages undergo fermentation, which enhances their nutritional profile and introduces probiotic properties. Cereal grains such as barley, rice, corn, and wheat are commonly used in the production of these beverages. They provide a rich source of vitamins, minerals, and dietary fiber. Additionally, cereal-based fermented beverages offer diverse flavours and can be enjoyed as a healthy alternative to traditional beverages. Continued research and innovation in this field will likely lead to further advancements and increased availability of these products in the market.

REFERENCES

[1]. Amri, A., Ouammou, L., Nassif, F., & others. (2005). Barley-based food in Southern Morocco. Food Barley: Importance, Uses and Local Knowledge, 22.

[2]. Aune, D., Keum, N., Giovannucci, E., Fadnes, L. T., Boffetta, P., Greenwood, D. C., Tonstad, S., Vatten, L. J., Riboli, E., & Norat, T. (2016). Nut consumption and risk of cardiovascular disease, total cancer, all-cause and cause-specific mortality: a systematic review and dose-response meta-analysis of prospective studies. BMC Medicine, 14(1), 207. https://doi.org/10.1186/s12916-016-0730-3

[3]. Baublis, A. J., Lu, C., Clydesdale, F. M., & Decker, E. A. (2000). Potential of Wheat-Based Breakfast Cereals as a Source of Dietary Antioxidants. Journal of the American College of Nutrition, 19(sup3), 308S-311S. https://doi.org/10.1080/07315724.2000.10718965

[4]. Chandi, G. K., & Sogi, D. S. (2007). Functional properties of rice bran protein

concentrates. Journal of Food Engineering, 79(2), 592–597. https://doi.org/10.1016/j.jfoodeng.2006.02.018

[5]. Chao, S.-H., Huang, H.-Y., Kang, Y.-H., Watanabe, K., & Tsai, Y.-C. (2013). The diversity of lactic acid bacteria in a traditional Taiwanese millet alcoholic beverage during fermentation. LWT - Food Science and Technology, 51(1), 135–142. https://doi.org/10.1016/j.lwt.2012.09.015

[6]. Charalampopoulos, D., Wang, R., Pandiella, S. ., & Webb, C. (2002). Application of cereals and cereal components in functional foods: a review. International Journal of Food Microbiology, 79(1–2), 131–141. https://doi.org/10.1016/S0168-1605(02)00187-3

[7]. Chiba, Y., Bryce, J. H., Goodfellow, V., MacKinlay, J., Agu, R. C., Brosnan, J. M., Bringhurst, T. A., & Harrison, B. (2012). Effect of Germination Temperatures on Proteolysis of the Gluten-Free Grains Sorghum and Millet during Malting and Mashing. Journal of Agricultural and Food Chemistry, 60(14), 3745–3753. https://doi.org/10.1021/jf300965b

[8]. Das, A., Raychaudhuri, U., & Chakraborty, R. (2012). Cereal based functional food of Indian subcontinent: a review. Journal of Food Science and Technology, 49(6), 665–672. https://doi.org/10.1007/s13197-011-0474-1

[9]. Edge, M. S., Jones, J. M., & Marquart, L. (2005). A New Life for Whole Grains. Journal of the American Dietetic Association, 105(12), 1856–1860. https://doi.org/10.1016/j.jada.2005.10.022

[10]. Kantachote, D., Ratanaburee, A., Hayisama-ae, W., Sukhoom, A., & Nunkaew, T. (2017). The use of potential probiotic Lactobacillus plantarum DW12 for producing a novel functional beverage from mature coconut water. Journal of Functional Foods, 32, 401–408. https://doi.org/10.1016/j.jff.2017.03.018

[11]. Kaur, K. D., Jha, A., Sabikhi, L., & Singh, A. K. (2014). Significance of coarse cereals in health and nutrition: a review. Journal of Food Science and Technology, 51(8), 1429–1441. https://doi.org/10.1007/s13197-011-0612-9

[12]. KIM, K., TSAO, R., YANG, R., & CUI, S. (2006). Phenolic acid profiles and antioxidant activities of wheat bran extracts and the effect of hydrolysis conditions. Food Chemistry, 95(3), 466–473. https://doi.org/10.1016/j.foodchem.2005.01.032

[13]. Kotásková, E., Sumczynski, D., Mlček, J., & Valášek, P. (2016). Determination of free and bound phenolics using HPLC-DAD, antioxidant activity and in vitro digestibility of Eragrostis tef. Journal of Food Composition and Analysis, 46, 15–21. https://doi.org/10.1016/j.jfca.2015.11.001

[14]. Lazaro, E. L., & Favier, J. F. (2000). Alkali Debranning of Sorghum and Millet. Cereal Chemistry Journal, 77(6), 717–720. https://doi.org/10.1094/CCHEM.2000.77.6.717

[15]. Macfarlane, S. (2010). Prebiotics in the Gastrointestinal Tract. In Bioactive Foods in Promoting Health (pp. 145–156). Elsevier. https://doi.org/10.1016/B978-0-12-374938-3.00010-4

[16]. Mälkki, Y., & Virtanen, E. (2001). Gastrointestinal Effects of Oat Bran and Oat Gum: A Review. LWT - Food Science and Technology, 34(6), 337–347. https://doi.org/10.1006/fstl.2001.0795

[17]. Mälkki, Yrjö, Myllymäki, O., Teinilä, K., & Koponen, S. (2004). Method for preparing an oat product and a foodstuff enriched in the content of $β$-glucan. Google Patents.

[18]. Marquart, L., & Cohen, E. A. (2005). Increasing whole grain consumption.

[19]. Nout, M. J. R. (2009). Rich nutrition from the poorest – Cereal fermentations in Africa and Asia. Food Microbiology, 26(7), 685–692. https://doi.org/10.1016/j.fm.2009.07.002

[20]. Otles, S., & Cagindi, O. (2012). Safety Considerations of Nutraceuticals and Functional Foods. In Novel Technologies in Food Science (pp. 121–136). Springer New York. https://doi.org/10.1007/978-1-4419-7880-6_5

[21]. Raes, K., Knockaert, D., Struijs, K., & Van Camp, J. (2014). Role of processing on bioaccessibility of minerals: Influence

of localization of minerals and anti-nutritional factors in the plant. Trends in Food Science & Technology, 37(1), 32–41. https://doi.org/10.1016/j.tifs.2014.02.002

[22]. Rosa-Sibakov, N., Poutanen, K., & Micard, V. (2015). How does wheat grain, bran and aleurone structure impact their nutritional and technological properties? Trends in Food Science & Technology, 41(2), 118–134. https://doi.org/10.1016/j.tifs.2014.10.003

[23]. Sanz-Penella, J. M., Frontela, C., Ros, G., Martinez, C., Monedero, V., & Haros, M. (2012). Application of Bifidobacterial Phytases in Infant Cereals: Effect on Phytate Contents and Mineral Dialyzability. Journal of Agricultural and Food Chemistry, 60(47), 11787–11792. https://doi.org/10.1021/jf3034013

[24]. Shahidi, F., & Chandrasekara, A. (2013). Millet grain phenolics and their role in disease risk reduction and health promotion: A review. Journal of Functional Foods, 5(2), 570–581. https://doi.org/10.1016/j.jff.2013.02.004

[25]. Slavin, J. (2013). Fiber and Prebiotics: Mechanisms and Health Benefits. Nutrients, 5(4), 1417–1435. https://doi.org/10.3390/nu5041417

[26]. Taylor, J. R. N. (2017). Millets: Their Unique Nutritional and Health-Promoting Attributes. In Gluten-Free Ancient Grains (pp. 55–103). Elsevier. https://doi.org/10.1016/B978-0-08-100866-9.00004-2