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Cereal based probiotic foods

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Abstract
Cereals, pulses, and their products are the principal sources of sustenance for the Indian people. Various processing processes are used on all grains and pulses (soaking, malting, germination, fermentation, cooking etc.). Nowadays, the focus of functional food research is shifting from providing dietary supplements to developing probiotic and prebiotic strategies. The probiotic yeast is well-suited to influencing the functionality of cereal substrate during fermentation, and probiotic yeasts have a number of characteristics that lead to their inclusion in the fermentation process for the production of cereal-based functional meals. The healthy functional foods diet can lower saturated and trans fatty acid intake while increasing hypolipidemic nutraceuticals and functional foods consumption. Bioactive components such phenolics (flavones, anthocyanins, alkylresorcinols, chalcones, ferulic acid), carotenoids (-carotene, xanthophylls), vitamin E, and carbohydrate contents (-glucans, arabinoxylans, inulin) give cereal-based foods functional dietary qualities. Tocotrienols, a bioactive molecule, protects against cardiovascular illnesses by lowering harmful cholesterol levels in the blood.

Keywords: Fermentation, probiotic, cereals, bioactive components

1. Introduction
Functional foods are defined as the food or dietary components which helps to provide health benefits beyond the basic nutrition. Cereals are considered as an most important crops used for human nutrition in world. This are available in greater amount because they are cultivated in large quantities were they constitute important sources of nutrients, phytochemicals and other bioactive compounds (Ogunremi *et al*., 2015) [22]. Cereals and their constituents will be recognised as functional foods and nutraceuticals in the coming years due to their antioxidants, vitamins, proteins, energy and dietary fibre, all of which are essential for human health. The grains and their components are also utilised as fermented substrates for probiotic bacteria development (Das *et al*., 2011). The cereals are also a good source of different phytochemicals such as phenolic acids, flavones, phytic acid, flavonoids, terpenes and coumarins. Phytic acid, phytosterols, ferulic acid, and glutathione are also abundant in them. The cereal grains also contains vitamin like B1, B2, B3 and E minerals like Mg, Ca, Zn, P, K and fiber due to all this properties cereals are important ingredients for the functional foods production (Sidhu *et al*., 2007) [29].

The whole cereal grains are replete with nutrients and bioactive the various successful and sufficient scientific evidence are proved that the consumption of this type of foods has an positive effect on human health. Fermentation is a metabolic process that uses enzymes to cause chemical changes in organic substrates. Thus, the various different types of cereal grains are processed multiples times to produce the excellent form of functional food (Fernandes *et al*., 2018) [9]. Wheat, buckwheat, brown rice, barley, oat, flaxseed, soy products, and psyllium are some of the most frequent cereal-based functional foods. The cereals are used as staple foods in world-wide. The fermentation process is widely utilised in the production of cereal-based goods for human consumption. The reason for using the fermentation process is their attractive texture and flavour and shelf-life and digestibility (Das *et al*., 2011). Nowadays, the research in functional food are increased and moved towards the developing dietary supplements and generating the probiotic and prebiotic methods. The probiotic yeast is suitable to influence the functionality of cereal substrate during fermentation and various features of probiotic yeasts which contributes to their inclusion during the fermentation process to produce the cereal based functional foods. The consumers of functional foods are very much interested in their personal health it has be observed that they are excepting the food which are preventing the illnesses and are attracted towards the healthy functional food

products (Granato *et al*., 2010) [10].
The healthy functional foods diet can reduce the intake of saturated and trans fatty acids and also increasing the intake of hypolipidemic nutraceuticals and functional foods (Chen *et al*., 2014) [5]. The whole cereal grains are with higher nutritional values than the refined gains this is due to the greater amount of fiber content in bran and germ portion and the majority of bioactive compounds. Bioactive components such as phenolics (flavones, anthocyanins, alkylresorcinols, chalcones, ferulic acid), carotenoids (β-carotene, xanthophylls), vitamin E, and carbohydrate contents (β-glucans, arabinoxylans, inulin) give cereal-based foods functional dietary qualities. The bioactive compound tocotrienols plays an protective role against the cardiovascular diseases by reducing the bad cholesterol level in blood (Rawat *et al*., 2013) [26]. Lactic acid bacteria have a good influence on the health of consumers, which has led to the development of certain functional foods. (Molina *et al*., 2012) [19].

2. Role of nutrition in cereals
The cultivation of cereals is around 73% of the total world harvested area and contribute over 60% of the world food production providing minerals, fiber, energy, vitamins and proteins which are required for human health (Das *et al*., 2011). All over the World cereals are considered as an staple foods and are also a major source of calories. The cereal based probiotic foods are available in each and every year and they are rich in bioactive compounds. There are seven different and major cereals such as Rice, Rye, Maize, Barley, Millets Sorghum and Wheat which are consumed by humans. There are also some pseudo cereals like Quinoa, amaranth and buckwheat consumed in diet. The cereal based probiotic products used cereals are valuable source of macro and micronutrients, antioxidants and phytochemicals (Fernandes *et al*., 2018) [9]. The various Microorganisms are used to produce new different cereal based probiotic foods to obtain the nutritional and sensorial qualities of food product and it also produces various metabolites which inhibits the growth of spoilage. The generated metabolites includes organic acids like acetic acid, lactic acid and propionic acid and many more this helps to improve the shelf life of the food product by decreasing the pH value. The acids generating in the fermented food makes environment acidic in food. There are some other metabolites which acts as an antimicrobial compounds this are produced by LAB and yeast spices (Tsafrakidou *et al*., 2020) [33]. The most of fermented food products depends on Lactic acid bacteria to mediate the process of fermentation. The Lactic acid fermentation is considered as an important as the safety nutritional value, shelf life and acceptability in cereal based probiotic food products (Ashenafi 2006).

3. Probiotics
The probiotic defined as living bacteria and supportive substances important effects on the host by improving the bacterial balance in the intestine. The probiotic also defined as bacteria that works to maintain the health of human (Kalui *et al*., 2010) [13]. The beneficial effect of probiotic foods on human health are day by day increasing. The bioingredients are used in probiotic foods. The commonly used bacteria in probiotic foods are LAB (Lactobacillus, Enterococcus) and various yeast and other microbes also used as potential probiotic during the fermentation. Some other probiotic culture used popularly which are available in market are bacillus coagulans, Lactobacillus acidophilus, Lactobacillus rhamnosus and Bifidobacterium lactis this are available in market (Tamang *et al*., 2016) [32]. Lactose intolerance, cholesterol reduction, immune system stimulation, constipation alleviation, enhanced mineral absorption, and antimutagenic properties are all connected with probiotic foods. Clinical indications based on evidence-based investigations are far more limited and they are still being evaluated. Scientists are constantly researching the impact of microorganisms on human health and the sort of probiotic microbes that should be used (Perera *et al*., 2017) [25].

4. Cereals as probiotic food
The various epidemiological evidences has claimed that the whole cereal grains protect the body against different age related diseases such as some cancers, cardiovascular diseases and diabetes (Das *et al*., 2011). Functional foods, according to the majority of countries, contain bioactive components and substances that serve to provide additional health advantages beyond the fundamental requirements of the body and are particularly useful in reducing diseases. This type foods are in the form of natural food and are also consumed as an daily diet (Chai-Lau *et al*., 2013) [15]. The functional foods are able to contain the bioactive substances which helps to prevent the development of allergies, initiation and promotion also some diseases such as cancer and cardiovascular diseases. Probiotics, prebiotics, antioxidants, minerals, vitamins, soluble fibre, and polyunsaturated fatty acids are some of the functional components found in functional foods. The biotechnology trade is day by day improving the functional foods and probiotic have taken lead importance. The probiotics are associated with fermented food products. This type foods include conventional foods which contains the naturally synthesizing bioactive substances (Kalui *et al*., 2010) [13].

4.1 Wheat
Dietary antioxidants are abundant in whole wheat and wheat bran-based cereals. Wheat's phenolic acids, both free and esterified, offer the most health-promoting properties. Wheat antioxidants are found mostly in the bran layers, and the amount of antioxidants varies greatly depending on the grain variety, with red wheat having higher quantities than white wheat (Das *et al*., 2011). Wheat phenolic acids have potent antioxidant activity in vitro at concentrations obtained from a standard serving of whole wheat grain (Otles and Cagindi, 2006) [24].

4.2 Rice
In a research conducted by Hassan *et al*., 2012 [11] competes the rice intently with wheat as the sector maximum critical crop. There are various different types of rice varieties present in the market almost in include 5000 varieties which as differentiated on the basis of biochemical, physical, cooking qualities (Giri *et al*., 2018). The rice is an predominant nutritional supply of carbohydrate which consumed through more than ½ of population. The LAB L plantarum decreases the pH related to an boom in overall titrable acidity and natural acid manufacturing at some point of fermentation days (Fernandes *et al*., 2018) [9]. Among the LAB typically related to meals fermentation processes, participants of the genera Lactobacillus and Bifidobacterium usually predominate. The affiliation among LAB or saccharomyces and the coaching of the traditional rice primarily based totally fermented liquid

has been reported (Giri *et al*., 2018).

4.3 Barley
The barley is taken into consideration as a wealthy supply of nutritional fiber, niacin, magnesium, copper and iron. Barley was crucial to the emergence and development of Neolithic culture. (Suman and Sreeja, 2019) [31]. In a study performed by Charalampopoulos *et al*., (2002) evaluated the overall growth kinetics of the possibly probiotic L. Fermentum, L. reuteri, L. acidophilus and L. plantarum strains. β-glucan is a component found in barley. glucan. The β-glucan is an major component of soluble fiber. In case of nutrition barley has an more acceptance than any other cereal grains and it used as malt, feed and food purpose consist with high functional and nutritional properties (Sidhu *et al*., 2007) [29].

4.4 Maize
The maize (Zea Mays) is an one of the popular and important cereal grain in Asia. Because of its hardness and size, it is possible to decorticate by abrasion, and fine grinding is required to provide a smooth texture in cooked items. (Sidhu *et al*., 2007) [29]. In a research consumed by Mashau *et al*., 2021 explored and adjusted the physical and biochemical features of most of these maize-based fermented products. The beverage produced by fermenting maize is mahewu (amahewu), which can be made from either thin or thick maize porridge (sadza) (Gadaga *et al*., 2000).

4.5 Oats
In a study performed by Angelov *et al*., 2018 [2] recognized oats as precise amongs cereals as they are therapeutically energetic in opposite to diabetes, hypertension, inflammatory state, vascular injury and dyslipidaemia. Oats are a good source of dietary fibre, antioxidants, and a protein portion that is well balanced. Because of its composition, oats have a great functional potential. Oats' health benefits have been linked mostly to the very viscous b-glucan fraction, which has been shown to reduce blood cholesterol and glucose absorption in the intestine. Oats and probiotics have long been known to provide health advantages. (Tsetsegmau and Tsetsegee, 2016).

4.6 Buckwheat
The study performed by Fernandes *et al*., 2018 [9] examined about highly nutritious cereal grain buckwheat (Fagopyrum esculentum) is an pseudo cereal generally found in origin of central and eastern European countries. Buckwheat is an rich source of protein, starch, lipids and dietary fiber. The goal of study conducted by Kowalska and Ziarno, 2020 is to see how four distinct industrial starting cultures containing lactic acid bacteria (LAB) and bifidobacteria affected some aspects of buckwheat beverages that were stored at 4 degrees Celsius for 28 days. The buckwheat has functional components as phenolic content and dietary fiber with different variation in it such as total phenolic content, free phenolic and total dietary fiber, insoluble and soluble dietary fiber. The bioactive phenolic like rutin and quercetin are present in buckwheat. In case of insoluble and soluble dietary fiber large amount of pectic polysaccharides are found.

4.7 Sorghum
The use of sorghum as human consumption food and as fermented foods or probiotic foods are widespread. The technology for processing the cereal grains for the fermented consumable food products are developed. After rice, wheat, maize, and barley, sorghum is the world's fifth most important cereal crop (Adebo, 2020). Das *et al*., 2011 research studies on the Foods or food ingredients that improve host health and/or lower the risk of chronic disease are referred to as functional foods. The cultivation of sorghum is widely done in semiarid topics of Asia. It is a major source of proteins and carbohydrates for consumption of Peoples daily diet.

5. Current development in cereal based fermented food
Due to the growth and acceptance of fermented foods, numerous studies have been conducted to increase the nutritional value and efficacy of cereal-based fermented products in reducing illness risk. The microorganism used for the fermentation are mainly lactic acid bacteria group and mainly of the genera Lactobacillus, Pediococcus, Leuconostoc and Enterococci. The many studies are also involved in development of probiotic fermented food products which depends on antimicrobial activity of LABs. The presence of lactic acid (among other metabolic acid products) and antibiotic compounds produced by these microbes is thought to be the cause of LAB inhibition. The fermented food products consisting of lactic acid bacteria also having some health benefits on different risk associated diseases. One of them is Diarrhea is an major cause of morbidity and mortality of millions children in developing world. The microorganism present in production of fermented food also shows antimicrobial activity against Listeria Innocua which is a pathogenic microorganisms (Kalui *et al*., 2010) [13]. The probiotic fermented foods are healthy but are nit satisfactory in case of shelf-life and organoleptic acceptance when compared to dairy food products. Maintaining rigorous refrigeration conditions at temperatures below 4 C to sustain sufficient probiotic cell counts that give functionality for a longer storage time could solve shelf-stability difficulties. (Angelov *et al*., 2018) [2]. In last 15 years the consumer interest in fermented food product are become very high due to different key factors associated with it such as growing health awareness, changes in food regulations. The various different cereal based fermented food products based on commodities are launched in market, cereals hold a prominent place in the new market. This is due to the whole cereal grains rich source in many phytochemicals such as dietary fiber (Sidhu *et al*., 2006).

Table 1: Cereal based probiotic foods

Product name	Cereals	Microorganisms used for Fermentation	Generating compounds	Effects on bioactive compounds	Health effects	Country	References
Yosa	Oats	*Bifidobacterium Lactis, L. rhamosus, L. Plantarum, L. acidophilus*	Phenolic acid, avenanthramides, tocopherols, tocotrienols	Phenolic compounds improved	Lower Blood cholesterol level	Finland	(Sidhu *et al*., 2007) [29], (Angelo *et al*., 2018) [2] (Aspri *et al*., 2020) [3]
Kisra	Sorghum	*Lactobacillus cellobioses, L. brevis, L. fermentum, L. amylovorus, Candida intermedia, Debaryomyces hansenii, S. cerevisiae, Lactobacillus reuteri*	Amino acid	Amino acids improved	Increase in protein content	Sudan	(Tsafrakidou *et al*., 2020) [33], (Mariod *et al*., 2017) [17] (Ali and Mustafa 2009) [1]
Ogi	Maize, Sorghum	*L. plantarium, Lactobacillus sp., Aerobacter, Corynebacterium, Lb. plantarum, yeast and mould*	Lactic acid, acetic acid, butyric acid	Enzymes improved	Liner growth of poor children	Nigeria	(Osungbaro and Taiwo *et al*., 2009) (Angelo *et al*., 2018) [2] (Olaniran *et al*., 2020) [23]
Sourdough bread	Rye, Wheat	*L. plantarum, Lb. sanfranciscensis, Lb. alimentarius, Lb. buchneri, Lb. casei, Lb. delbrueckii, Lb. fructivorans, Lb. plantarum, Lb. reuteri, Lb. johnsonii, Cand. humili, Issatchenkia orientalis*	Phytic acid and citric acid	Antioxidants improved	Lower the plasma glucose and improve blood lipids	America, Europe, Australia	(Tsafrakidou *et al*., 2020) [33] (Charalampopoulos *et al*., 2002)
Puto	Rice	*Leuc. Mesenteroides, Ent. Faecalis, ped. Cerevisiae, yeast*	Acid forming bacteria generated			Philippines	
Selroti	Rice, Wheat	*Leuc. mesenteroides, Ent. faecium, Ped. pentosaceus and Lb. curvatus, Sacch. cerevisiae, Sacch. kluyveri, Deb. hansenii, P. burtonii, Zygosaccharomyces rouxii*	Rapid production of maltose and glucose	Flavonoids improved	Protect form dyslipidaemia and cardiometabolic risk	India, Nepal, Bhutan	(Das *et al*., 2011) (Ramraj *et al*., 2012) (Ray *et al*., 2016) [27] (Yonzan and Tamang 2012) [34]
Kulcha, nan, Bhatura	Wheat (White Wheat Flour)	*Saccharomyces cerevisiae, LAB*	Amylase activity	Antioxidants Improved	Protective to colon cancer	India	(Sharma *et al*., 2017) [28] (Das *et al*., 2011)
Chilra	Barley, wheat and buckwheat	*LAB, Sacch. Cerevisiae, L. Plantarum, L. fermentum, l. reuteri*	Lactic acid β-glucan	Phenolic compound increased	Reduce cardiovascular diseases and lower LDL and Total cholesterol risks	India	(Charalampopoulos *et al*., 2002) (Kumar *et al*., 2012) [14] (Sidhu *et al*., 2007) [29] (Chailu

6. Health benefits of bioactive compound present in cereals

There are various types of bioactive compounds present in cereals like phenolic compound contains benzene ring with one or more hydroxyl groups. They are present in all plant-based foods and affects their appearance, colour, taste and oxidative stability. This are present in pericarp of cereal grain and are concentrated by removing the bran (Fernandes *et al*., 2018) [9]. The vitamins play important role in metabolic functions and thus its daily intake in diet is essential and this cannot be synthesized at adequate amount in the human body (Tsafrakidou *et al*., 2020) [33]. This vitamins and minerals are important in human body for the appropriate functioning of critical biochemical pathway. The vitamin B and vitamin E is most commonly found in cereals. This antioxidant properties can be considered as good health by preventing the disease like cancer and cardiovascular diseases (Chen *et al*., 2014) [5]. The various different generating compounds or the microbial strains present in fermented food product are responsible for the probiotic and health promoting qualities in product. The clinical trials are necessary to confirm this type of assumptions, in some countries like Canada and Italy the probiotic strain containing foods are included in regulatory guidelines and the country like India contains the probiotic culture containing foods in dietary guidelines (Tsafrakidou *et al*., 2020) [33].

7. Functional properties of fermented probiotic foods

Bioactive compounds are extra-nutritional constituents which are found in fermented foods provides the health benefits beyond the basic nutritional value of the product. The beneficial impact of bioactive compounds are classified on the basis of antimicrobial activity, anticancer property, antioxidant property, antihypertensive property, anti-inflammatory activity, Hypocholesterolemic property.

7.1 Antimicrobial activity

Antimicrobial activity against potentially pathogenic microorganisms was one of the recommended features for prospective Probiotic strains in the FAO/WTO draught recommendations for the evaluation of probiotics in food published in 2002. Lactic acid bacteria have been shown to produce antimicrobial compounds and have a strong antagonistic effect on food-borne pathogens. Organic acids, hydrogen peroxide, diacetyl, antifungal fatty acids, phenyllactic acid, bacteriocins, and bacteriocin-like compounds are only a few of the antimicrobial agents available (Kalui *et al*., 2010) [13]. Due to the synthesis of antimicrobial substances like bacteriocin and nisin, several species of LAB isolated from fermented vegetable and milk products have antimicrobial activity (Tamang *et al*., 2016) [32]. LAB produces antimicrobial peptides called bacteriocins, which are linked to fermented items longer shelf life. The enterococci strains recovered from fermented cereal products,

as well as their prospective use as starter cultures, based on their technological, functional, and safety qualities Antimicrobial activity was investigated in 63 LAB isolates from a spontaneously fermented beverage (ogi) (Tsafrakidou *et al*., 2020) [33]. Many LAB strains identified from kimchi generate antibacterial chemicals such bacteriocin and pediocin, which are produced by L. lactis BH5 and L. citreum GJ7, respectively. Listeria monocytogenes, Staphylococcus aureus, E. coli, and Salmonella typhimurium are all resistant to the antibacterial action of LAB isolated from kimchi. Weissella cibaria, a Gram-positive and Gram-negative pathogen identified from fermented cabbage product, has antibacterial action against both Gram-positive and Gram-negative pathogens. Lactococcus lactis, a bacterium inhibitor found in dahi (Indian curd), produces nisin Z, which kills L. monocytogenes and S. aureus (Tamang *et al*., 2016) [32].

7.2 Antioxidant property

Antioxidants shield cells from the damaging effects of oxygen radicals. Cereals include a wide spectrum of antioxidant components, including vitamins, sterols and phenolic compounds, as well as phytic acid. The majority of the listed compounds are concentrated in the bran or germ. They may all contribute to the antioxidant capabilities to some extent, and germination affects them in different ways. Some minerals and trace elements, which can act as co-factors for specific enzymes, have an indirect antioxidant impact. While several antioxidant activities have been demonstrated in vitro, the precise impact of the relevant chemicals in vivo is yet unknown. Some of the chemicals may serve as synergists or antagonists, and others may have antioxidant activities in vitro but not *in vivo* (Hubner and Arendt, 2013) [12]. 1,1-diphenyl2-picryl hydrazyl (DPPH) radical scavenging activity, 2,20-azinobis (3-ethylbenzo-thiazoline-6-sulfonic acid; ABTS) radical scavenging activity, total phenol content (TPC) calculation, and reducing power assay are all antioxidant activities found in fermented foods. Antioxidant qualities can be found in several Asian fermented soybean foods, such as natto, a Japanese Bacillus-fermented soybean snack. Kimchi has been shown to have antioxidant properties (Tamang *et al*., 2016) [32]. Antioxidants are compounds that slow or stop the oxidation process. They defend the body from reactive oxygen species (ROS), which damage biomolecules and cause degenerative aging-related morbidities like diabetes, Alzheimer's, and atherosclerosis, among others. Lipid oxidation in food goods can degrade the product's quality while also shortening its shelf life. Several studies have found that lipid oxidation in food can harm human health and result in a variety of disorders. Antioxidants in diet can lessen the pace at which poisons are produced, lowering the risk of chronic diseases. Proteolytic methods such as enzyme digestion, probiotic fermentation, and chemical synthesis can all be used to purify antioxidant peptides (Sharma *et al*., 2021). Antioxidant dietary supplements may be beneficial to human health; but, as worries about artificial antioxidant use have grown, natural sources of antioxidants, such as fermented foods, have gotten more attention. The microbial strain responsible for the fermentation is another element that influences the antioxidant activity of fermented milks. Because phenolic compounds are bio-converted from conjugated to free forms during fermentation, it is possible to enhance total phenolic component content. The hydrolytic activity of enzymes produced by fermenting microorganisms enhances grain cell wall structural disintegration, resulting in increased bio-accessibility and bio-availability of bound and conjugated phenolic chemicals (Melini *et al*., 2019) [18].

7.3 Anti-Hypertensive property

The rise in the prevalence of hypertension has spurred the food industry to create new sodium-reduced foods. This is also true for bakery products, where much effort has gone into enhancing product formulas and incorporating new biotechnologies. Sourdough fermentation is a promising method for baking anti-hypertensive baked goods (Melini *et al*., 2019) [18]. Animal models and clinical trials have been used to validate the antihypertensive characteristics of various fermented milk products. Fermented probiotic bacteria, as well as fermented soybean dishes, reduce the risk of heart disease. Consumption of fermented whole grains appears to protect against the development of heart disease and diabetes. Hypertensive and Type 2 diabetes patients who eat Korean fermented soybean meals on a regular basis see improvements in their cardiovascular risk factors. Fermented foods, which are high in fibrinolytic enzymes, can be used as part of thrombolytic therapy to prevent heart attacks (Tamang *et al*., 2016) [32]. LAB convert cereal matrix proteins into bioactive peptides, which give fermented grains antihypertensive effects, thanks to their proteolytic activity. Peas et al. looked at how a 21 percent addition of whole meal wheat sourdough (made by Lb. brevis CECT 8183 and protease) affected ACE inhibitory substances. They discovered that combining sourdough fermentation with a lower sodium content could be an interesting technique for developing unique bread products with a lower blood pressure impact (Melini *et al*., 2019) [18]. Short amino acid chains with hydrophobic or positively charged residues at the C-terminus characterise ACE inhibiting peptides. Inhibition of ACE is aided by the presence of an aromatic amino acid at the bioactive peptide's C terminus (Sharma *et al*., 2021).

7.4 Anticancer property

According to a study, diet/lifestyle is responsible for 20-80 percent of human cancer mortality. Food and food ingredients, particularly those that can combat the effects of reactive oxygen species, can protect DNA and stimulate the immune system, reducing cancer chances. Bioactive chemicals found in barley and its derivatives have antioxidative and immunomodulatory properties that have been linked to cancer prevention. The majority of investigations on barley's chemoprevention of carcinogenesis have focused on the effect of barley fibre, particularly-glucan. Barley is a rich source of insoluble fibre, which is crucial for maintaining digestive health and preventing colon cancer, in addition to its high level of soluble-glucan fibre. Colon cancer can be prevented by eating barley regularly. Germinated barley foodstuffs have anti-carcinogenic properties (Suman and Sreeja, 2019) [31]. Cancer has been on the rise around the world in recent years. Despite advances in cancer research and treatment procedures, it continues to be a major source of illness and mortality. Chemotherapy and radiotherapy, as well as other traditional cancer treatments, are frequently associated with significant side effects. By fighting signals of growth inhibition, cancer cells are able to avoid cell death and reproduce. As a result, triggering apoptosis would be a good way to deal with them. The ability of peptides to promote apoptosis and angiogenesis has been demonstrated in studies (Sharma *et al*., 2021). Antimutagenic and anticarcinogenic

properties have been found in some LAB-fermented foods. Kefir is a type of fermented milk that is used to treat cancer. Sauerkraut, a fermented German vegetable, includes s-methylmethionine, which lowers the risk of stomach tumorigenesis (Tamang *et al*., 2016) [32].

8. Conclusion

This research suggests that a cereal-based matrix could be a promising delivery mechanism for probiotic yeasts. Due to the significant obesity problem in industrialised nations, as well as the need to preserve normal and sound health, many formulations and activities are emerging, focusing on delivering soluble fibres to consumers through various meals such as cereals and cereal goods including antioxidants. Bioactive components such as phenolics (flavones, anthocyanins, alkylresorcinols, chalcones, ferulic acid), carotenoids (β-carotene, xanthophylls), vitamin E, and carbohydrate contents (β-glucans, arabinoxylans, inulin) give cereal-based foods functional dietary qualities. It's a difficult challenge to create a variety of functional foods from whole grain cereals. However, in the future, cereal technologists should focus on developing novel technologies for cereal processing to improve its use, health potential, and customer acceptability.

9. References

1. Ali AA, Mustafa MM. Use of Starter Cultures of Lactic Acid Bacteria and Yeasts in the Preparation of Kisra, a Sudanese Fermented Food. Pakistan Journal of Nutrition. 2009;8(9):1349-1353.
2. Angelov A, Marinova TY, Gotcheva V. Oats as a matrix of choice for developing fermented functional beverages. Journal of Food Science Technology. 2018;55(7):2351-2360.
3. Aspri M, Papademas P, Tsaltas D. Review on Non-Dairy Probiotics and Their Use in Non-Dairy Based Products. MDPI journal of fermentation. 2020;6:30.
4. Banaay CGB, Balolong MP, Elegado FB. Lactic Acid Bacteria in Philippine Traditional Fermented Foods, 2013.
5. Chen G, Wang H, Zhang X, Yang ST. Nutraceuticals and Functional Foods in the Management of Hyperlipidaemia. Critical Reviews in Food Science and Nutrition. 2014;54:1180-1201.
6. Corbo MR, Bevilacqua A, Petruzzi L, Casanova FP, Sinigaglia M. Functional Beverages: The Emerging Side of Functional Foods. Comprehensive Reviewsin Food Science and Food Safety. 2014;13:1193-1206.
7. Das A, Raychaudhuri U, Chakraborty R. Cereal based functional food of Indian subcontinent: a review. Journal of Food Science Technology. 2012;49(6):665-672.
8. El-Aidie SAA, El-Dieb SM, El-Nawawy M, Emara E, Sobhy H. Nutraceutical Food Based on Cereal and Probiotic Fermented Milk. International Journal of Dairy Science. 2017;12(6):377-384.
9. Fernandes CG, Sonawane SK, Arya SS. Cereal Based Functional Beverages: A Review. Journal of Microbiology Biotechnology Food Science. 2018;8(3):914-919.
10. Granato D, Branco GF, Nazzaro F, Cruz AG, Faria JAF. Functional Foods and Nondairy Probiotic Food Development: Trends, Concepts and Products. Comprehensive Reviews in Food Science and Food Safety. 2010;9:292-302.
11. Hassan AA, Aly MA, El-Hadidie ST. Production of Cereal-Based Probiotic Beverages. World Applied Sciences Journal. 2012;19(10):1367-1380.
12. Hubner F, Arendt EK. Germination of Cereal Grains as a Way to Improve the Nutritional Value: A Review. Critical Reviews in Food Science and Nutrition. 2013;53:853-861.
13. Kalui CM, Mathara JM, Kutima PM. Probiotic potential of spontaneously fermented cereal-based foods-A review. African Journal of Biotechnology. 2010;9(17):2490-2498.
14. Kumar RS, Kanmani P, Yuvaraj N, Paari KA, Pattukumar V, Arul V. Traditional Indian fermented foods: a rich source of lactic acid bacteria. International Journal of Food Sciences and Nutrition, 2012. ISSN 1465-3478.
15. Lau TC, Chan MW, Tan HP, Kwek CL. Functional Food: A Growing Trend among the Health Conscious. Asian Social Science, 2013, 9(1).
16. Mariod AA, Idris YMA, Osman NM, Mohamed MA, Sukrab MA, Farag MY, Matthaus B. Three Sudanese sorghum-based fermented foods (kisra, hulu-mur and abreh): Comparison of proximate, nutritional value, microbiological load and acrylamide content. Ukrainian Journal of Food Science, 2016, 4(2).
17. Mariod AA, Idris YMA, Osman NM, Mohamed MA, Sukrab MA, Matthaus B. Nutritional Value and Chemical Composition of Sudanese Millet-Based Fermented Foods as Affected by Fermentation and Method of Preparation. Acta Sci. Pol. Technol. Aliment. 2017;16(1):43-51.
18. Melini F, Melini V, Luziatelli F, Ficca GA, Ruzzi M. Health promoting components in fermented foods: An up-to-date systematic review. Nutrients. 2019;11:11-89.
19. Molina V, Medici M, Valdez GFD, Taranto M. Soybean-based functional food with vitamin B12-producing lactic acid bacteria. Journal of Functional Foods. 2012;4:831-836.
20. Nazish N. Knowledge of Traditional Fermented Food Products Harbored by the Tribal Folks of the Indian Himalayan Belt. International Journal of Agriculture and Food Science Technology. 2013;4(5):401-414.
21. Nyanzi R, Jooste PJ. Cereal-Based Functional Foods, 2012.
22. Ogunremi OR, Agrawal R, Sanni AI. Development of cereal-based functional food using cereal-mix substrate fermented with probiotic strain-Pichia kudriavzevii OG32. Food Science & Nutrition. 2015;3(6):486-494.
23. Olaniran AF, Abiose SH, Adeniran HA, Gbadamosi SO, Iranloye YM. Production of A Cereal Based Product (Ogi): Influence of Co-Fermentation with Powdered Garlic and Ginger on the Microbiome. Agrosearch. 2020;20(1):81-93.
24. Otles S, Cagindi O. Cereal Based Functional Foods and Nutraceuticals. Acta Sci. Pol. Technol. Aliment. 2006;5(1):107-112.
25. Perera ODAN, Weerahewa HLD, Vidanagamage S. Role and Current Trends of Developing Fruit, Vegetable and Cereal based Probiotic Foods: A review. Intl. J Ferment. Food. 2017;6(2):85-93.
26. Rawat N, Laddomada B, Gill SB. Genomics of Cereal-Based Functional Foods, 2013.
27. Ray M, Ghosh K, Singh S, Mondal KC. Folk to functional: An explorative overview of rice-based fermented foods and beverages in India. Journal of Ethnic

Foods. 2016;3(5):18.
28. Sharma P, Nagar R, Kaur R. Comparative Study of the Nutritive Values and Acceptability of Different Types of Bhatura in India. International Journal of Pharmaceutical Science Invention. 2017;6(9):52-55.
29. Sidhu JS, Kabir Y. Functional Foods from Cereal Grains. International Journal of Food Properties. 2007;10:231-244.
30. Subhashree S, Kavita MS. A Study on Suitable Non-Dairy Food Matrix for Probiotic Bacteria-A Systematic Review. Current Research in Nutrition and Food Science. 2019;07(1):05-16.
31. Suman D, Sreeja V. Barley: A Cereal with Potential for Development of Functional Fermented Foods. Intl. J Ferment. Food, 2019, 8(1).
32. Tamang JP, Shin DH, Jung SJ, Chae SW. Functional properties of microorganisms in fermented foods. Frontiers in microbiology. 2016;7:578.
33. Tsafrakidou P, Michaelidou AM, Biliaderis CG. Fermented Cereal-based Products: Nutritional Aspects, Possible Impact on Gut Microbiota and Health Implications. MDPI journal. Foods. 2020;9:734.
34. Yonzan H, Tamang JP. Optimization of Traditional Processing of Selroti, A Popular Cereal Based Fermented Food. Journal of scientific and industrial research. 2012;72:43-47.
35. Zareian M, Oskoueian E, Forghani B, Ebrahimi M. Production of a wheat-based fermented rice enriched with γ-amino butyric acid using *Lactobacillus plantarum* MNZ and its antihypertensive effects in spontaneously hypertensive rats. Journal of Functional Foods. 2015;16:194-203.