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## Cereals: Functional constituents and its health benefits

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### Abstract

Cereals are the major source of energy to good health over the world. The major and minor cereals are consumed either processed and semi processed with addition of other food ingredients. The cereals contains nutrients like carbohydrates, proteins, minerals, vitamins, fat and some of cereals having good amount of dietary fibre (soluble and insoluble). Some cereals especially colored rice, colored wheat, colored maize and some millets having the functional bioactive components such as polyphenols, tocopherol, oryzenol (antioxidants) and vitamins these cereals having functional properties and ultimately fight against diseases and prevent or control the some disease in body i.e. cardiovascular risk, reduces the risk of cancer, type-2 diabetes, hypertension, high blood pressure etc. The cereal is consumed with pulses and fulfils the requirements essentials amino acid and its availability. Functional foods are consumed around the world; each functional food has its significance unique properties like taste, aroma, texture, consistency and flavour. The food may be consumed fermented while some are non-fermented. Fermented cereals are increasing the vitamins B complex and some other nutrients.

**Keywords:** Cereals, functional foods, bioactive components, antioxidant, fermentation

### Introduction

Functional foods are those categories or types of food that are good in providing important nutritional aspects that have a good health impact towards our human body, these are the foods that contain an essential amount of nutrient as well as certain other important compounds that have a beneficial impact on the consumer (Hasler, 2002; Sidhu, Kabir, & Huffman, 2007) <sup>[1, 2]</sup>. As with all important nutritional benefits they also have a good medicinal property, therapeutic and nutraceutical food as they are rich in minerals, proteins, vitamins, certain amino acids, antioxidants, phosphates, that aids good health to prevent diseases and provides a good amount of energy. The term cereal-based functional foods are defined as that food that is made up from cereals like toward, bajara, flaxseed, wheat etc. Cereals are a good source of rich-dietary fibre, vital nutrients like vitamin E, some of the vitamins B-complex, omega 3 fatty acid, folate, phosphorous, magnesium and zinc (Macauley, 2015) <sup>[3]</sup>. Despite having this they also have phytochemical compounds that give them antioxidant and other significant health benefits by reducing the risk of some cancers, heart disease, diabetes and other major health issues that are been faced by people.

During the past few years kinds of cereal are known for their nutraceutical importance because of their bioactive components, dietary fibres, protein, minerals and other vital nutrients as well as ethical values (Baublis *et al.*, 2000; Charalampopoulos *et al.*, 2002) <sup>[4, 5]</sup>. These functional foods are consumed globally all over the world, each functional food has its significance unique aroma texture consistency and flavour. The food may be consumed either in the form of processed and semi processed i.e. fermented while some are non-fermented (Dambu, Roti); fermented cereals are sometimes used as a substrate.

In Indian the cereals may consumed as per region preference like southerner may consumed mainly rice fermented products like IDLI, dhokla, koozhu and dosa etc. In African regions, these foods are extensively used as staple food likely, Jandh, Uji, Togwa. Despite giving nutritional value to our diet some cereal-based functional food also has weaning effect also they have probiotic and prebiotic properties associated with them (Bartłomiej *et al.*, 2012; Charalampopoulos *et al.*, 2002) <sup>[5, 6]</sup>. Cereals are full of valuable important nutrients that aid towards a god healthy body, every cereal grain has important unique nutraceutical importance this is due to the presence of specific compounds like in case of wheat it gives up to 8-14% of

protein present in gluten (Bartłomiej *et al.*, 2012; Klopčič, Slokan *et al.*, 2020; Macauley, 2015) [3, 6, 7]. Gluten is a group or chain of protein present in endosperm of pulses and cereal grains but eating food that is rich in gluten will cause and trigger coeliac disease that can cause digestion issues diarrhoea and bloat. Each cereal has its important significance and important nutrients that help to boost our body health (Klopčič *et al.*, 2020) [7]. During recent years research has taken an advance step in developing dietary supplementation from cereal-based functional food by introducing the idea of probiotics and prebiotics that affect gut activities (Baublis *et al.*, 2000; Klopčič *et al.*, 2020; Macauley, 2015) [3, 4, 7]. Functional foods obtained from cereals supply helpful advantageous health benefits to our body by reducing and prevention of diseases or by boosting our immunity, helps in defending against blood pressure, cholesterol levels, blood sugar levels, decreasing risk of getting heart failure (Bartłomiej *et al.*, 2012; Charalampopoulos *et al.*, 2002) [5, 6] (Fig. 1). The major cereals are potential source of energy for human i.e. wheat, rice, maize and oat. This review article aim is to present different types of cereals and their applications as functional ingredients.

### Composition of cereals

In general, cereals are being composed of 65-75% carbohydrates, 7-12% protein, 2-6% lipids, 12-14% water. Further, each cereal has its own unique composition based on types type of cereal, solid, geographical location presented in Table 1.

**Table 1:** Composition of different type of cereals

Cereals	Energy (kcal)	Protein (g)	Carbohydrates (g)	Fibre (g)	Fat
Wheat	339	13.3	71	10.7	2g
Durum	198	7	40	7	>1%
Emmer	360	13	34	5	4%
Spelt	110	3	23	7.6	>1.7%
Einkorn	100	4	20	2	1%
Buckwheat	343	13	71	10	3%
Rice	370	6.81	81.68	2.8	1.9g
Brown rice(cooked)	111	2.6	23	0.4	1.8g.
White Basmati rice	160	3	36	0	0g
Jasmine Rice	180	4	38	2	1.5g
Millet	378	9.9	72.9	3.2	2.9g
Finger Millet	336	7.3	72	3.6	1.3g
Pearl Millet	363	11.8	67	2.3	4.8g
Sorghum	329	10.62	72.09	6.7	3.3g
Barley	352	9.9	77.7	15.6	2.3g
Quinoa	368	14.12	64.16	7	6g
Maize	360	8.9	72.2	2	3.9g
Psyllium	160	2	8.5	6.7	14.6g
Oats	180	7	29	5	3g
Flaxseed	530	20.3	28.9	37.1	24g

Data compiled from different sources; (Sramkova *et al.*, 2009) [61]

### Types and potential of cereals

#### Wheat (*Triticum*)

Wheat belong to the family of Poaceae, which is cultivated worldwide as a staple food. It is an excellent source of dietary fibers, antioxidants (black wheat), free and esterified phenolic acids, vitamins and minerals (magnesium, phosphorous, and selenium) which played an imperative role in to maintain and regulate various body metabolic functions(Xu *et al.*, 2019) [8]. Selenium in wheat ranges from 10 µg kg<sup>-1</sup> to 2000 µg kg<sup>-1</sup> (P. R. Shewry, 2009) [9], which also found to be toxic above

600 µg d<sup>-1</sup>. Wheat kernel is being composed of endosperm, germ and branny husk (Liu *et al.*, 2020) [10]. Bioactive components of wheat including; phenolic acids (hydroxycinnamic acids and: hydroxybenzoic), flavonoids, benzoxazinoids (BXs), carotenoids, alkylresorcinols and other possess veracious numerous therapeutic applications in the treatment and prevention of obesity, cardiovascular disease (CVD), type-2 diabetes, anti-colorectal cancer etc. (Liu *et al.*, 2020) [10]. As per FAO-statistics (2020), the global production of wheat (*Triticum aestivum* L.) in 2019 is around 763.1 million tons (Liu *et al.*, 2020) [10]. Based on the area, time or climacteric conditions cultivated wheat can be of many types; if wheat is hard and little firm then it is possible that it is cultivated in dry regions where climacteric conditions are mostly sunny this type of wheat has also a strong amount of elastin protein and 11%-12% of protein content while wheat grown in sultry conditions is softer and contains less amount of protein somewhat in between 8%-9% and loss amount of elastin protein or gluten, due to their softer character they are used in cakes, pastry, biscuit and other bakery products. Hard wheat has a high amount of protein content as well as they are also rich in elastin protein and vice versa (Baublis *et al.*, 2000; Chauhan *et al.*, 2018; Kumar *et al.*, 2014) [4, 11, 12]. Bread wheat or *Triticum aestivum* is a hexaploid species which is most cultivated wheat throughout the world variety followed by *T. turgidum* var. durum, which usually grown in the hot/dry conditions (Kumar H. *et al.*, 2013; Peter R. Shewry & Hey, 2015) [13, 14]. Durum wheat- (*Triticum durum*) is 2nd most cultivated species that come after common wheat, although durum is rich in gluten and also found to be the toughest of all wheat types. Wheat served as a chief ingredient in the manufacturing of flour, semolina, pasta, noodles, and fermented foods like kefir, biscuits and other confectionary products.

#### Rice (*Oryza sativa*)

Rice is widely cultivated and consumed staple food for a large part of human population, particularly in Asia (Mohd Esa & Ling, 2016) [15] and also referred as grain of life. Rice is good source of carbohydrates (amylose and amylopectin), Bcomplex vitamins including, thiamine, niacin and riboflavin, amino acids, minerals (Ca, Mg, P, Fe, Cu, Zn and Mn) (D. K. Verma & Srivastav, 2017) [16]. But unlike wheat rice is gluten free cereal so it is good for people who face issues from gluten consumption. Due to the presence of lysine in rice, it is preferred food for infants. Processing of rice including cleaning, husking, separation, de-stoning, whitening, polishing and sifting, which also produce bran and husk as a by-product. These by products can be utilised as an animal feed (Mohd Esa & Ling, 2016) [15]. Brown rice is a type of whole grain product that is low in calories but high in fiber, vitamin especially vitamin-B, iron, manganese, brown rice helps to reduce heart problems by lowering the cholesterol levels, and also have been proven important for cleaning the digestive tract and by also stopping the formation of blood clots, crushed rice powder when applied on skin shown medicament effect on skin problems (Manickavasagan *et al.*, 2017) [17]. Rice is known for its anti-oxidant and chemoreceptive properties, and the red colour of this rice is due to the presence of pigment "proanthocyanidin" (Mehra *et al.*, 2020) [18]. When cooked rice is left overnight the bacteria growth enhances and lactic acid produces during fermentation and result in enhancing of vital macronutrients, minerals like iron phosphorous. Rice due to its high glycaemic index 85 can

cause diabetes to the consumer that is why it is advised to eat rice with something like curry that ultimately lowers its glycaemic index and also in research it is found that protein quality found in rice is much better than whey and soy protein (Chelliah *et al.*, 2019; Phongthai *et al.*, 2017) <sup>[19, 20]</sup>. Parboiled rice is also good source of nutrients and it is lower down the glycemic index and ultimately it is beneficial for type-2 diabetics person.

#### **Barley (*Hordeum vulgare*)**

Barley was originated in early 10,000 years ago in parts of Eurasia; like wheat, rice, barley is also a member of the grass family. It is grown mostly in hot or temperate climates worldwide. During early times in Babylonia barley is also sometimes used as a mode of payment for buying and selling of things. Barley is rich in fibers, vital nutrients including vitamins, niacin and also have a rich amount of  $\beta$ -glucan that is a type of soluble dietary fibers, they strongly help to improve cholesterol levels and thus therefore ultimately improve heart health (Baik & Ullrich, 2008) <sup>[21]</sup>. Barley also provides 352 calories but it is more nutritious when barley is eaten with other grains. This consumption enhances fiber content, reduce blood sugar levels and helps to boost the immune system. Despite this, it is also rich in antioxidants like tannins, flavonoids that help to reduce oxidative stress and inflammation. It is also a gluten-free grain and can be used to manufacture bread and other items so it is a replacement of wheat. But the most important product from barley is beverages that can be alcoholic drinks or nonalcoholic drink. Alcoholic drinks are made from fermented grain mesh which is mainly from barley, various varieties of fermented alcoholic drinks are available in the market whose key ingredient is barley grain. Barley especially the hull-less barley is found to be very beneficial high  $\beta$ -glucan content that helps in lowering the risk of induced colon cancer (Bartłomiej *et al.*, 2012; Dykes & Rooney, 2007; Idehen *et al.*, 2017) <sup>[6, 22, 23]</sup>.

#### **Quinoa (*Chenopodium quinoa*)**

Quinoa (*Chenopodium quinoa*) is a flowering plant characterized in amaranth family where it used as a sacred thing and it is sometimes called as pseudo-grain. The most important part of this plant is its seed which is the main reason for the cultivation of quinoa. It is first originated in Chile and was domesticated by Andean people. Raw, uncooked quinoa in its raw form contains 6% fat, 13% water, 15% protein, 64% carbohydrates. Quinoa seed contain are rich in protein, dietary fibers, protein, and essential amino acids like arginine, histidine, lysine, valine but is high in carbohydrate content. It is also rich in manganese, phosphorous, insoluble fibers that reduce cholesterol help in weight loss, potassium and other beneficial antioxidants that neutralize free radicals. It is also gluten-free grain therefore it can be used as a wheat alternative; protein content is also more as compared to other types of grains plus it has more

nutritional aspects. The seeds of quinoa have coatings of saponins that make them non-palatable with a good amount of oxalic acid that helps in binding and maintaining the health of the gut. The GI (Glycaemic index) of quinoa also comes to be very low i.e., 53 low glycaemic index means it stimulates hunger (Bhargava *et al.*, 2006; Navruz-Varli & Sanlier, 2016; Ogungbenle, 2003) <sup>[24, 26]</sup>.

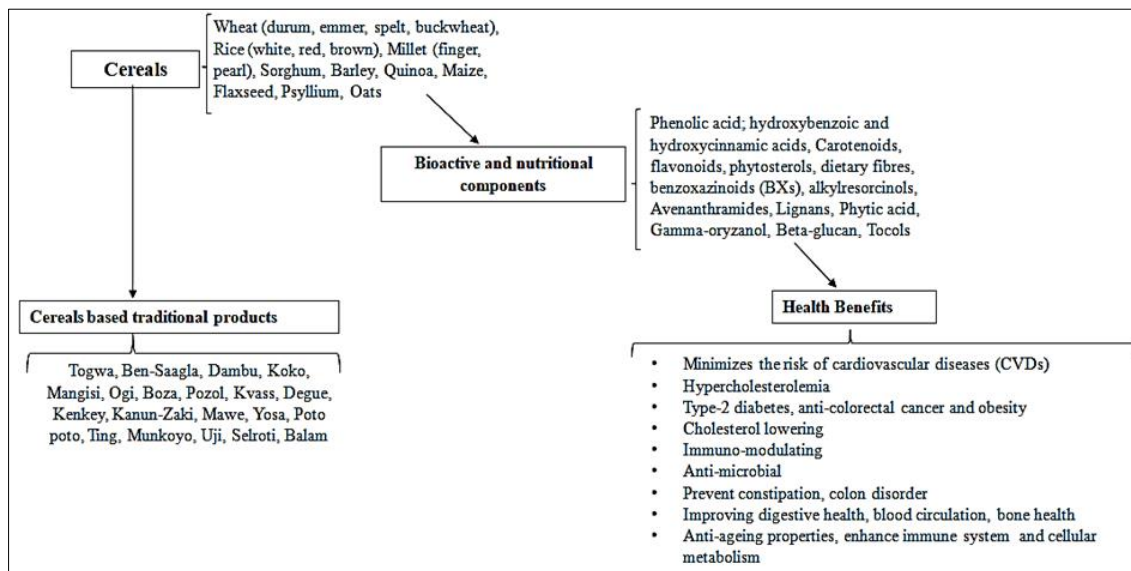
#### **Buckwheat (*Fagopyrum esculentum*)**

Buck wheat is sometimes referred to as pseudo-cereal because they are not grown on grass and as its name says wheat but it is different from wheat, also gluten-free. Buckwheat main nutritional component is carbohydrates that are present in its kernel, it also contains essential minerals and antioxidants that help to promote good health. They comprise good amount of fiber that contributes towards a healthy gut. Buckwheat is gluten-free and has a moderate. It contains a small amount of protein relatively 3%-4% that too is not easily digestible by the body due to the presence of certain anti-nutrients that makes it slow digestible, but the main crucial substances present in buckwheat are flavonoids, phytosterols, fagopyritols, fagopyrins and polyphenols like rutin, catechin aids importance to diet. The role of fagocytrols in the human body is reducing the level of cholesterol with decreased risk of coronary heart disease and also lowers the risk of cancer (Holasoava *et al.*, 2002; Ikeda, 2002; Zhang *et al.*, 2012) <sup>[27, 29]</sup>.

#### **Oats (*Avena sativa*)**

Oats are the type of cereal that contains wide range of potential health benefits. From the ancient times, oats have been recognized as nutritious food containing the well exact number of proteins, energy, carbohydrates, proteins. Due to the presence of rich number of fibers, polyphenols which assist in the lowering of cholesterol levels. Researchers have found that it is also effective in to minimize the risk of cardiovascular diseases (CVDs), cancer. In general consumption of oats found to be a better option than taking anti-hypertensive medicines for lowering blood pressure. Oats kernels, exhibits adequate number of polyphenols, phenolic acids, anti-oxidant activities which helps to maintain and stabilize blood cholesterol and glycaemic response also delays gastric emptying absorption of nutrients. A study conducted by (Lattimer & Haub, 2010) <sup>[30]</sup>, suggest that fibers in oats have the potential to reduce LDL cholesterol level especially fibers from oats are important for people that are suffering from diabetes. Beta-glucan present in oats assist in to maintain blood sugar levels (Chen & Raymond, 2008) <sup>[31]</sup>. Besides this Oats are rich source of protein ranging from 11%-14%. Overconsumption of oats leads to bloating and digestion disorders. Oats are rich source of good quality protein and highly nutritious, they have a high protein content of 11%-14%, oats have this unique structural composition along with a different fraction of proteins distribution in contrast to other cereal grains (Clemens & Van Klinken, 2014a, 2014b; Katz, 2001; Zwer, 2017) <sup>[32, 35]</sup>.





**Fig 1:** Cereals and its health benefits

### Psyllium (*Plantago ovata*)

Psyllium is a type of fiber that are made from the husks of the *Plantago ovata*/ispaghula plant seeds. Psyllium is water soluble natural occurring material which exhibits therapeutic applications in the treatment of skin irritations, blood pressure and other (Masood & Miraftab, 2010) [36]. It is consumed as a dietary fiber because of presence of glycoprotein which is not digested by the small intestine. Recent studies suggest that the consumption of psyllium assist in the reduction of LDL levels by 0.028-0.029 which gives a significant improvement in cholesterol levels, also it is preferable to eat psyllium over bran for treating irritable bowel syndrome (Theuwissen & Mensink, 2008) [37]. Further, Psyllium is considered as adequate source of soluble and insoluble dietary fibers, and the concentration of these fibers is eight-folds higher than oats bran (A. Verma & Mogra, 2013) [38]. Dietary fibers obtain formed psyllium can be utilized as functional ingredients which exhibits numerous health attributes including; heart disease diseases, weight loss, obesity, hypercholesterolemia (Kumar *et al.*, 2017) [39]. Flax seed (*Linum usitatissimum*) Flax seed belongs to Lineaceae family, which have numerous health and industrial applications (Goyal *et al.*, 2014) [40]. The consumption of flax has been reported from the ancient's times. It is an important alternate source of omega 3 fatty acid for vegetarian people. Flaxseed comprises of elevated amount of omega-3 fatty acid, alpha linolenic acid (ALA), phenolic compounds i.e., ferulic acid, chlorogenic acid, gallic acid which imparts anticancer, antioxidative properties (Parikh *et al.*, 2019) [41]. Beside this, it is also a vital source trace and major minerals including calcium, phosphorous, magnesium, sodium, water and fat-soluble vitamins. Cereals based functional-foods/beverages and its applications Malt Malt is well known traditional germination of cereal grain that undergoes processes including drying, soaking and gets converted from grain to malt commercially is made from millet, sorghum and barley (Ratnavathi & Chavan, 2016) [42]. The process of malting is used since ancient times in the production of beverages mainly alcohol and in the production of infant food. Enzymes present in cereals governs all processes of malting starting from soaking to germination and at last drying. Malting modifies cereals starch content that has quite a benefit as modifying starch content has a direct impact on the growth of

microbes hinders but microbes including *Saccharomyces cerevisiae* plays a major role in fermentation procedures by converting starch into sugar (Bokulich & Bamforth, 2013; Ratnavathi & Chavan, 2016) [43, 44].

### Togwa

It is non-alcoholic fermented drink usually made from millet and maize flour by lactic acid fermentation. This drink is widely consumed as refreshment in the regions of Saharan Africa. Process involve in the manufacturing of Togwa begin with cooking in which cereal flour with water is cooked and left undisturbed. After cooling previous culture of Togwa (which has *L. planatarum*) is added which kick starts the fermentation process. The shelf life this drink is less due to absence of alcohol to inhibit microbial growth (Oi & Kitabatake, 2003) [44].

### Ben-saagla

It is a cereal-based fermented/complementary oatmeal made from millets especially from pearl millet. This food is more popular in African countries mainly in the west side as a complementary food eaten by young and infants. This complementary food in generally made with pearl millet grains by the process start with soaking of grains, then grinding takes place after the product obtained from grinding is then knead into dough or paste when after proper kneading is done it is then clarified using sieving then it is cooked for some minutes to ensure proper cooking and marinated with some spices like ginger, black pepper that enhances its flavors. The sour paste obtained is then adjusted according to the consumer requirement (Tou *et al.*, 2006) [45].

### Dambu

It is a type of non-fermented food mostly produce from millets, sorghum and maize. In general, this food is basically round in shape dumplings that are properly steamed powdery in texture. The food is made by when damp flour is cooked or steamed and garnished with some spices for around 30 minutes followed by sprinkling of fermented milk or sugar on it. As like other beverages it also has a very low shelf life because grains get easily destroyed or contaminate by microbes (Aguet *et al.*, 2008) [46].

**Roti**

Roti the well-known type of flatbread eaten mostly in every part of the world especially in Asian regions and native to India. Roti can be made from wheat, ragi, jowar, maize and some other cereal grains. Roti is commonly eaten with cooked vegetables or with curries. It is made when millet flour of cereal grains like wheat is milled into flour and then this flour is mixed with some amount of water is added as it holds the flour after it is evenly kneaded to make the dough and then it is made into the desired shape and cooked. This roti or flatbread is a major part of the diet for Indian people especially central and northern Indian region (Lopez-García, 2008) [47].

**Koko**

It is a type of porridge (breakfast food) which is made by soaking cereal grains followed by boiled with water. After boiling mixing of cereals frequently used millet with spices including ginger, pepper and other spices and water is added so that it forms a paste. Afterwards, paste is left for some hours to allow fermentation to take place via the natural microbes present in kodo i.e., *Lactobacillus fermentum* and *Weisella confuse* (Lei & Jakobsen, 2004) [48].

**Mangisi**

It is bittersweet in taste fermented beverage fermented by lactic acid bacteria. This beverage is generally made from a mash of millet. The milled millet mixture is slowly boiled for one and half hour that finally converts into the mash and undergoes certain process like straining and cooling and then fermentation which helps it to achieve its final stage and become a sour bitten beverage. The rural African families are very fond of this beverage also this beverage is used in social gathering and ceremonies in Africa (Zvauya *et al.*, 1997) [49].

**Ogi**

Ogi is most favored traditional cereal-based fermented porridge of Western African. This food is generally made from fermented maize, sorghum. besides this, it has also acted as weaning food babies which are 6-7 months to remove their habit of breastfeeding and is given in the jelly form. It is prepared with the help of traditional methods used for the fermentation process and malting process. Fermentation is achieved together with the help of microbes species including, *Lactobacillus* species, *Saccharomyces* spp., *Aerobacter* species, *Aspergillus* species, in which the microbe which is prominently responsible for fermentation (Oyarekua & Eleyinmi, 2004) [50].

**Boza**

Boza is the millet-based fermented beverage widely consumed in Kazakhstan, Albania. It is a result of spontaneous fermentation of millet which is when mixed with water and other cereals, then milled. The milled paste is now drawn to remove all impurities and unwanted particles, after its flavouring is done where sugar is added as per the quantity and then it is subjected to fermentation processes for a day at ambient temperature 30 °C. After 24 hours our fermentation is done and boza is ready to consume. Fermentation is achieved by the LAB and the yeast strains including, *Candida tropicalis*, *Saccharomyces cerevisiae*, *Leuconostoc Paramesenteroides*, *Geotrichum Candidum* (Todorov *et al.*, 2008) [51].

**Pozol**

Pozol is fermented dough and drink made from corn which is famous in Colombian countries, Mexico and India. Pozol is prepared when maize is soaked and cooked in lime water solution which is then cleaned washed and hulling is done in corn, then grains are grounded and formed into sphere-shaped and then they are packed in leaves. The packed sphere-shaped balls are then allowed to undergo spontaneous fermentation which lasts for 5-7 days. During these fermentation process, the pH of pozol starts rising and after 2 days pH ranges from 3.7 to 4.7. These balls when gets prepared are dipped into water at different levels of fermentation then it forms a gruel, gruel is a variety of food containing some cereal whether maize, rye, oat boiled in milk or water. On the other hand, Pozol dough is mixed with sugary water or if making sour then left for 3 days fermentation. Pozol also have pharmaceutical values in promoting good health of the gut, also controls diarrhoea problems and other major intestine issues regarding gut health (Ben Omar & Ampe, 2000) [52].

**Kvass**

It is a type of non-alcoholic fermented beverage made from cereals like barley malt, rye which is famous in Central and Eastern European countries. It is made by naturally occurred fermentation of bread in which rye bread, barley malt and flavoured using fruits, dry fruits like raisins are added. There are two methods for the preparation of Kvass, traditional method involves using of different types of malt with flour and mixing them with help of boiling water till it reaches up to consistency as that of pasta and then it is heated up for hours. After the heat treatment is done it is again mixed with warm water and baker's yeast is added and left form fermentation processes to take place and by subjecting it to 4 °C, fermentation process is terminated and product obtain is rich in proteins, the activity of the fermenting microorganisms, despite having one microbe it contains a wide range of microbes those are responsible for lactic acid fermentation this distinct feature make it different from beer. (Dlusskaya *et al.*, 2008; Gambus *et al.*, 2015) [53, 54].

**Other cereals-based foods and beverages**

Numerous of cereals-based foods are found in literature which exhibits different therapeutic properties. Some of these including, Degue which is a fermented malted beverage and its preparation starts when grains hulled and grind into powdery form after they are soaked into the water and cooked to make them in round sphere-shaped gelatinized balls (Angelov *et al.*, 2017) [55]. Kenkey made from fermented maize dough in Ghana and is widely consumed and liked by the people of Ghana. Kenkey flavour and odour is so good that it leads to mouth-watering because of its unique pleasing flavour and odour. Kenkey is the result of spontaneous fermentation which is favoured by lactic acid bacteria (LAB) (Halm *et al.*, 2004) [56]. Kanun-Zaki is fermented beverage made from maize and pearl millet. Kanun-Zaki is widely used in northern Nigeria as a breakfast food as well as it also has some very beneficial nutraceutical values that are the main reason for its wide consumption in African countries (Blandino *et al.*, 2003) [57] and whole cereals such as puffed rice, flaked rice and roasted wheat can be consumed as a snacks food in some parts of Asian countries (Kumar and Prasad, 2018) [58]. Obushera is made from spontaneous fermentation of malted sorghum and millet flour and is widely

famous in Uganda (Muyanja *et al.*, 2003) <sup>[59]</sup>. Poto-poto is a maize fermented dough used in Congo mainly for weaning purposes i.e., is to stop the habit of the child from breastfeeding. Poto-poto is made when kernels are soaked milled then paste is formed which is fermented for some hours then cooked so cruel is made. The paste obtained can be used to make poto-poto balls (Omar *et al.*, 2008) <sup>[60]</sup>.

### Conclusion

Cereals are the fulfil the approximately 60-70% daily requirements of energy over the world. The cereals are consumed either processed and semi processed and whole. Cereals especially colored rice, colored wheat, colored maize and some millets having number of functional bioactive components such as polyphenols, tocopherol, oryzenol (antioxidants) ultimately they prevent or control the some disease in body heart disease, reduces the risk of cancer, type2 diabetes, hypertension, high blood pressure and decrease the glycemic index. The food may be consumed fermented in some region while some are non-fermented. Fermented cereals are increasing the vitamins B complex and some other nutrients and increase the digestibility and availability of nutrients.

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