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Importance of multigrain consumption over single grain: A review

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Abstract
Grains are a staple and major part of the f human diet. Multigrain products are made by combining more than two grains. They give more nutrients than two grains. They give more than regular single grain consumption and fulfil deficiencies of nutrients of other grains. Processing of grains may lead to the destruction of nutrients from grain therefore different types of grain are mixed to make multigrain food products. Different types of bioactive compounds are present in grains. They do not give any nutrients to the body but they play role in physiological activities which gives health benefits to the body. Bioactive compounds are like fatty acids, minerals, vitamins, prebiotic, probiotic, dietary fibre, carotenoids, enzymes, antioxidants and phytochemicals. These bioactive compounds help in the prevention of various chronic diseases as well as keep your body healthy. In this review, we discuss about multigrain products and their nutrition, the effect of processing on grains and major bioactive compounds in grains and their health benefits.

Keywords: Multigrain, effect of processing, bioactive compounds, health benefits, diseases

Introduction

Grains is the one of most important factor in human diet. It is also considered as a staple food. It helps in growth as well as providing nutrients to body to do day to day activities. Today consumers not only eat food to satisfy his appetite but also for to gain more nutrients from it. Today food is helping in fighting against nutritional disorder related diseases (Behera & Srivastav, 2018) [3]. In 21st century, lifestyle of humans changes a lot. Now days peoples are more concern about their health and nutrition intake. Peoples are looking for food which gives more nutrients in less intake. This leads to creation of food with health benefits which also called as functional foods. In simple language functional food can be define as "food and food components that provide a health benefits beyond basic nutrition" (Fernandes *et al*., 2018) [12].
Major nutrients are present in bran and germ part of grain. During grain processing (refining) germ and bran are removed and loss of nutrients occurred. In many scientific studies reported that keeping whole grains in diet helps in decrease the chances of coronary heart diseases and various types of cancer. Dietary fibre plays important role in slow down the rate of glucose breakdown which leads to less absorption in body and facilitate balanced breaking of carbohydrates and glucose release (Pande *et al*., 2017) [25].
According to Dahatonde *et al*. (2018) [6], multigrain product is mixture of two or more grains. Every grain has its own nutritional properties, therefore when we mixing multiple grains together they gave more nutrition as compare to single grain consumption. Other than these, multigrain product gives various phytochemicals as well as enhance texture and sensory qualities.

Nutritional Properties of Multigrain Products

Multigrain products are comprising of two or more than two grains. They help in overcoming nutrient deficiencies of each other. Also increases the nutritional properties of product. Some of multigrain products reviewed in this paper.
Multigrain sticks prepared by Dahatonde *et al*. (2018) [6], this product composed of flours of rice, Bengal gram dhal, green gram dhal, and black gram. It is rich in protein and carbohydrates which is 16.6 g and 64.9 g per 100g respectively. This product contains less amount of fat so it's helpful for obese people. Multigrain Noodles made by Herath *et al*. (2018) [15], brown rice, wheat flour, whole grain legumes, chickpea, green gram, black gram are used for making product.

This product is having 6.64g of proteins and 21.46g of carbohydrates per 100g. Glycemic index of this product is about 44.29. It is great alternative for traditional less healthy noodles present in market.

Ready-to-eat snack mix prepared by Pradeep *et al*., (2013) [26], made up of sorghum pearl millet, grain amaranthus, Bengal gram, green gram, soya bean and groundnut seeds. It comprised of 14g of proteins, and 6.3g fibre and 58.4g of carbohydrates per 100g. Other than these, it also contains 0.8g of polyphenols, 1.6g of free fatty acids. Minerals like calcium 219.3mg, iron 6.6mg, zinc 4.1mg, and magnesium 49mg per 100gm. In fatty acid they found oleic (58.4%), palmitic (8.8%), linolenic (3.6%), and linoleic (29%). Monosaturated fatty acids (MUFA) like oleic acid help in low density cholesterol and hypercholesterolemia.

Multigrain Taco made by Modi & Gupta (2015) [20], it is simply described as tortilla wrapped around filling. Multigrain taco made up of soy flour, sorghum, oats and corn flour. It contains protein 10.03gm, fat 24.95g, carbohydrates 63.12g. Antioxidant activity of multigrain taco found 48.1%. Minerals estimated like calcium 278ppm, chromium 1.25ppm, copper 2.50ppm, iron 38.25ppm, magnesium 532ppm, manganese 7.5ppm, strontium 2.50ppm, and zinc 20ppm. In multigrain tacos, they did not find any traces of trans-fatty acids and good amount of unsaturated fatty acids such as monounsaturated fatty acids (MUFA) 9.77g/100g and polyunsaturated fatty acids (PUFA) 2.38g/100g as well as saturated fatty acids 12.80g/100g.

Multigrain bread prepared by Olagunju *et al*., (2021) [22], comprised of whole wheat flour, amaranth and acha flour. This bread contains 22.21g of protein and 33.66g of fat. Chelating ability of Fe^{2+} having IC_{50} value of 0.97mg/ml. Amaranth grain comprise of rutin as major polyphenol where as in wheat ferulic acid is major phenolic acid. This phenolic acid is showing antioxidant activity. Structural application of rutin for complexing metal ion. Hydroxyl radical (OH) is very reactive in nature. It attacks on biological or organic molecules. Therefore, scavenging of this radical is most important and ability to scavenge OH radical may considered as exogenous dietary antioxidant. Multigrain bread showed around 0.78mg/ml value of IC_{50}. Glycemic index (GI) and glycemic load (GI) are boundaries to portray amount and nature of carbohydrates in food product. GI categorized into 3 types, which is low (0-54), medium (55-70), and high (above 70). Whereas low GL (below 10), medium (10-20) and high (above 20). Multigrain bread showed GI value of 44.57 and GL value of 17.46

Mordum made by Gervase *et al*., (2020) [14], is Nigerian breakfast meal was made from mixes comprised of rice, millet, maize each sustained with cowpea, soybean and powdered milk. In macronutrients, protein constitutes around 22.81g, carbohydrates 52.57g, fibre 2.43g, fat 12.08g and ash 4.63g per 100g. In micronutrients like zinc, calcium, magnesium, potassium and phosphorous constitutes around 4.46, 6.66, 280.09, 20, 252.20 and 5.34 mg/100g respectively. Bacterial and fungal count of product nearly about 3×10^3 and 1.2×10^3 cfu/g respectively which is in limit of 10^5 cfu/g.

Multigrain gluten free cookies prepared by Radhika *et al*., (2019) [27], made from finger millet, pearl millet, soybean and groundnut in equal proportion of 25% each. Protein constitutes around 11.66g, carbohydrates 53g, fats 25.19g, fibre 4.28g and ash 2.21g. While multigrain gluten free steamed pasta comprised of finger millet, pearl millet and soybean in proportion of 30:35:35. Protein content in pasta is around 11.23g, carbohydrates 66g, fat 5.58g, fibre 2.83g ash 5.01g per 100g.

Multigrain mix incorporated with unripe banana flour Shalini *et al*., (2020) [30], prepared from wheat, ragi, cumbu, kuthiraivalli, sorghum, bengal gram, banyard millet and red banana flour. Protein content of sample is around 12.58g, carbohydrates 69.16g, fat 2.45g, fibre 14.81g and ash 2.38g per 100g. In micronutrients like β-carotene and calcium is around 29.85µg and 46.51mg per 100g. Resistant starch value is about 29.82g/100g.

Table 1: Macronutrient Composition of Multigrain Products

Nutrients Products	Grain Used for Product Formulation (in gm)	Proteins (gm/100gm)	Carbohydrates (gm/100gm)	Fats (gm/100gm)	Fibre (gm/100gm)	Minerals (Ash) (gm/100gm)	References
Multigrain Sticks	RF:BF:GF:BLF (45:25:8:8)	16.6	64.9	11.4	1.07	4.5	(Dahatonde *et al*., 2018) [6]
Multigrain Noodles	RF:WF:BF:BLF:GF (20:50:10:10:10)	6.64	21.46	0.18	3.11	0.68	(Herath *et al*., 2018) [15]
Ready-to-eat Snack mix	S:A:B:GF:BF:G:SF (10:10:10:8:8:3:4)	14	58.4	1.6	6.3	1.63	(Pradeep, *et al*., 2013) [26]
Multigrain Taco	-	10.03	63.12	24.95	13.95	1.5	(Modi & Gupta, 2015) [20]
Multigrain Bread	WF:A:AF (70:20:10)	22.21	39.17	33.66	0.59	4.37	(Olagunju *et al*., 2021) [22]
Mordum (Nigerian Multigrain Breakfast Cereal)	RF:MF:SF (50:30:20)	22.81	52.57	12.08	2.43	4.63	(Gervase *et al*., 2020) [14]
Multigrain Gluten Free Cookies	FM:PM:SF:G (25:25:25:25)	11.66	53	25.19	4.28	2.21	(Radhika, *et al*., 2019) [27]
Multigrain Gluten Free Steamed Pasta	PM:FM:SF (30:35:35)	11.23	66	5.58	2.83	5.01	(Radhika, *et al*., 2019) [27]
Unripe Banana Flour Incorporated Multigrain Mix	BF+R+C+K+S+B:BNF (75:25)	12.58	69.61	2.45	14.81	2.38	(Shalini *et al*., 2020) [30]

(RF=Rice flour, BF=Bengal gram Flour, GF=Green gram flour, BLF=Black gram flour, WF=Wheat Flour, S=Sorghum, A=Amaranthus, SF=Soya flour, B=Bajra, G=Groundnut, MF=Millet flour, AF=Acha flour, FM=Finger millet, PM=Pearl millet, R=Ragi flour, C=Cumbu, K=Kuthiraivalli, B=Banyard millet, BNF=Banana flour)

Effect of Processing on Grains

Soaking

Soaking is traditional household processing method. Many research studies result showed that soaking may increase the nutritional properties, bioactivity and bioactive compounds in grains. In research of EL-Suhaibani *et al*. (2020) [8], found that soaking of goatpea increase protein content mainly methionine, isoleucine, lucine, phenyl alanine and histidine. On the other hand, decrease in fat, ash, fibre, carbohydrates, phytate and tannin content is seen. On soaking of sorghum Eltayeb *et al*. (2016) [9], found that there is increase in protein, ash, carbohydrates, magnesium. While on contradict, decrease in potassium and phytate content. There is no any changes observed in phosphorous, calcium, iron and zinc. Agume *et al*. (2017) [1] in their research observed that, on soaking of soyabean there is reduction in protein, soluble sugar and tannin content while increase in lipid content. There is no significant change in phytate, ash content. Soaking of rice leads to increase in total phenolic and γ-oryzanol cotent (Saleh *et al*., 2018) [28]. Finger millet sokaing resulted in increase in protein digestibility and reduction in phytic content (Yousaf *et al*., 2021) [37].

Germination

Germination is traditional household technique used for centuries to soften structure to enhance nutrtional characteristics and to decrease anti-nutritional properties (Farooqui *et al*., 2018) [11]. Erba *et al*. (2018) [10], studied the germination of chickpea and green pea, they observed increase in protein, lipid, insoluble fibre. While decrese in carbohydrates, ash and soluble fibre. EL-Suhaibani *et al*. (2020) [8] studied about germination of goatpea and they found decrease in protein, fat, fibre, phytate and tannin. In other hand, increase in ash and amino acids (isolucine, valine, histidine). Germination of cowpea studied by Devi *et al*. (2015) [7], they observed increase in protein, ash, fibre, calcium, iron, vitamin C and moisture. There is reduction in fat, carbohydrates, phytic acid, trypsin inhibitor activity.

Saleh *et al*. (2018) [28], studied brown rice germination, they seen enhancement in lipid, protein, γ-aminobutyric acid, total phenolic and high oxygen radical absorpion capacity. Reduction in phytic acid and glycemic index. They also studied about barley germination and they observed high antioxidant actvity due to breakdown of polysaccharides by increase in activity of enzymes.

Increase in protein, fibre, calcium, magnesium, zinc and total flavonoid. While decrease in fat, ash, potassium, phosporous, iron, manganese, copper and total phenolic content observed in barley germination by (Farooqui *et al*., 2018) [11]. Warle *et al*. (2015) [35-36], did research on germination of sorghum and they observed increase in protein, amylose, total sugar, non-reducing sugar. Increase in sugar due to conversion of fructose and maltose to glucose due to α and β-amylase enzymes. On the contrary, decrease in ash, starch, amylopectin, fat, oil absorption capacity and carbohydrates. Carbohydrates degradation because of active respiration process during germination. In another study Warle *et al*. (2015) [35, 36], studied about germination of soya bean, the result are same as germination of sorghum. Shah *et al*. (2011) [29], did germination of mungbean, they observed that, there is increase in ash, protein, fibre, ascorbic acid (vitamin C). Increase in protein content due to synthesis of protein enzyme by germination. On the other hand, reduction of fat, nitrogen free extracts and phytic acid. Reduction of fat is because of loss of total solid in soaking prior germination or use of fat as energy source.

Roasting

Roasting is method use from long time to make food suitable for consumption. Various kinds of sources like oven, open flame are used to increase the flavour by milliard browning and increase aroma compounds (Yousaf *et al*., 2021) [37]. Agume *et al*. (2017) [1], studied about roasting of soyabean and they observed there is decrease in protein, tannin, phytate, polyphenol, carbohydrates and lipid. While there is no any significant change seen in ash content. Pearl millet roasting reviewed by Yousaf *et al*. (2021) [37], they noted that increase iron content due to leaching from roasted iron pan. On the other hand, decrease in protein, fat, moisture, crude fibre and calcium observed. Decrease in protein is because of destruction of amino acids. They also reviewd that decrease in antinutritional factors like tannin and phytic acid in roasting of foxtail millet. Finger millet roasting showed increase in ash, crude fibre, minerals (calcium and iron). While reduction in protein, moisture, fat and phytic acid.

Tiwari & Awasthi (2012) [32], studied roasting of oats, they seen increase in protein, carbohydrates and calcium. On contradict, decrease in moisture, fat, phytic acid, and ash. Castro-Alba, *et al*. (2019) [5], studied about quinoa roasting, they observed increase in lactic acid and decrease in phytic acid. Increase in total phenolic content, antioxidant activity and decrease in total flavonoid content duirng roasting of chickpea seen by (Jogihalli *et al*., 2017) [17]. Muyonga *et al*. (2014) [21], studied about roasting of amaranth they, observed that there is increase in total flvonoid, antioxidant activity while decrease in protein digestibilty. No any significant change observed in total phenolic content.

Fermentation

Fermentation is important for preservation of food, where modern technique are need to increase nutrition and flavor and reduce anti-nutrients in food product (Yousaf *et al*., 2021) [37]. Castro-Alba, *et al*. (2019) [5], did study of fermantation of quinoa, they observed increase in zinc, calcium. Also enhance bioavailability of zinc and iron. Saleh *et al*. (2018) [28], reviwed fermentation of brown rice flour, barley, maize. In brown rice flour fermentation, increase protein, ash, insoluble and soluble fibre, minerals, total phenolics, resistant starch, riboflavin, pyridoxine, nicotinic acid, γ-tocotrienols, δ-tocotrienols. In barley fermentation they noted enhance in γ-aminobutyric acid, 1, 3-propanedoil and histamine. In maize fermentation they noted enhance in total carotenoids and vitamin C. Decrease radical scavenging activity. Yousaf *et al*. (2021) [37], reviewed about fermentation of pearl millet and finger millet. In pearl millet fermentation, increase in proteins, crude fat and polyphenols. While decrease fibre, ash, carbohydrates and phytic acid. In finger millet fermentation increase in minerals (like zinc, calcium, iron and phosphorous), vitamins (like thiamine, niacin and riboflavin), protein (methionine and cysteine). While decrease in phytate and tannin.

Table 2: Effect of Processing on Grains

Processing	Grain	Effect of Processing	Reference
Soaking	Goat pea	Increase protein (methionine, isoleucine, leucine, valine, phenyl alanine, histidine). Decrease fat, ash, fibre, carbohydrates, phytate, tannin.	(EL-Suhaibani *et al.*, 2020) [8]
	Sorghum	Increase protein, ash, carbohydrates, magnesium. Decrease moisture, lipid, fibre, potassium, phytic acid. Phosphorous, calcium, iron and zinc not affected significantly.	(Eltayeb *et al.*, 2016) [9]
	Soyabean	Increase lipid. Ash and phytate does not affected significantly. Decrease protein, soluble sugar, tannin	(Agume *et al.*, 2017) [1]
	Rice	Increase phenolics and γ-oryzanol	(Saleh *et al.*, 2018) [28]
	Finger Millet	Increase protein digestibility. Reduce phytic content	(Yousaf *et al.*, 2021) [37]
Germination	Chickpea	Increase protein, lipid, starch, fibre. Decrease carbohydrates, ash (calcium, magnesium, iron, zinc, phosphorous)	(Erba *et al.*, 2018) [10]
	Green pea	Increase protein, lipid, insoluble fibre. Decrease carbohydrates, soluble fibre, ash (magnesium, iron)	(Erba *et al.*, 2018) [10]
	Goat pea	Increase ash, amino acids (isoleucine, valine, histidine). Decrease protein, fat, fibre, phytate, tannin	(EL-Suhaibani *et al.*, 2020) [8]
	Cowpea	Increase protein, ash, moisture, calcium, iron, ascorbic acid (vitamin C), fibre, in-vitro protein digestibility. Decrease fat, carbohydrates, phytic, trypsin inhibitor activity.	(Devi *et al.*, 2015) [7]
	Brown Rice	Increase protein, lipids, γ-aminobutyric acid, total phenolics and higher oxygen radical absorption capacity. Reduce phytic acid and glycemic index	(Saleh *et al.*, 2018) [28]
	Barley	Increase protein, fibre, calcium, magnesium, zinc, antioxidants activity, total flavonoid content. Decrease polysaccharides, fat, ash, potassium, phosphorous, iron, manganese, copper, total phenolic content,	(Saleh *et al.*, 2018; Farooqui *et al.*, 2018) [28, 11]
	Sorghum	Increase moisture, protein, amylose, total sugar, non-reducing sugar. Decrease carbohydrates, starch, amylopectin, ash, fat, oil absorption capacity	(Warle *et al.*, 2015) [35, 36]
	Soyabean	Increase moisture, protein, reducing sugar, non-reducing sugar, amylose, water solubility index. Decrease carbohydrates, starch, amylopectin, ash, fat, oil absorption capacity	(Warle *et al.*, 2015) [35, 36]
	Mungbean	Increase ash, protein, fibre, ascorbic acid (vitamin C). Decrease fat, nitrogen free extracts, phytic acid	(Shah, *et al.*, 2011) [29]
Roasting	Soyabean	Ash not change significantly. Decrease protein, lipid, tannin, phytate, polyphenol and carbohydrates	(Agume *et al.*, 2017) [1]
	Pearl Millet	Increase iron. Decrease protein, fat, moisture, crude fibre and calcium	(Yousaf *et al.*, 2021) [37]
	Oats	Increase protein, carbohydrates, calcium. Decrease moisture, fat, phytic acid and ash	(Tiwari & Awasthi, 2012) [32]
	Foxtail Millet	Decrease antinutritional factors like tannins and phytic acid	(Yousaf *et al.*, 2021) [37]
	Quinoa	Increase lactic acid. Decrease phytic acid, moisture	(Castro-Alba, *et al.*, 2019) [5]
	Finger Millet	Increase ash, crude fibre, minerals (calcium and iron). Decrease protein, moisture, fat, phytic acid.	(Yousaf *et al.*, 2021) [37]
	Chickpea	Increase total phenolic content, antioxidant activity. Decrease total flavonoid content	(Jogihalli *et al.*, 2017) [17]
	Amaranth	Increase total flavonoid content, antioxidant activity. Total phenolic content not changed significantly. Decrease protein digestibility	(Muyonga *et al.*, 2014) [21]
Fermentation	Quinoa	Increase zinc, calcium. Also increase bioavailability of zins and iron	(Castro-Alba, et al., 2019) [5]
	Brown Rice Flour	Increase protein, ash, insoluble and soluble fibre, minerals, total phenolics, resistant starch, riboflavin, pyridoxine, nicotinic acid, γ-tocotrienols, δ-tocotrienols.	(Saleh *et al.*, 2018) [28]
	Barley	Increase γ-aminobutyric acid, 1,3-propanedoil and histamine.	(Saleh *et al.*, 2018) [28]
	Pearl Millet	Increase proteins, crude fat and polyphenols. Decrease fibre, ash, carbohydrates and phytic acid.	(Yousaf *et al.*, 2021) [37]
	Maize	Increase total carotenoids and vitamin C. Decrease radical scavenging activity.	(Saleh *et al.*, 2018) [28]
	Finger Millet	Increase minerals (zinc, calcium, iron and phosphorous), vitamins (thiamine, niacin and riboflavin), protein (methionine and cysteine). Decrease phytate and tannins	(Yousaf *et al.*, 2021) [37]

Major bioactive compounds present in grains and their health benefits

A multigrain product is combinations of two or more than two grains for formulation of product. Because of various grain its nutritional properties are increased. Ultimately the health benefits of consumption of these product also great than usual single grain products. Multigrain products not only concentrated for tackle specific kind of disease but also have various health benefits for chronic diseases as well as nutritional deficiencies.

Fernandes *et al.* (2018) [12] reported that, functional food should be excellent source of bioactive compounds. Bioactive substances do not give any kind of nutrition but they play role in physiological activities and hence they have significant importance in human health. In bioactive compound mainly include fatty acids, minerals, vitamins, dietary fibre, prebiotics, probiotics, carotenoids, enzymes, phytochemicals and antioxidants.

According to Bartłomiej *et al*. (2012) [2], arabinoxylans are non-starch polysaccharides. They are polymers of pentoses and hence they also called as ‘pentosans’. Arabinoxylans found in bran section of cereal grains. Rye is richest source of water extractable arabinoxylans with 12.1-14.8 % db. Other than this, in wheat (9-18), barley (4.8-9.8) and oat (4-13) % db. Total arabinoxylans content in range of 3.1-4.3 % db in whole grain flour. Arabinoxylans comprised of fractions of dietary fibre which impact on digestive system. Arabinoxylans fermentation in large intestine results into formation of short chain fatty acids which leads to lowers the cholesterol transportation of low-density lipoprotein (LDL) which formed in liver resulted into improvement in minerals absorption like magnesium and calcium. Another health benefit of arabinoxylans is having high (upto 800%) water binding capacity of their mass. Which decreases the harmful and carcinogenic compound like secondary bile acids. Of stool in large intestine. Arabinoxylans also produces ferulic acid residues which is having antioxidant and anti-inflammatory activity.

Jideani, *et al*. (2014) [16] in their book chapter reported that, legumes, oilseeds, nuts and whole grains are excellent source of sterols and stanols. They help in lowering low-density lipoprotein cholesterol and serum level in body. Other than this, phytosterol react with cholesterol and form micelle in intestinal lumen and prevent absorption of cholesterol. Pajari *et al*., (2021) [23] in their bookchapter discussed about folate and their health benefits. They noted that folate belongs to vitamin B group. As per FAO and WHO recommendation of intake for adults is 400 µg/day. Folate is majorly found in outer layer and germ part of grain. Wheat and rye bran are richest source of folate followed by oat, barley, and maize. Folic acid and folate helps in preventing several cancer is proved in several studies but promote existing cancer cells to grow.

Gani *et al*. (2012) [13], reviewd that lignans are polyphenolic bioactive compounds. They mainly found in whole grains like wheat, rye, oats and corn. Usually matairesinol, larieiresinol, syringaresinol, secoisolariciresinol and pinoresinol are present in human diet. On consumption matairesinol and secoisolariciresinol are turned into mammalian lignans enterolactone and enterodiol respectively by microbial enzymes in colon. These mammalian lignans have weak oestrogenic activity and strong antioxidant activity which having biological effects and health benefits. These lignans helps in prevention of breast and prostate cancer also fight against heart diseases. Lignans level in blood is inversely related to cardiovascular diseases.

As per review of Calinoiu & Vodnar (2018) [4], phenolic acids are definite class of polyphenol which generally associated with defense mechanism in oppose to abiotic and biotic stresses. Phenolic compounds mainly concentrated in bran section of grain. Nearly about 15 to 17 fold higher than endosperm. *In vivo* study found that ferulic acid helps in capturing free radical, hence prevent stress due to oxidation related to PUFA induced toxicity. Ferulic acid play significant role in anti-inflammatory activity. They helps in lowering the plasma tumor necrosis factor-α. Phenolic acids have antimicrobial activity and use as preservative in food and food packaging material.

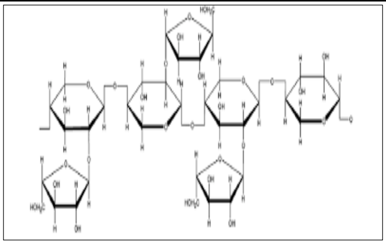
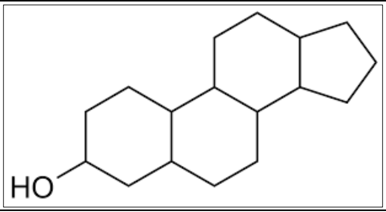
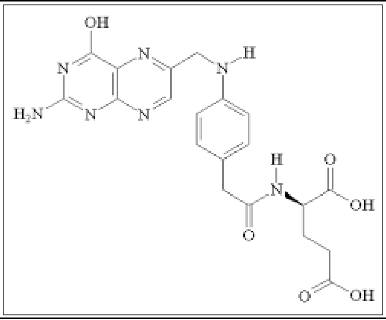
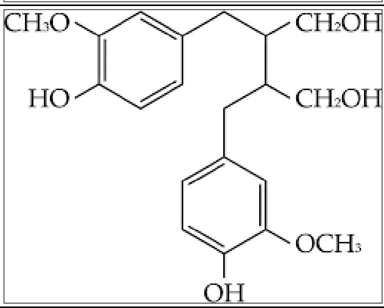
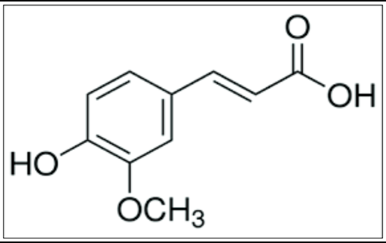
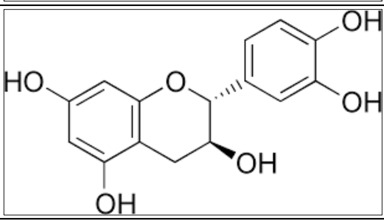
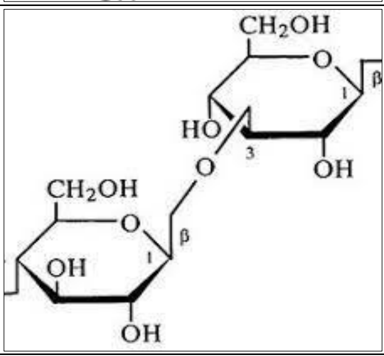
Panche *et al*. (2016) [24], in their paper reviewd that, flavonoids are from secondary metabolites class. Flavoides concentrated in pricarp area of all cerals. Barley is richest source of catechin and di and tri pro-cynidins among all cereals (Sofi *et al*., 2019) [31]. Isoflavonoids like daidzein and genistein are known for its oestrogenic activity hence, they also called as phyto-oestrogens. Genistein make metabolites and hormonal changes which can turn disease pathway (Panche *et al*., 2016) [24].

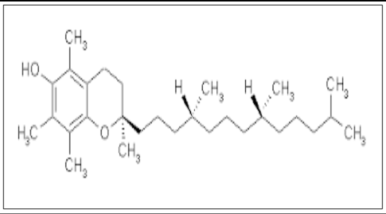
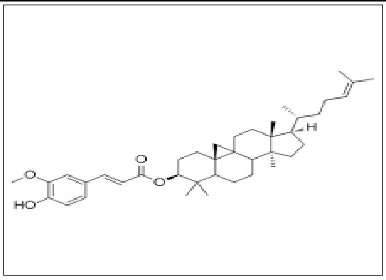
β-glucans are major part of dietary fibre. They mainly concentrated in bran and aleuron layer cells. Barley and oats are rich source of β-glucans (Bartłomiej *et al*., 2012) [2]. They are linear polymers of glucose molecules out of which 70% connected by β-(1-4) and 30% by β-(1-3) linkages. β-glucans is more flexible, soluble and viscous in contrast to cellulose. Due to viscous in nature and soluble fibre, it bind cholesterol and bile acids and remove it from body. β-glucans also helps in lowering blood sugar level which is helpful for diabetes. Many studies showed that β-glucans from oats help in weight management and blood pressure control (Gani *et al*., 2012) [13].

Tocols are also called as vitamin E. tocopherol and tocotrienols are included in this group. These tocols further occure in eight form, α, β, γ, and δ-tocopherol and α, β, γ, and δ-tocotrienol that distinct in number of methyl groups attached to ring of 6-chrmanol (Bartłomiej *et al*., 2012) [2]. Wheta and rye are excellent source of tocols with 27.81 and 27.78 mg db respectively (Sofi *et al*., 2019) [31]. α-tocopherol have highest vitamin E activity. While α-tocotrienol have highest antioxidant activity. Other than these, tocol containing grains health benefits like lowering blood cholesterol level, reduce risk of cardiovascular diseases, cancer. Average requirement is about 12 mg per day (Gani *et al*., 2012) [13].

γ-Oryzanol is compound mainly found in rice bran oil. It is combination of sterol, ferulic acid and 10 phytosterylferulate. Nearly about 18-63 mg/100g content present in rice grain and 185-421 mg/100g present in bran. Health benefit of γ-oryzanol are like lower serum cholesterol, decrease platelet aggregation and reduce cholesterol absorption. Oryzanol also helpful in tretament of disorders of menopause, hyperlipidemea and to gain mass of muscle (Sofi *et al*., 2019) [31].

Table 3. Major bioactive compound in grains and their health benefits

Bioactive Compound	Structure	Health Benefits	References
Arabinoxylans		Lowers cholesterol transportation of LDL, remove harmful and carcinogenic compound from body	(Bartłomiej *et al*., 2012) [2]
Sterols and Stanols		Prevent absorption of cholesterol, they help in lowering low-density lipoprotein cholesterol and serum level in body	(Jideani, *et al*., 2014) [16]
Folate		Prevention from several kinds of cancers	(Pajari *et al*., 2021) [23]
Lignans		Helps in prevention of breast and prostate cancer, heart diseases.	(Gani *et al*. 2012) [13]
Phenolic acid (Ferulic Acid		Capture free radicals and prevent oxidation, anti-inflammatory activity, lower plasma tumor necrosis factor-α	(Calinoiu & Vodnar, 2018) [4]
Flavonoids (catechin)		Oestrogenic activity, hormonal and metabolic changes can turn disease pathway change	(Panche *et al*., 2016) [24]
Beta-glucan		Lower blood sugar level, control blood pressure, helps in weight management	(Gani *et al*., 2012) [13]

Tocols (α-tocopherol)		Lower blood cholesterol level, reduce risk of cardiovascular disease, cancer	(Gani *et al*., 2012) [13]
Gamma-oryzanols		Lower serum cholesterol, reduce platelet aggregation, cholesterol absorption, helpful in treatment of disorders of menopause, hyperlipidemia	(Sofi *et al*., 2019) [31]

Conclusion

Grains are excellent source of all nutrients and bioactive compounds which help in prevention of various chronic diseases. In this review, we conclude various multigrain product and their nutritional profiles, effect of processing on grains. Soaking, germination and fermentation are helpful for enhancing the nutritional properties of grains. While in roasting, reduction in anti-nutritional properties and nutrients in some amount is observed. Therefore, multigrain product is very beneficial for consumption as it contains more than two grains which fulfill nutrient deficiencies of other grains. Grain based product consumption is beneficial for maintaining body health at very less cost.

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