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A Review on Pharmaceutical Potential of Commonly Consumed Cereal Grains

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Abstract: *Cereal grains constitute the principal dietary staples for a large proportion of the global population and serve as important sources of macronutrients, micronutrients, and diverse biologically active phytochemicals. Beyond their nutritional importance, cereal grains have gained considerable scientific attention for their pharmaceutical and nutraceutical potential owing to the presence of phenolic acids, flavonoids, dietary fiber, β-glucans, vitamins, minerals, and other secondary metabolites. These bioactive constituents exhibit a wide range of pharmacological activities, including antioxidant, anti-inflammatory, hypoglycemic, hypolipidemic, gastroprotective, immunomodulatory, and chemopreventive effects. Consequently, regular consumption of cereal-based functional foods may contribute significantly to the prevention and management of chronic non-communicable diseases such as diabetes mellitus, cardiovascular diseases, obesity, certain cancers, and gastrointestinal disorders.*
Major cereal grains such as rice (Oryza sativa), wheat (Triticum aestivum), oats (Avena sativa), barley (Hordeum vulgare), maize (Zea mays), finger millet (Eleusine coracana), sorghum (Sorghum bicolor), pearl millet (Pennisetum glaucum) and Barnyard Millet or Bhagar (Echinochloa frumentacea) possess distinct phytochemical compositions that support their therapeutic relevance. For instance, oats and barley are rich in β-glucans known for cholesterol-lowering and glycemic control effects, while millets are abundant in polyphenols and dietary fiber with strong antioxidant and antidiabetic potential. Similarly, pigmented rice and maize varieties contain anthocyanins and carotenoids that demonstrate protective effects against oxidative stress and degenerative disorders.
This review critically summarizes the major bioactive compounds found in commonly consumed cereal grains and highlights their pharmacological significance as functional foods, nutraceutical ingredients, and potential adjuncts in preventive healthcare strategies..

Keywords: Cereal grains, functional foods, nutraceuticals, bioactive compounds, pharmaceutical applications, chronic diseases

I. INTRODUCTION

Cereal grains belonging to the family *Poaceae* are among the most extensively cultivated and consumed food crops worldwide. They provide a substantial proportion of daily caloric intake and are indispensable to food security. The most commonly consumed cereals include *Oryza sativa* (rice), *Triticum aestivum* (wheat), *Avena sativa* (oats), *Hordeum vulgare* (barley), *Zea mays* (maize), *Eleusine coracana* (finger millet/ragi), *Sorghum bicolor* (sorghum/jowar), *Pennisetum glaucum* (pearl millet/bajra) and. *Echinochloa frumentacea* (Barnyard Millet or Bhagar). Traditionally, cereals have been valued primarily for their nutritional contribution, especially carbohydrates, proteins, lipids, vitamins, and minerals. However, contemporary research has demonstrated that cereal grains also contain a wide range of bioactive compounds capable of exerting physiological benefits beyond basic nutrition (Dykes & Rooney, 2018; Nayik et al., 2023; Liu, 2017). These include polyphenols, phytosterols, carotenoids, tocopherols, tocotrienols, resistant starch, arabinoxylans, and β-glucans. Such compounds modulate oxidative stress, inflammatory pathways, lipid metabolism, glycemic responses, and gut microbiota composition.

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Consequently, cereal grains are increasingly recognized as functional foods and nutraceutical resources with potential pharmaceutical utility. The present review evaluates the therapeutic properties and biomedical relevance of major cereal grains commonly incorporated into human diets.

Bioactive Constituents of Cereal Grains

The health-promoting potential of cereals is largely attributed to phytochemicals concentrated in the bran, aleurone, and germ fractions. Refining processes often remove these layers, resulting in significant nutrient loss. Whole grains therefore exhibit superior biological activity compared with refined grain products.

Major bioactive constituents of cereals include:

Phenolic acids (ferulic acid, caffeic acid, p-coumaric acid)
Flavonoids (anthocyanins, flavones, flavanols)
Dietary fiber (cellulose, hemicellulose, β-glucans, arabinoxylans)
Carotenoids (lutein, zeaxanthin)
Tocols (tocopherols and tocotrienols)

Phytosterols
Resistant starch
Essential minerals (iron, zinc, magnesium, calcium)

These compounds exhibit free radical scavenging, anti-inflammatory, lipid-lowering, antidiabetic, antimicrobial, and anticancer activities (Sharma & Gujral, 2019; Shahidi & Chandrasekara, 2018, Liu, 2017; Garutti et al., 2022).

Methodology-

Data of pharmaceutical applications of cereal grains was searched from various google databases using various keywords and using other scientific search sites like Scopus, PubMed, Science Direct, Research gate and Science hub, Google Scholar etc.

Discussion

Pharmaceutical Uses of Major Cereal Grains

1. *Oryza sativa* (Rice)

Rice is one of the most widely consumed cereals globally and serves as a major source of energy. Brown rice and rice bran are particularly rich in γ-oryzanol, tocopherols, tocotrienols, ferulic acid, and other phenolic compounds that contribute to its medicinal properties. Rice-based oral rehydration solutions are effective in treating diarrhoea, while rice bran oil has hypocholesterolemic and cardioprotective effects (Kumar et al., 2021; Juliano, 2017). Additionally, rice-derived compounds are used in dermatological formulations due to their antioxidant properties.

2. *Triticum aestivum* (Wheat)

Wheat is a major cereal rich in starch, proteins, B-complex vitamins, and dietary fiber. Whole wheat and wheat bran contain alkyl resorcinol, lignans and ferulic acid. Wheat is a rich source of dietary fiber and antioxidants such as alkyl resorcinol and vitamins (B-complex). Wheat bran acts as a natural laxative and improves gastrointestinal health. Whole wheat consumption has been associated with a reduced risk of colorectal cancer and cardiovascular diseases (Aune et al., 2016; Reynolds et al., 2019; Kumar et al., 2021). Wheat germ oil is widely used in nutraceutical formulations as a natural source of vitamin E due to its high tocopherol content (Kumar & Gopala Krishna, 2015).

3. *Avena sativa* (Oats)

Oats possess a unique nutritional profile characterized by high β-glucan content and avenanthramides. β-glucan content in oat lowers LDL cholesterol and improves heart health. Avenanthramides exhibit anti-inflammatory and antioxidant effects. Oat extracts are widely used in dermatology for managing eczema and itching (Wood, 2019; Garutti et al., 2022). *Avena sativa* (oats) has gained considerable attention as a functional food with significant antidiabetic potential.

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β-glucan in oats increases the viscosity of intestinal contents, thereby slowing glucose absorption and reducing postprandial blood glucose spikes. Regular consumption of oats has been shown to improve insulin sensitivity, lipid metabolism and glycemic control in individuals with type 2 diabetes (Zhang et al., 2021, Daou & Zhang, 2017). It plays significant role as an effective dietary intervention in diabetes prevention and management (Tiwari & Cummins, 2018; Hou et al., 2015).

4. *Hordeum vulgare* (Barley)

Barley is rich in β-glucan, Tocols (vitamin E compounds), phenolic acids, flavonoids, dietary fiber, selenium and antioxidants. Barley contains β-glucans that help regulate blood glucose levels and reduce cholesterol. It is beneficial in managing diabetes and cardiovascular diseases (Baik & Ullrich, 2017; Kumar et al., 2021). Barley contains significant amounts of tocols (tocopherols and tocotrienols) and phenolic compounds, which exhibit antioxidant and cardioprotective effects (Shahidi & de Camargo, 2016; Piironen et al., 2017, Idehen et al., 2017).). Tocols present in barley, especially in the germ and bran fractions, contribute significantly to the prevention of chronic diseases such as cardiovascular disorders, cancer, and metabolic syndromes. Additionally, barley Tocols play a role in maintaining lipid stability and improving overall health outcomes, supporting their use in nutraceutical and pharmaceutical formulations (Idehen et al., 2017). Barley fiber act as gastroprotective content which protects constipation, and promotes gut microbiota growth, making it useful in digestive health (Baik & Ullrich, 2008). Barley exhibits anti-inflammatory properties, which may help in chronic inflammatory disorders (Zhao et al., 2020)

5. *Zea mays* (Maize/Corn)

Maize contains carotenoids, polyphenols, anthocyanins (in pigmented varieties), and vitamin E. Carotenoids such as lutein and zeaxanthin are essential for eye health and prevention of macular degeneration. Corn silk has diuretic properties and is used in traditional medicine for urinary tract infections (Nayik et al., 2023; Ranum et al., 2018). Maize kernels, particularly pigmented varieties, are rich in phenolic compounds, flavonoids, carotenoids (such as lutein and zeaxanthin), and vitamin E, all of which contribute to strong antioxidant activity (Lopez-Martinez et al., 2009; Žilić et al., 2012). Corn starch (derived from Zea mays) is widely utilized in pharmaceutical formulations, particularly in topical powders and wound dressings due to its biocompatibility, absorbent nature, and ability to maintain a dry environment at the wound site (Eskandarinia et al., 2019; Waghmare et al., 2017).

6. *Eleusine coracana* (Ragi)

Finger millet is nutritionally distinguished by exceptionally high calcium content and significant levels of polyphenols, essential amino acids, flavonoids, and dietary fiber.

Because of these bioactive constituents, ragi has gained attention in pharmaceutical and nutraceutical research for disease prevention and health promotion (Devi et al., 2014; Kumar et al., 2016). It exhibits antidiabetic, antioxidant, and anti-obesity properties and is beneficial in bone health (Chandrasekara & Shahidi, 2018; Kumar et al., 2021). Ragi has a low glycemic index and contains dietary fiber and polyphenols that help slow glucose absorption, reduce postprandial blood sugar levels. Hence, ragi is useful for diabetic diet formulations (Shobana et al., 2013). Antioxidant components like phenolic acids, tannins, and flavonoids scavenge free radicals and reduce oxidative stress and protect cell damage (Devi et al., 2014). Ragi is one of the richest natural cereal sources of calcium, making it useful for bone strength, osteoporosis prevention, and child nutrition (Chethan & Malleshi, 2007). Its fiber content useful for bowel regularity, digestive health and gut microbiota. Due to polyphenolic component ragi possesses anti-inflammatory activity (Kumar et al., 2016).

7. *Sorghum bicolor* (Sorghum/Jowar)

Jowar recognized for its high nutritional value. Sorghum is a drought-resistant cereal rich in resistant starch, tannins, phenolic acids, flavonoids, anthocyanins, and dietary fiber. Due to these components itis valuable in pharmaceutical and nutraceutical applications (Taylor et al., 2014; Awika & Rooney, 2004). Sorghum contains resistant starch and dietary fiber that help slow glucose absorption and improve glycemic control (Taylor et al., 2014). The high fiber and resistant starch content in jowar helps to regulate body weight and digestive wellness. he fiber and phytosterols present in sorghum may help lower serum cholesterol and support cardiovascular health (Dykes & Rooney, 2006). It is gluten-

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free and suitable for individuals with gluten intolerance (Awika, 2017; Dykes & Rooney, 2018, Taylor et al., 2014). Sorghum contains phenolic compounds and tannins with antioxidant and anti-cancer properties.

8. *Pennisetum glaucum* (Bajra)

Pennisetum glaucum (Bajra or pearl millet), is a nutritionally important cereal grain widely cultivated in arid and semi-arid regions. Pearl millet is rich in proteins, essential amino acids, minerals (iron, zinc, magnesium), polyphenols, flavonoids dietary fiber and resistant starch (Taylor et al., 2006; Kumar et al., 2018). Pearl millet beneficial to manage diabetes as it has a low glycemic index and contains dietary fiber and resistant starch (Anitha et al., 2017; Nayik et al., 2023). It is also gastroprotective and anti- inflammatory. The fiber content of bajra may help reduce total cholesterol and LDL cholesterol, thereby supporting cardiovascular health (Taylor et al., 2006). Bajra is also gluten free cereal. Pearl millet is rich in iron, zinc which helps to prevent anemia (Kumar et al., 2018).

***Echinochloa frumentacea* (Barnyard Millet)-**

Echinochloa frumentacea Link (barnyard millet) is a nutritionally rich cereal grain widely cultivated in Asia and Africa. It is an excellent source of dietary fiber, phenolic compounds, flavonoids, minerals, and resistant starch. The presence of resistant starch, high fiber content, gluten-free nature, and low glycemic index makes barnyard millet particularly suitable for regulating blood glucose levels in diabetic individuals. It is also considered beneficial in anti-obesity and weight-management diets due to its satiety-enhancing properties and slower carbohydrate digestion (Shobana et al., 2013; Anitha et al., 2019; Sharma & Niranjan, 2018).

Barnyard millet also exhibits significant antioxidant potential owing to the presence of phenolic acids and flavonoids. These bioactive compounds help neutralize free radicals and protect against cellular damage associated with aging, cancer, and cardiovascular diseases (Chandrasekara & Shahidi, 2011; Pradeep & Sreerama, 2018). Furthermore, the grain is a rich source of magnesium, potassium, and soluble fiber, all of which contribute to cardiovascular health by helping reduce serum cholesterol levels and regulate blood pressure (Saleh et al., 2013).

In addition, the insoluble fiber present in barnyard millet supports gastrointestinal health by improving bowel function and exerting gastroprotective effects, thereby aiding digestion and reducing the risk of digestive disorders (Renganathan et al., 2020). Overall, barnyard millet is increasingly recognized as a functional cereal with promising pharmaceutical and nutraceutical applications.

Table 1. Bioactive components and Pharmaceutical Applications of Commonly Consumed Cereal grains

Plant Name	Bioactive Components	Pharmaceutical Applications
Oryza sativa (Rice)	γ-oryzanol, tocopherols, tocotrienols, ferulic acid, and other phenolic compounds	Antioxidant, Anti-diarrheal, Hypocholesterolemic Dermatological care
Triticum aestivum (Wheat)	Starch, proteins, B-complex vitamins, and dietary fiber, alkyl resorcinol, lignans, ferulic acid	Laxative, Anti-cancer, Cardioprotective, antioxidant
Avena sativa (Oats)	high β-glucan content and avenanthramides.	Hypocholesterolemic, Anti-inflammatory, Antidiabetic, Skin treatment, Antidiabetic
Hordeum vulgare (Barley)	β-glucan, Tocols (vitamin E compounds), phenolic acids, flavonoids, dietary fiber, selenium and antioxidants.	Hypoglycemic, Cardioprotective, Anti-inflammatory, gastroprotective
Zea mays (Maize/Corn)	carotenoids, polyphenols, anthocyanins (in pigmented varieties), and vitamin E. Carotenoids such as lutein and zeaxanthin	Antioxidant, diuretic, urinary tract infection preventor, Eye protector, Wound healing
Eleusine coracana	high calcium content and significant levels	Antioxidant, Antidiabetic, Anti-

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(Ragi)	of polyphenols, essential amino acids, flavonoids, and dietary fiber.	obesity osteoporosis preventor
Sorghum bicolor (Jowar)	resistant starch, tannins, phenolic acids, flavonoids, anthocyanins, and dietary fiber	Antioxidant, anti-cancer, gastroprotective, Anti-inflammatory
Pennisetum glaucum (Bajra)	proteins, essential amino acids, minerals (iron, zinc, magnesium), polyphenols, flavonoids dietary fiber and resistant starch	Cardioprotective, Antidiabetic, gastroprotective, Anemia prevention
Echinochloa frumentacea (Barnyard Millet)	dietary fiber, phenolic compounds, flavonoids, minerals, and resistant starch	Antidiabetic, Anti-obesity, Antioxidant, Anticancer, Gastroprotective, Cardioprotective

The pharmaceutical potential of cereal grains lies in their bioactive compounds, which exhibit antioxidant, anti-inflammatory, antidiabetic, and cardioprotective effects. Regular consumption of whole grains has been linked to reduced risks of chronic diseases such as cardiovascular disorders, diabetes, and cancer (Reynolds et al., 2019; Garutti et al., 2022; Patra et al., 2023). Advances in food science have further enhanced their applications in functional foods and nutraceuticals. The mechanisms underlying these benefits include:

- Reduction of oxidative stress
- Modulation of inflammatory signalling pathways
- Improvement in insulin sensitivity
- Reduction of cholesterol absorption
- Enhancement of gut microbiota diversity
- Regulation of satiety hormones and body weight

Current trends in food science increasingly utilize cereal bioactive in the development of fortified foods, functional beverages, dietary supplements, and pharmaceutical excipients.

II. CONCLUSION

Cereal grains play a dual role as both nutritional and therapeutic agents. Their incorporation into daily diets contributes significantly to disease prevention and health promotion. Continued research into cereal bioactive compounds will further expand their pharmaceutical applications and support their role in modern healthcare systems. This article gives information of bioactive compounds and pharmaceutical uses of cereal grains used in daily diet.

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