

Wheat: A Prominent Source of Modern Green Revolution in Agriculture

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Wheat is one of the most widely grown and consumed cereal grains worldwide. That plays a significant role in global food security, providing essential nutrients and energy to a large portion of the world's population. The nutritional quality of wheat is determined by various factors, including its protein content, vitamin and mineral composition, fibre content and the presence of bioactive compounds. Wheat has been a cornerstone of the Green Revolution, a period of rapid technological advancements and increased agricultural productivity that began in the mid-20th century. The Green Revolution aimed to address food security concerns by developing and disseminating high-yielding crop varieties, improving agricultural practices, and enhancing farm mechanization and infrastructure. Here is a detailed overview of the nutritional quality of wheat

Macronutrients

Carbohydrates

- **Energy Source:** Wheat is a major source of carbohydrates, primarily in the form of starch. Carbohydrates provide the body with the energy required for various physiological functions and daily activities.

Proteins

- **Gluten:** Wheat contains gluten, a complex mixture of proteins that gives wheat dough its elasticity and is crucial for the baking properties of wheat flour. Gluten is also responsible for the texture of bread and other baked goods.
- **Essential Amino Acids:** Wheat proteins contain all the essential amino acids, making it a valuable source of high-quality protein for vegetarians and vegans.

Fats

Wheat grains contain a small amount of fat, predominantly unsaturated fats, which are beneficial for heart health.

Micronutrients

Vitamins

Wheat is a good source of various B vitamins, including thiamine (B1), riboflavin (B2), niacin (B3) and folate (B9). These vitamins play crucial roles in energy metabolism, nerve function and DNA synthesis.

Minerals

- Iron:** Wheat contains iron, an essential mineral that is crucial for oxygen transport in the blood and the formation of haemoglobin.
- Magnesium:** Wheat is a good source of magnesium, which is involved in numerous physiological processes, including muscle function, nerve transmission, and bone health.
- Zinc, Phosphorus, and Selenium:** Wheat also provides other essential minerals like zinc, phosphorus, and selenium, which are important for immune function, bone health and antioxidant defence, respectively.

Dietary Fiber

- **Digestive Health:** Wheat is a good source of dietary fiber, which promotes digestive health by supporting regular bowel movements and maintaining gut health.
- **Blood Sugar Control:** Fiber helps regulate blood sugar levels by slowing down the absorption of glucose, which is beneficial for preventing and managing diabetes.
- **Cholesterol Reduction:** Soluble fiber found in wheat can help lower cholesterol levels, reducing the risk of heart disease.

Bioactive Compounds

- **Antioxidants:** Wheat contains bioactive compounds like phenolic acids, flavonoids, and lignin's, which have antioxidant properties. These compounds help neutralize harmful free radicals, reducing oxidative stress and inflammation in the body.

Nutritional Comparison

- **Whole vs. Refined Wheat:** Whole wheat products, which include the bran, germ, and endosperm, are more nutritious compared to refined wheat products like white flour. Whole wheat retains more vitamins, minerals and dietary fibre, making it a healthier choice.
- **Glycaemic Index:** Whole wheat has a lower Glycaemic index compared to refined wheat, which means it does not cause a rapid spike in blood sugar levels. This makes whole wheat a better choice for individuals with diabetes or those trying to manage their blood sugar levels.

Some potential examples of nutritional enhancements in transgenic wheat include

1. **Biofortification:** Wheat can be genetically modified to produce higher levels of essential micronutrients such as vitamin A, iron, zinc and folate.

2. **Reduced Allergenicity:** Wheat varieties can be engineered to have reduced levels of gluten or altered gluten composition to make them more tolerable for individuals with gluten sensitivities, such as celiac disease or wheat allergy.
3. **Increased Antioxidants:** Transgenic wheat can be developed to produce higher levels of antioxidants, such as phenolic compounds or flavonoids, which have been associated with various health benefits, including reduced risk of chronic diseases like cardiovascular disease and cancer.
4. **Enhanced Nutrient Absorption:** Wheat can be genetically modified to improve the bioavailability and absorption of nutrients, making it easier for the human body to utilize the vitamins and minerals present in the grains.

Table 1. Chemical composition and nutrient content of wheat per 100 grams

Nutrient/Component	Amount per 100g (Approximate)	Reference
Carbohydrates		
Total Carbohydrates	71-75 grams	USDA Food Data Central
Dietary Fiber	10-15 grams	USDA Food Data Central
Protein		
Total Protein	10-15 grams	Food and Agriculture Organization
Gluten	8-12 grams	Food and Agriculture Organization
Fats		
Total Fat	1.5-2.5 grams	USDA Food Data Central
Saturated Fat	0.2-0.4 grams	USDA Food Data Central
Vitamins		
Thiamine (Vitamin B1)	0.4-0.5 mg	USDA Food Data Central
Riboflavin (Vitamin B2)	0.1-0.2 mg	USDA Food Data Central
Niacin (Vitamin B3)	5-7 mg	USDA Food Data Central
Folate (Vitamin B9)	40-60 mcg	USDA Food Data Central
Minerals		
Iron	2-4 mg	USDA Food Data Central
Magnesium	100-150 mg	USDA Food Data Central
Phosphorus	300-400 mg	USDA Food Data Central
Zinc	2-4 mg	USDA Food Data Central
Other Compounds		
Water	10-12 grams	USDA Food Data Central
Ash	1.5-2.5 grams	USDA Food Data Central

Table 2. Comparative health benefits of wheat for humans and livestock

Health Benefits	Humans	Livestock
Energy Source	Provides carbohydrates for energy	High-energy feed ingredient for energy
Protein	Contains protein but not a complete source of essential amino acids	Valuable source of amino acids, lower protein quality compared to other feed grains
Vitamins and Minerals	Source of B vitamins (thiamine, riboflavin, niacin), iron, magnesium, zinc	Source of B vitamins, phosphorus, potassium
Dietary Fiber	Good source of dietary fiber for digestive health	Not a significant source of dietary fiber
Complex Carbohydrates	Provides complex carbohydrates for sustained energy, lower glycemic index	Easily digestible and metabolized for energy
Antioxidants	Contains antioxidants such as phenolic acids and flavonoids	Not a significant source of antioxidants
Palatability	-	Generally palatable to various livestock species
Digestibility	-	Relatively easily digestible compared to other feed grains
Anti-Nutritional Factors	Contains phytic acid and enzyme inhibitors; proper processing can help mitigate these factors	Contains anti-nutritional factors that can reduce nutrient absorption and digestibility
Allergenic Potential	Contains gluten; may cause allergic reactions and intolerances such as celiac disease and gluten sensitivity	-

Recent Wheat Varieties and Hybrids**North America**

- AAC Elevate (Canada)
- SY Tamarack (USA)

Europe

- KWS Siskin (Germany)
- LG Motown (UK)

Asia

- DBW 187 (India)
- Ankalagi (India)

Australia

- Scepter (Australia)
- Mace (Australia)

Global

- HRS 3873 (International)
- CL Plus (International)

New Nutrient-Rich Wheat Varieties and Hybrids**Biofortified Wheat Varieties****High-Zinc Wheat Varieties**

1. **Zincol-2016:** Developed by the International Maize and Wheat Improvement Center (CIMMYT) and partners. Contains 30-40%

higher zinc content compared to conventional wheat varieties.

2. **Batan:** Developed by the Bangladesh Wheat and Maize Research Institute (BWMRI). Contains elevated levels of zinc and is adapted to local growing conditions in Bangladesh.
3. **Zinc-Shakti:** Developed by the Indian Agricultural Research Institute (IARI). Contains higher zinc content and is suitable for cultivation in zinc-deficient soils prevalent in India.
4. **WB02:** Developed by the University of Western Australia. A high-zinc wheat variety with improved grain yield and agronomic traits.
5. **King II:** Developed by the International Centre for Agricultural Research in the Dry Areas (ICARDA). Contains elevated levels of zinc and is adapted to dryland farming conditions.

Drought-Tolerant and Nutrient-Efficient Varieties

1. **Ankalagi (India):** A drought-tolerant wheat variety developed for dryland farming conditions, which may have improved nutrient uptake and efficiency under stress conditions.
2. **Kukri:** Developed by the International Maize and Wheat Improvement Center (CIMMYT). A high-yielding, drought-tolerant wheat variety adapted to the semi-arid regions of South Asia. Exhibits good performance under water-limited conditions and is suitable for rainfed and irrigated environments.
3. **Drysdale:** Developed by the University of Adelaide, Australia. A drought-tolerant wheat variety with improved water-use efficiency and yield stability under drought conditions.
4. **NAC Patna:** Developed by the National Agriculture and Food Research Organization (NARO), Japan. A drought-tolerant wheat variety with enhanced root system and water-use efficiency.
5. **N-20:** Developed by the International Center for Agricultural Research in the Dry Areas (ICARDA). A nutrient-efficient wheat variety with improved nitrogen-use efficiency and grain yield.
6. **Yitpi:** Developed by the University of Adelaide, Australia. A high-yielding wheat variety with improved phosphorus-use efficiency and grain quality. Suitable for cultivation in phosphorus-deficient soils and low-input farming systems.
7. **Sahel 202:** Developed by the International Center for Agricultural Research in the Dry Areas (ICARDA). A drought-tolerant and heat-tolerant wheat variety adapted to the harsh growing conditions of the Sahelian region in Africa.

Advanced technologies in wheat cultivation

Precision Agriculture

- **Precision Farming Tools:** Use of Global Positioning System (GPS), Geographic Information System (GIS) and Remote Sensing

technologies to collect data on soil fertility, moisture levels, and crop health, enabling farmers to make informed decisions on crop management practices, nutrient application, and irrigation scheduling.

- **Variable Rate Technology (VRT):** Application of fertilizers, pesticides, and irrigation water at variable rates across the field based on soil and crop requirements, optimizing resource use, reducing production costs, and minimizing environmental impacts.
- **Drones and Unmanned Aerial Vehicles (UAVs):** Use of drones and UAVs equipped with multispectral and infrared cameras to monitor crop growth, detect pest infestations and assess field conditions, providing real-time data and insights for timely interventions and crop management decisions.

Genomic and Biotechnology Tools

- **Marker-Assisted Selection (MAS):** Utilization of molecular markers and genomic tools to accelerate the breeding process, identify desirable traits, and develop high-yielding, disease-resistant and stress-tolerant wheat varieties adapted to specific growing conditions and farming systems.
- **Genome Editing Technologies:** Application of CRISPR/Cas9 and other genome editing technologies to modify and improve the genetic traits of wheat, such as yield potential, quality attributes, and resistance to biotic and abiotic stresses, facilitating the development of new wheat varieties with enhanced agronomic and nutritional characteristics.

Smart Irrigation Systems

- **Drip Irrigation and Micro-Irrigation Systems:** Implementation of drip irrigation, sprinkler irrigation and micro-irrigation systems to deliver water directly to the root zone of wheat plants, improving water-use efficiency, reducing water wastage and enhancing crop yield and quality.
- **Soil Moisture Sensors and Automated Irrigation Controllers:** Installation of soil

moisture sensors and automated irrigation controllers to monitor soil moisture levels in real-time and automate irrigation scheduling, ensuring optimal soil moisture conditions for wheat growth and reducing water consumption.

Mechanization and Robotics

- **Precision Planting and Seeding Equipment:** Use of precision planting and seeding equipment, such as variable rate seeders and no-till planters, to optimize seed placement, spacing, and depth, enhancing crop establishment, uniformity, and stand density.
- **Autonomous and Robotic Farm Machinery:** Deployment of autonomous tractors, robots, and machinery equipped with advanced sensors, cameras and Artificial Intelligence (AI) algorithms to perform various agricultural tasks, such as planting, seeding, spraying, and harvesting, increasing operational efficiency, reducing labor costs, and improving productivity in wheat cultivation.

Integrated Pest Management (IPM) and Biocontrol

- **Biological Control Agents and Biopesticides:** Use of biological control agents, such as predatory insects, parasitic nematodes, and microbial biopesticides, to manage pests and diseases in wheat crops, reducing reliance on chemical pesticides, minimizing environmental pollution and promoting ecological balance in agroecosystems.
- **Trap Crops and Pheromone Traps:** Implementation of trap crops and pheromone traps to attract, monitor and control insect pests, such as aphids, thrips and cereal leaf beetles, mitigating pest damage, and conserving natural enemies in wheat fields.

Conclusion

Wheat is a nutritionally important crop that provides a range of essential nutrients and bioactive compounds beneficial for overall health and well-being. It serves as a staple food for billions of people

worldwide, contributing significantly to energy intake, protein supply, and micronutrient intake. Incorporating whole wheat products into the diet can help promote a balanced and healthy diet, supporting optimal health. Transgenic wheat with nutritional benefits represents a promising approach to improving the nutritional quality of this important food crop. However, it is crucial to proceed with caution, transparency and responsibility to ensure that the development and deployment of GM wheat varieties are conducted in a manner that prioritizes safety, sustainability and public welfare. These advanced technologies are revolutionizing wheat cultivation practices, enabling farmers to enhance productivity, sustainability and resilience in the face of increasing challenges posed by climate change, water scarcity, soil degradation, pest and disease pressures and labor shortages. Adopting and integrating these innovative technologies into wheat farming systems can contribute to optimizing resource use, improving crop yield and quality, reducing production risks, and fostering economic growth and environmental sustainability in agricultural systems globally.

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