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The Importance of Wheat Biofortification in India - Enhancing Nutrition for a Healthier Future

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ABSTRACT

Biofortification of wheat is a crucial strategy to combat global micronutrient deficiencies, particularly in regions where wheat is a staple food. By enhancing the nutrient content of wheat through conventional breeding, genetic engineering, and agronomic practices, biofortification can improve public health by reducing deficiencies in essential nutrients like iron and zinc. This sustainable approach offers long-term benefits, including better health outcomes, reduced healthcare costs, and increased resilience to climate change. Despite challenges such as public acceptance and accessibility, biofortified wheat has the potential to contribute to global food security and nutrition significantly.

INTRODUCTION

Green revolution resulted into record production of wheat and other food grains that leads to food security in India. Subsequently, multi-nutrient deficiency in soil leads to nutrient lacking in most of the food grains. Wheat is one of the most widely consumed staple foods globally, forming the backbone of diets in many countries. However, while it provides essential calories and macronutrients, wheat often lacks sufficient micronutrients such as Zn, Fe and vitamins vital for human health. Biofortification, the process of increasing the nutritional value of crops through breeding techniques, offers a propitious solution to this challenge. In this article, we will try to explore the importance of biofortification in wheat, its benefits, and its potential to improve global nutrition.

THE NEED FOR BIOFORTIFICATION

Micronutrient deficiencies often referred to as "hidden hunger," affect more than two billion people worldwide. These deficiencies are particularly pervasive in developing countries where diets heavily depend on staple crops like wheat. As plant require several essential nutrients for proper growth and yield. That reflects into nutritive quality of food. Lacking of particular nutrient for example, Iron deficiency, is a leading cause of anemia, which affects energy levels, cognitive development, and immune function. Zinc deficiency can impair growth, increase susceptibility to infections, and complicate pregnancy outcomes. Traditional wheat varieties, while abundant, do not provide sufficient amounts of these critical nutrients. By enhancing the nutrient profile of wheat, biofortification addresses this gap, ensuring that populations with limited access to diverse diets can still receive the necessary vitamins and minerals to thrive.

METHODS OF BIOFORTIFICATION

There are several approaches to biofortification, each with its strengths:

CONVENTIONAL BREEDING

This method involves selecting and crossbreeding wheat varieties that naturally have higher levels of specific nutrients. Over time, this process can yield wheat varieties that are richer in iron, zinc, and other essential micronutrients.

GENETIC ENGINEERING

Genetic modification techniques allow for the direct insertion of genes responsible for higher nutrient content. This approach can be faster and more precise than conventional breeding, though it often faces regulatory and public acceptance challenges.

AGRONOMIC PRACTICES

Applying nutrient-rich fertilizers (ferti-fortification) to wheat crops can increase the uptake of certain micronutrients like zinc. Precise nutrient management as per need can improve yield as well as nutrient content of food grain. This method is a complementary strategy that can boost the nutrient content of wheat in the short term.

Table 1. Biofortified varieties of wheat

SN	Name of the variety	Developing center	Year of release	Salient features
1	WB 02	ICAR-IIWBR, Karnal	2017	Fe: 40.0 ppm, Zn: 42.0 ppm
2	HPBW 01	PAU, Ludhiana	2017	Fe: 40.0 ppm, Zn: 40.6 ppm
3	Pusa Tejas (HI 8759) (T. durum)	ICAR-IARI, Indore	2017	Protein:12.0 %, Fe: 41.1 ppm, Zn:42.8 ppm
4	Pusa Ujala (HI 1605)	ICAR-IARI, Indore	2017	Protein:13.0 %, Fe: 43.0 ppm
5	HD 3171	ICAR, New Delhi	2017	Zn:47.1 ppm
6	HI 8777 (T. durum)	ICAR-IARI, Indore	2018	Fe: 48.8 ppm, Zn: 43.6 ppm
7	MACS 4028 (T. durum)	ARI, Pune	2018	Protein:14.7 %, Fe: 46.1 ppm,
8	PBW 752	PAU, Ludhiana	2018	Protein:12.4 %
9	PBW 757	PAU, Ludhiana	2018	Zn:42.3 ppm
10	Karan Vandana (DBW 187)	ICAR-IIWBR, Karnal	2018	Fe:43.1 ppm
11	DBW 173	ICAR-IIWBR, Karnal	2018	Protein:12.5 %, Fe: 40.7 ppm
12	UAS 375	UAS, Dharwad	2018	Protein:12.4 %
13	DDW 47	ICAR-IIWBR, Karnal	2020	Protein:12.7 %, Fe: 40.1 ppm
14	PBW 771	PAU, Ludhiana	2020	Zn:41.4 ppm
15	HI 8802 (T. durum)	ICAR-IARI, Indore	2020	Protein:13.0 %
16	HI 8805 (T. durum)	ICAR-IARI, Indore	2020	Protein:12.8 %, Fe: 40.4 ppm
17	HD 3249	ICAR, New Delhi	2020	Fe:42.5 ppm
18	MACS 4058 (T. durum)	ARI, Pune	2020	Protein:14.7 %, Fe: 39.5 ppm,
19	HD 3298	ICAR, New Delhi	2020	Protein: 12.1 %, Fe:43.1 ppm
20	HI 1633	ICAR-IARI, Indore	2020	Protein:12.4 %, Fe: 41.6 ppm,
21	DBW 303	ICAR-IIWBR, Karnal	2020	Protein:12.1 %
22	DDW 48 (T. durum)	ICAR-IIWBR, Karnal	2020	Protein:12.1 %

BENEFITS OF BIOFORTIFICATION

COMBATING MALNUTRITION

Biofortified wheat has the ability to greatly lower the occurrence of micronutrient deficiencies, especially in areas where wheat is a key part of the diet. This could result in better public health outcomes, such as decreased rates of anemia, stunted growth, and compromised immune systems.

SUSTAINABILITY

As we achieve food security but nutritional security is in question. Unlike supplementation and food fortification, which require continuous external inputs, biofortified crops provide a sustainable solution to overcome nutritional security. Once developed and distributed, biofortified wheat varieties can continually deliver enhanced nutrition without additional costs to producer and consumers.

ECONOMIC IMPACT

By improving the nutritional quality of wheat, biofortification can reduce healthcare costs associated with micronutrient deficiencies. Healthier populations are more productive, which can contribute to economic growth, particularly in developing countries.

RESILIENCE TO CLIMATE CHANGE

Some biofortified wheat varieties are bred not only for higher nutrient content but also for greater resilience to environmental stresses such as drought or heat. This dual benefit can help secure food supplies in the face of climate change.

BIOFORTIFICATION OF WHEAT IN INDIA

Despite India attaining self-sufficiency in overall food grain production, food availability and nutritional status vary significantly across different regions. Half of females of reproductive age in India are anemic, and one-third of children under five years are stunted. India primarily grows rice and wheat as staple food grain crops for direct consumption. Whole grains make up approximately 47% of the total calories consumed by the average Indian household, with cereals contributing up to 70% of the caloric intake in rural areas. According to a report by the World Health Organization (WHO), the prevalence of iron-deficiency anemia (IDA) in India was 53.4% among children aged 0-5 years and 53.0% among women aged 15-49 years, highlighting the potential for biofortification to combat micronutrient malnutrition. While various strategies, such as food fortification, medical supplementation, dietary diversification, and crop biofortification, are recommended to tackle micronutrient deficiencies, improving crop nutrient content through genetic enhancement is considered a sustainable and cost-effective approach. This approach provides nutrients in their natural form without requiring significant changes to infrastructure or the creation of a complex distribution system.

The Indian Council of Agricultural Research (ICAR) has enhanced the nutritional quality of high-yielding varieties of cereals, pulses, oilseeds, vegetables, and fruits through breeding techniques. During the 12th Plan, a special project under the Consortium Research Platform on Biofortification was launched to focus on this goal. Collaborative efforts with other national and international initiatives have resulted in the development of 22 biofortified wheat varieties (Table 1). These biofortified varieties will play a crucial role in ensuring the country's nutritional security.

Efforts are underway to promote the adoption of these biofortified varieties among the general population. High-quality seeds of these varieties are being produced and made accessible for commercial farming. Additionally, ICAR's Extension Division has introduced two special programs: Nutri-sensitive Agricultural Resources and Innovations (NARI) and Value Addition and Technology Incubation Centres in Agriculture (VATICA). These programs aim to scale up the use of biofortified varieties through KVKs.

CHALLENGES AND FUTURE DIRECTIONS

While biofortification holds great promise, there are challenges to its widespread adoption. Public awareness and acceptance are crucial, as some consumers may be skeptical of new crop varieties, particularly those developed through genetic engineering. Additionally, biofortified wheat must be accessible to farmers, particularly smallholder farmers in developing regions, who may need support in adopting these new varieties.

To overcome these challenges, continued investment in research, public education, and policies that support the distribution and adoption of biofortified crops is essential. International collaboration between governments, research institutions, and non-governmental organizations can accelerate progress and ensure that the benefits of biofortification reach those who need it most.

CONCLUSION

Biofortification of wheat represents a vital strategy in the global effort to combat malnutrition and improve public health. By enhancing the nutrient content of one most important staple crops of the world, biofortification can help ensure that populations worldwide have access to the essential vitamins and minerals they need for a healthy life. As we look to the future, the continued development and adoption of biofortified wheat will be crucial in building a more nutritious, resilient, and sustainable global food system.

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