

Fortified Rice: Combating Malnutrition and Enhancing Public Health in India

Manoj Kumar* and Roshni Kumari

School of Agriculture and Environmental Sciences, Shobhit Deemed University, Meerut (U.P.)

Corresponding Author

Manoj Kumar

Email: researchscholar3439@gmail.com



OPEN ACCESS

Keywords

Rice fortification, micronutrients, anemia, maternal and child health, public health, malnutrition, biofortification, India.

How to cite this article:

Kumar, M. and Kumari, R. 2025. Fortified Rice: Combating Malnutrition and Enhancing Public Health in India. *Vigyan Varta* 6 (10): 102-108.

ABSTRACT

Rice, a staple food for over half the world's population, is inherently low in essential micronutrients such as iron, folic acid, vitamin B12, zinc, and vitamins A and D. Regular consumption of polished rice contributes to hidden hunger, anemia, malnutrition, and poor maternal and child health, particularly in vulnerable populations. Rice fortification—through coating grains with micronutrient premix or blending extruded fortified kernels—offers a cost-effective, scalable, and accessible solution to address these deficiencies. In India, the Fortified Rice Program under schemes like PMGKAY and PDS has demonstrated improvements in anemia reduction, child growth, cognitive development, immunity, and maternal-infant health while generating employment across the rice fortification value chain. Future strategies include integration with biofortification, advanced fortification technologies, public awareness campaigns, and public-private partnerships to enhance reach and effectiveness. Fortified rice represents a sustainable intervention to combat malnutrition, improve health outcomes, and promote socio-economic development.

INTRODUCTION

Rice is the staple food for more than half of the world's population, particularly in Asia and Africa, where

it provides a major share of daily calories. However, polished white rice, which is most commonly consumed, is poor in essential



micronutrients such as iron, zinc, folic acid, and vitamins (WHO-2018). This widespread consumption of nutrient-poor rice contributes to hidden hunger, malnutrition, anemia, and related health problems, especially among vulnerable groups like children, women, and low-income populations.

Rice fortification “The process of adding nutrients to food that are absent or insufficient in the diet. Rice can be fortified by coating grains with a micronutrient premix or producing extruded rice kernels enriched with nutrients like iron, folic acid, and vitamin B12. According to FSSAI norms, 1 kg of fortified rice contains 28-42.5 mg of iron, 75-125 µg of folic acid, and 0.75-1.25 µg of vitamin B12 (Pachón H, *et al.*, 2019, Thankachan P, *et al.*, 2012). India faces high malnutrition, with every second woman anemic and one-third of children stunted. Rice, a widely consumed staple, loses some nutrients during milling, making fortification a viable solution to supplement diets and address widespread deficiencies, particularly iron deficiency anemia and associated health issues.

Iron fortification of rice improves cognitive development, particularly in children, and enhances maternal and infant health by reducing anemia and pregnancy complications. Vitamin B12, essential for brain and nervous system function, prevents pernicious anemia, while folic acid is crucial for pregnant women to prevent neural tube defects in babies (Kupka R, *et al.*, 2020). By fortifying rice with these micronutrients, populations dependent on rice as a staple can benefit from improved nutritional status, better cognitive outcomes, and reduced health risks, particularly in regions like India, Southeast Asia, and parts of Africa where deficiencies are prevalent.

Despite its benefits, iron fortification faces challenges such as limited bioavailability, potential toxicity in sensitive individuals, and technical, regulatory, or social barriers.

Strategies to overcome these include deploying nanotechnology to improve iron absorption, integrating fortification with biofortification to naturally enrich rice, fostering public-private partnerships to scale up efforts, and encouraging ongoing research to enhance fortification techniques. By addressing these challenges, fortified rice can become an effective, accessible, and sustainable solution to combat micronutrient deficiencies and improve public health (Thankachan P, *et al.*, 2012).

- ❖ **Fortified Rice Program in India:** The Union Cabinet approved the continuation of fortified rice distribution under government schemes, including PMGKAY, from July 2024 to December 2028. The initiative aims to address widespread micronutrient deficiencies in India, particularly among populations that rely heavily on rice. Fortification involves adding essential nutrients to rice that are either absent or insufficient, achieved by coating grains with a micronutrient premix or blending extruded rice kernels enriched with vitamins and minerals with regular rice (Hindustan Times-2023).
- ❖ **Implementation and Reach:** India's rice fortification program began as a pilot in 2019 and has scaled up in three phases. Fortified rice has been distributed in states such as Jharkhand and Maharashtra, reaching people under schemes like PMGKAY, which provides additional free grains to beneficiaries under the National Food Security Act, 2013. The program aligns with WHO guidelines, addressing the needs of the 65% of India's population that consumes rice daily. No adverse effects have been reported in these regions (Wegmüller R, *et al.*, 2016, Raghunath R, *et al.*, 2019).
- ❖ **Safety and Regulatory Updates:** Scientific studies confirm that fortified

rice is safe for individuals with conditions like Thalassemia and Sickle Cell Anaemia (Raghunath R, *et al.*, 2019). Following a review, health advisories on fortified rice packaging have been removed, reflecting global practices where such labeling is not mandated by organizations like WHO and the FDA. This ensures both safety and broader acceptance of fortified rice across India. (Kapil U. *et al.*, 2024).

- 1. Role of Fortified Rice in Combating Malnutrition:** Malnutrition, particularly micronutrient deficiencies, remains a critical challenge in many developing countries, including India. Traditional diets that rely heavily on polished rice often fail to provide essential vitamins and minerals. Fortified Rice serves as a practical intervention to address this issue, as it combines the wide consumption of rice with targeted nutrient enrichment.

Key Roles in Combating Malnutrition:

- ❖ **Reducing Micronutrient Deficiencies:** Fortified rice is enriched with essential nutrients such as iron, folic acid, and vitamin B12, which directly address anemia and other related health issues. In addition, the inclusion of zinc, vitamin A, and vitamin D further supports immunity, promotes healthy growth, and strengthens bone development, making fortified rice a comprehensive solution to combat multiple micronutrient deficiencies.
- ❖ **Improving Maternal and Child Health:** Pregnant and lactating women greatly benefit from the folic acid and iron present in fortified rice, as these nutrients help reduce the risks of birth defects and maternal mortality. At the same time, children who consume fortified rice demonstrate improved growth, enhanced cognitive development, and better school performance, highlighting the crucial role

of fortified rice in supporting the health and development of vulnerable populations.

- ❖ **Widespread Reach Through Staple Food:** Rice is a staple for over half the global population. Fortifying rice ensures that essential nutrients reach households consistently without changing food habits.
 - ❖ **Cost-Effective and Scalable Intervention:** Fortification requires only a minimal additional cost when compared to supplementation or dietary diversification programs, making it a highly affordable and sustainable solution. Moreover, it has the advantage of being easily scalable through large public welfare schemes such as the Public Distribution System (PDS), the Mid-Day Meal Scheme, and the Integrated Child Development Services (ICDS). These channels ensure that fortified rice reaches millions of vulnerable households, school children, and women, thereby maximizing its impact on reducing malnutrition across the country.
 - ❖ **Long-Term Socio-Economic Benefits:** Healthier populations mean reduced healthcare costs, higher productivity, and improved quality of life, particularly for vulnerable communities.
- 2. Accessibility and Affordability of Fortified Rice:** One of the key advantages of fortified rice is its high accessibility and cost-effectiveness, which make it a practical solution for vulnerable populations. Since rice is already a staple food consumed daily by millions, fortifying it ensures that essential nutrients reach households without requiring any change in dietary habits. This inherent accessibility reduces barriers to nutrition, particularly for low-income families and communities with limited access to diverse foods.

From an economic perspective, fortification adds only a minimal cost to the production and

distribution of rice, especially when compared to other interventions such as supplementation programs or dietary diversification strategies. Moreover, fortified rice can be widely distributed through established public welfare schemes such as the Public Distribution System (PDS), the Mid-Day Meal Scheme, and Integrated Child Development Services (ICDS). (World Health Organization 2018 and Moretti, D., *et al.*, 2021). These systems allow fortified rice to reach millions of children, women, and economically disadvantaged families, ensuring consistent nutrient intake and helping reduce malnutrition at a national scale.

By combining affordability with broad accessibility, fortified rice provides a scalable and sustainable approach to improving nutrition outcomes and addressing hidden hunger in vulnerable populations.

3. Impact on Health Outcomes in Low-Income Communities: Fortified rice has shown significant potential in improving health outcomes among low-income and nutritionally vulnerable communities. These populations often rely on staple foods like rice, which provide calories but are deficient in essential micronutrients. The regular consumption of fortified rice addresses these deficiencies and leads to measurable improvements in public health indicators.

Key Health Impacts:

❖ **Reduction in Anemia:** Fortification of rice with iron, folic acid, and vitamin B12 helps reduce the prevalence of anemia, especially among women of reproductive age and children. Studies have shown that communities consuming fortified rice exhibit higher hemoglobin levels and lower rates of iron-deficiency anemia, highlighting its effectiveness in improving

public health outcomes (Moretti *et al.*, 2012).

❖ **Improved Growth and Cognitive Development in Children:** Children who consume fortified rice regularly exhibit improved physical growth and enhanced cognitive development. Essential micronutrients such as iron, zinc, and vitamin B12 play a vital role in supporting brain development and strengthening learning abilities, making fortified rice an important tool for child health and educational outcomes (Stevens *et al.*, 2013).

❖ **Enhanced Maternal and Infant Health:** Pregnant and lactating women benefit from folic acid and iron fortification, which reduces the risk of birth defects, maternal mortality, and low birth weight in infants (Bhutta *et al.*, 2013).

❖ **Strengthened Immunity:** Vitamins A, D, and zinc enhance immune system functioning, making children and adults less susceptible to common infections and illnesses (Arsenault *et al.*, 2010).

❖ **Long-Term Community Health Benefits:** By improving nutrition at the population level, fortified rice helps reduce healthcare costs, enhances productivity, and promotes an overall better quality of life. Healthier communities are also more capable of actively participating in education, labor, and economic activities, thereby creating a positive cycle of growth, development, and long-term socio-economic benefits (Reddy *et al.*, 2020).

4. Employment and Livelihood Opportunities:

Employment and Livelihood Opportunities in Rice Fortification Value Chain		
Step-1	Raw Material Collection and Supply	Broken rice and pulses sales provide farmers income, supporting fortified rice.

Step-2	Milling and Processing	Broken rice and dal are processed, creating jobs in fortified rice production.
Step-3	Formulation and Fortification	Flours and premix combined, creating skilled jobs in food technology.
Step-4	Extrusion and Shaping of Rice Analogues	Dough extruded into rice-like kernels, creating jobs for production staff.
Step-5	Drying, Cooling, and Packaging	Rice analogues dried, packaged, creating jobs for warehouse and logistics staff.
Step-6	Distribution and Supply Chain	Fortified rice transport creates jobs for operators, managers, and handlers.
Step-7	Monitoring and Quality Assurance	Fortified rice quality monitored by analysts, inspectors, and lab technicians.
Step-8	Retail and Public Distribution	Fortified rice distribution creates jobs via shops, PDS, schools, coordinators.
Step-9	Research and Development	Continuous improvement in formulations and fortification technology creates roles for food scientists, nutritionists, and researchers.
Step-10	Training and Awareness Programs	Community programs promote fortified rice benefits, creating jobs and health awareness.

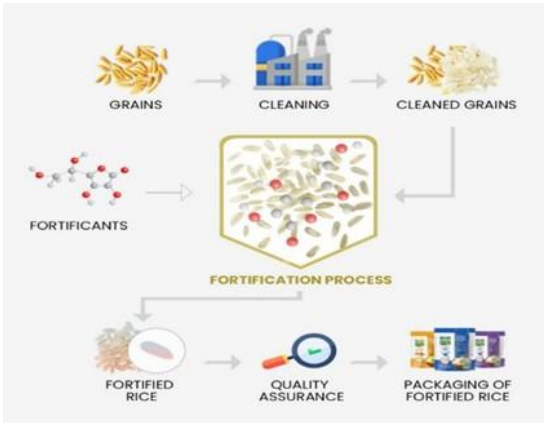


Fig.1. Process of Fortified Rice

5. Future Prospects and Recommendations:

❖ **Expansion of Coverage:** Scale up fortified rice distribution to cover all states and districts, particularly those with high

malnutrition and anemia prevalence, ensuring broader reach under schemes like PMGKAY and PDS.

- ❖ **Integration with Biofortification:** Combine rice fortification with biofortified varieties to naturally enhance nutrient content, providing a more sustainable approach to addressing micronutrient deficiencies.
- ❖ **Use of Advanced Technology:** Explore nanotechnology and microencapsulation techniques to improve nutrient stability, bioavailability, and retention during storage and cooking.
- ❖ **Public Awareness and Acceptance:** Conduct awareness campaigns to educate consumers about the benefits of fortified rice, addressing cultural, social, and taste-related concerns.
- ❖ **Monitoring and Research:** Continuously monitor the effectiveness and safety of fortified rice programs, encourage research on innovative fortification methods, and assess long-term health impacts.
- ❖ **Public-Private Partnerships:** Foster collaboration among government, private sector, NGOs, and research institutions to enhance production, distribution, and innovation in fortified rice programs.

CONCLUSION:

Fortified rice represents a practical, cost-effective, and scalable solution to combat malnutrition and hidden hunger in India and other rice-consuming regions. By enriching rice with essential micronutrients like iron, folic acid, vitamin B12, zinc, and vitamins A and D, it addresses anemia, supports maternal and child health, enhances cognitive development, and strengthens immunity. The program not only improves nutrition but also generates employment across the rice

fortification value chain and reduces economic burdens on households and public health systems. Continued implementation under government schemes like PMGKAY, combined with advanced technologies, biofortification, public awareness campaigns, and research, can further enhance its effectiveness. Public-private partnerships and nationwide expansion will ensure broad accessibility, acceptance, and sustainability. Ultimately, fortified rice offers a comprehensive strategy to improve health outcomes, socio-economic development, and the overall quality of life for vulnerable populations.

REFERENCES:

- Arsenault, J. E., Mora-Plazas, M., Forero, Y., López-Arana, S., Marín, C., Baylin, A., & Villamor, E. (2009). Provision of a school snack is associated with vitamin B-12 status, linear growth, and morbidity in children from Bogota, Colombia. *The Journal of Nutrition*, 139(9), 1744–1750.
- Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Webb, P., Lartey, A., Black, R. E., & the Lancet Nutrition Interventions Review Group. (2013). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *The Lancet*, 382(9890), 452–477.
- Drishti IAS. (2023, May 30). *Fortification of rice*. Drishti IAS.
- Drishti IAS. (2024, October 21). *Fortified Rice*. Retrieved from <https://www.drishtiias.com/daily-updates/daily-news-analysis/fortified-rice-6>.
- Hindustan Times. (2023, October 24). Rice fortification in Malkangiri shows reduction in anaemia. Retrieved from Hindustan Times
- Kapil, U., Bhardwaj, A., Sareen, N., & Gupta, A. (2024). Situational analysis of rice fortification through the public distribution system in six states of India. *Indian Journal of Community Medicine*, 49(1), 12–18.
- Kupka, R., Thankachan, P., Moretti, D., Zimmermann, M. B., & Hurrell, R. F. (2020). Stability, iron bioavailability, and sensory evaluation of triple fortified rice. *Food Science & Nutrition*, 8(12), 6916–6926.
- Laillou, A., Panagides, D., Wieringa, F. T., & Moench-Pfanner, R. (2022). Retention of micronutrients in fortified rice analogues during processing and cooking. *Food Science & Nutrition*, 10(7), 2251–2260.
- Moretti, D., Zimmermann, M. B., Muthayya, S., Thankachan, P., Lee, T. C., Kurpad, A. V., & Hurrell, R. F. (2012). Rice fortification with iron improves hemoglobin and reduces anemia in Indian schoolchildren: A double-blind randomized controlled trial. *The American Journal of Clinical Nutrition*, 96(1), 80–87.
- Moretti, D., Zimmermann, M. B., Wegmüller, R., Flores-Ayala, R., & Kupka, R. (2021). Impact of fortified rice on hemoglobin and cognitive performance in schoolchildren in Gujarat, India. *Nutrients*, 13(1), 211.
- Muthayya, S., Rah, J. H., Sugimoto, J. D., Roos, F. F., Kraemer, K., & Black, R. E. (2012). *The global hidden hunger indices and the role of rice fortification in combating micronutrient malnutrition*. Food and Nutrition Bulletin, 33(4), 272–284.
- Pachón, H., Spohrer, R., Mei, Z., & Serdula, M. K. (2019). Rice fortification with

- vitamins and minerals for addressing micronutrient malnutrition. *Cochrane Database of Systematic Reviews*, (6), CD009902.
- Radhika, M. S., Lakshmi, J. A., & Babu, K. S. (2011). *Effectiveness of micronutrient fortified rice in improving the nutritional status of schoolchildren in India*. *Public Health Nutrition*, 14(3), 448–456.
- Raghunath, R., Devi, R., Kannan, V., & Sudha, V. (2019). Iron and folic acid fortified brown rice: Effects on bioaccessibility, glycaemic index, and nutrient composition. *Food Chemistry*, 285, 201–208.
- Reddy, K. S., Rao, K. D., Ghosh, S., & Selvaraj, S. (2020). Health and economic impact of micronutrient fortification of rice in India: An economic evaluation. *Health Policy and Planning*, 35(9), 1155–1163.
- Stevens, G. A., Finucane, M. M., De-Regil, L. M., Paciorek, C. J., Flaxman, S. R., Branca, F., Peña-Rosas, J. P., Bhutta, Z. A., & Ezzati, M. (2013). Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: A systematic analysis of population-representative data. *Public Health Nutrition*, 16(5), 871–887.
- Thankachan, P., Rah, J. H., Thomas, T., Selvam, S., Amalrajan, V., Srinivasan, K., Steiger, G., Kurpad, A. V., & Hurrell, R. F. (2012). Iron-fortified rice improves the iron stores of Indian schoolchildren: results of a randomized controlled trial. *American Journal of Clinical Nutrition*, 96(6), 1428–1435.
- Vinodkumar, M., Bharathi, A., & Lakshmi, J. A. (2017). *Multiple micronutrient fortified rice improves vitamin B-12 status, homocysteine levels, and physical performance of Indian school children*. *Journal of Nutrition*, 147(8), 1517–1523.
- Wegmüller, R., Camara, F., Zimmermann, M. B., Adou, P., Hurrell, R. F., & Moore, S. E. (2016). Micronutrient fortification of rice: Strategies and technologies. *Annals of the New York Academy of Sciences*, 1379(1), 59–73.
- World Food Programme (WFP) & Government of India. (2022). *Proof is in the pilot: Insights from India's rice fortification pilot-to-scale approach*. WFP Publication.
- World Health Organization. (2018). *Fortification of rice with vitamins and minerals as a public health strategy*. Geneva: World Health Organization. Retrieved from NCBI Bookshelf.