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Rice Fortification: An Effective Approach To Eliminate Vitamin and Mineral Deficiency among women and children.

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Abstract :

Vitamins and minerals deficiency affects the growth and health of population especially belonging to low economic strata suffering from 'hidden hunger'. Micro-nutrient deficiency leads to anaemia, birth defects, retarded growth and other poor health outcomes. As rice being staple food for 65% of population of India provides an emerging opportunity to eliminate micro-nutrient deficiency. According to FSSAI, fortified could be made available through social service safety net of the government namely the Targeted Public Distribution System (PDS), the Mid Day Meal Scheme as well as ICDS scheme as well as through open market channels. Rice fortification with an effective communication awareness is a sustainable cost effective approach to combat anaemia. Awareness will lead to demand which in turn will make the intervention fruitful and effective.

Key words: Anaemia, Fortified rice, Hidden hunger, Rice fortification, Vitamin and mineral deficiency.

Introduction:

The Food and Agriculture Organization (FAO) estimates that the prevalence of undernourishment increased from 8.4% to around 9.9% between 2019 and 2020, heightening the challenge of achieving the Zero Hunger target by 2030 [4]. Around the world it is estimated that more than 2billions people suffer from micro nutrient malnutrition or 'hidden hunger' and half of them are living in India. [13] Rice is widely consumed in many countries and contribute to upto 70% of individual calorie intake but it is a poor source of micro nutrients which results in 'hidden hunger' an issue. Therefore rice is considered as an important resource which offers an unique opportunity for nutrition improvement - in the form of rice fortification.

Vitamin and Mineral deficiency (VMD) : Micro nutrient deficiency are widespread especially in developing countries. According to WHO, 45% of deaths among young children under age of 5years is linked to under nutrition. [15] In India, a total of 67.1% of children of age under 5 years are are anemic and 57% of women are anaemic.[8] Micro nutrient deficiency affects all age group of population but more severely affected population is children and women of reproductive age group.

FKR : A Qualitative Rice

The Lancet series on Maternal and Child Malnutrition includes micro nutrient fortification as a key intervention with a proven impact on reducing VMD, malnutrition, death and disease. [3] Rice fortification is a cost-effective, culturally appropriate strategy to address micro nutrient deficiencies in countries with high per capita rice consumption. As the most important staple food for an estimated 3 billion people, rice has the potential to fill an apparent gap in current fortification programs, particularly in low-income, food-deficit countries where VMD is widespread. A large proportion of the population in developing countries, particularly infants and young children, pregnant and lactating women, and the elderly suffer from high rates of VMD. Rice covers up to 60% of the daily energy requirement and a significant part of the protein intake and is therefore crucial for food security.

According to the Ministry of Agricultural Cooperation and Farmer Welfare, Indian rice production increased at a compound annual growth rate (CAGR) of 1.43 percent in 2005-06 and 2016-17. India was the second largest rice producer in 2015-16, followed by Indonesia and Bangladesh.

Fortifying rice makes it more nutritious by adding vitamins and minerals in the post-harvest phase; many of these are lost during milling and polishing. Rice fortification can be seen as having the greatest potential to fill the gap in current staple food fortification programs as it is the staple food of 65 percent of India's population and reaches the most vulnerable and poorer segment - with the highest uptake in the government Security network programs. Each state's food and civil supplies department hires a number of rice millers in each district for the regular supply of rice to the FCI, from which it is distributed to social safety net schemes.

In India, rice is enriched using extrusion technology. In this technology, ground rice is pulverized and mixed with a premix containing vitamins and minerals. Fortified rice kernels (FRK) are produced from this mixture using an extruder machine. FRK is added to traditional rice at a ratio of 1:50 to 1:200, resulting in fortified rice that is nearly identical to traditional rice in aroma, flavor and texture. It is then distributed for regular consumption.

Need for Rice Fortification:

According to National Family Health Survey (NFHS 5): [8]

- 67.1% of children under age of 5 years are anaemic
- 57.2% Women (reproductive age group) are anaemic
- 52.2% Women (pregnant) are anaemic
- Also, it is studied that many of birth defects are preventable. The major reason for these defects is the deficiency of folic acid.

Government Initiatives in Distribution of Fortified Rice:

Fortified rice could be delivered through the government's social safety nets, namely the Targeted Public Distribution System, the Midday Meal Scheme, as well as the Integrated Child Development Service Scheme (ICDS), as well as through open market channels.

Government of India has given its approval for the supply of fortified rice throughout the Targeted Public Distribution System (TPDS) under the National Food Security Act (NFSA), Integrated Child Development

Services (ICDS), Pradhan Mantri Poshan Shakti Nirman-PM POSHAN [formerly Mid-Day Meal Scheme (MDM)] and other Government of India Welfare Schemes (OWS) in all States and Union Territories (UTs) by 2024 in a phased manner.

The following three phases are envisaged for the full implementation of the initiative:

Phase-I: Coverage of ICDS and PM POSHAN in India by March 2022, which is under implementation.

Phase-II: Phase I above plus TPDS and OWS in all targeted and Districts with high exposure to stunting (291 districts total) by March 2023.

Phase III: Phase II above plus coverage of the rest of the country's districts by March 2024.

Fortified rice are beneficial in many terms:

- The quantity of micro nutrients added to the food products is less and well calculated, and so there is no risk of an overdose of nutrients.
- Fortification methods are adopted in such a way that the intrinsic characteristics of the food are not altered such as taste, appearance and texture remains same.
- Fortified rice already initiated in Mid Day Meal in school children soon it will be available at PDS and Anganwadi centres. This means that the objective of improving the health of needy communities can be attained in a short period of time.

Limitations of fortified rice:

- Communication gap is the major limitation between consumer and the product. Therefore there is a need of awareness campaigns by community health workers to spread benefits of consuming fortified rice.
- Population groups who consume relatively small amount of food such as infants, young children and elderly people are less likely to avail benefit from the consumption of fortified foods.

Significance:

In the context of minerals and vitamins deficiency the present paper maps and describes the evidence of efficacy and effectiveness of fortified rice at national and international level. This will aid in identifying potential areas for government engagement or action to combat micro-nutrient deficiency.

Objective:

The main objective of the study is to review the available national and international research works and initiatives by government to minimize micro-nutrient deficiency by rice fortification.

Methodology:

The national and international studies were reviewed to study the evidence of efficacy and efficiency of fortified rice. The sources for getting to these studies included uninhibitedly accessible online web search tools (Google, PubMed, Google Scholar, etc), electronic reference libraries, government sites (FSSAI), World Health Association (WHO), United Nations Kids' Fund (UNICEF), National Family Health Survey (NFHS), journals and research papers.

Result & Discussion

Several studies have been conducted among children and women of reproductive age which demonstrated that consumption of rice enriched with iron, Vitamin B12 and folic acid improves the anaemia and other micro nutrients level status significantly.

Table 1: Rice Fortification Effectiveness Studies (National)

Name of author, year	Area of study	Subjects	Methodology	Findings	Ref
TATA Trusts, 2020	Gadchiroli of Maharashtra, India	104 Women, adolescent girls and children	Intervention was implemented for one year through PDS.	Result showed reduction of 21.4% in prevalence of anaemia that received FRK.	12
Mahapatra S. et al., 2021	Gujarat, India	973 children of aged 6-12 years	Intervention was implemented for 8 months through mid day meal.	Intervention significantly increased hemoglobin by 0.4g/dL, reduced anaemia prevalence by 10% and improved cognitive scores.	9
Hussain S. et al., 2014	India	School children	Conducted for 6 months to study the efficacy of fortified rice	Study revealed that there is a significant increase in hemoglobin and serum ferritin. In sensory rice were indistinguishable after mixing with normal rice.	7
Thankachan P. et al., 2010	Bangalore, India	258 children of aged 6 - 12 years	To study the effect of extruded FRK	The results showed that after 6 months there is significant improvement in Vitamin B12 and homocysteine concentration ($p < 0.0001$). Physical performance also	14

				improved (p<0.05).	
Paithankar et al 2015	Orissa, India	945 School children (6-14year)	Pilot study was conducted fortified rice provided in Mid Day Meal.	Statistically significant increase in hemoglobin India and reduction in anemia prevalence for fortification district compared with control district	10

Discussion:

The above reviewed evidence from efficacy and effectiveness studies supports the fortification of rice with iron, folic acid and Vitamin B₁₂. Findings of studies concluded reduction in prevalence of anemia in women and significant improvement in cognitive power and physical performance among children.

Table 2: Rice Fortification Effectiveness Studies (International)

Name of author, year	Area of study	Subjects	Methodology	Findings	Ref
Arcanjo F P. et al., 2013	Brazil	171 children aged 10-23 months	Dosage of 56.4mg/day iron as ferric pyrophosphate through fortified rice administered once per week for 18 weeks	It was revealed that rice fortified with iron given weekly found to be effective in increasing Hb levels and reducing anaemia in infants	2
Hardinsyak I. et al., 2016	Indonesia	Women and teenagers	Efficacy of fortified rice was done through randomized clinical trial among 216 school teenage girls	Results showed that fortified rice with 2% of rice kernel was accepted organoleptically. The increase in hemoglobin concentration mean difference was 3.8g/L.	5
Pinkaew S. et al., 2013	Thailand, 2010	203 children of aged 4-12	Efficacy of Triple	Results showed significant	11

		years	fortified rice (with zinc, iron and vitamin A) in School Lunch Program	increase of 11.3 \pm 1.3umol/L (P<0.05) in serum zinc levels of group that consumed fortified rice.	
Hotz C. et al., 2008	Mexico	Women of aged 18-49 years old	Dosage of 13mg/day iron through fortified rice was administered for 5days per week for 6months.	Overall prevalence of anaemia was reduced by 80%. The absolute reduction observed in anaemia and iron deficiency was 10.3 and 15.1 respectively.	6
Angeles-Agdeppa et al 2011	Philippines	Mothers (n=392) and their children 6-9 years (n=424)	Hemoglobin measurement were done on mothers and children at baseline and endline.	Statistically significant improvement in hemoglobin and anemia for children, but not their mothers	1

Discussion:

Multiple studies conducted worldwide have found that fortified rice is an effective intervention to increase micro-nutrient status when the optimal quantities of micro-nutrients and fortificant forms are used with effective technology. Iron, zinc, folic acid, niacin and Vitamin A, B₁, B₆, and B₁₂ are advised for fortification.

Conclusion:

According to UNICEF's The State of the World's Children 2019 report states that malnutrition is the primary cause after 69percent of deaths of children under the age of 5years in India. This report also states that every second child in India is affected by some form of malnutrition. The malnutrition in young children can prevent brain development, body growth, immunity system and increases the risk of diseases which lasts life long. Therefore, rice being the staple food of India, considered to be the best resource available which can be fortified and can be made available to all strata of people without making any change in their dietary pattern, food habits, consumption pattern and cooking methods.

Although there are currently innovative and suitable technology for rice fortification, the true benefits of widespread rice fortification have not yet been realized. Global rice fortification could be one of the key contributing interventions that will provide a significant and sustainable reduction in the global burden of disease related to Vitamin and Mineral deficiency if this can be harnessed by nations over the next ten years. Many of the opportunities and difficulties faced in developing a successful global rice fortification initiative also were present in the fortification of wheat and maize flour. The creation of a global initiative for rice fortification is crucial to achieving the Millennium Development Goals. One of the highest priority programmes for achieving cost-effective human development on a worldwide scale is already thought to be rice fortification. The opportunities to further expand the potential of rice fortification are clear, the constraints are real, the need to address them is strong.

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