



## **Rice Fortification and Distribution: A Need of the Hour in Andhra Pradesh, India**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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### **ABSTRACT**

Malnutrition among mothers and children in India is extremely high. Every second woman in the nation is anaemic, and every third child is diminutive, according to the Food Ministry. On the Global Hunger Index (GHI), India ranks 94th out of 107 countries, placing it in the 'serious hunger' category. In the Indian state of Andhra Pradesh, micronutrient deficits are frequent among mothers and children. According to the NFHS-5 survey, In Andhra Pradesh, 59 % percent of non-pregnant women in the age group of 15-49 years are anaemic. 63.2 percent of children in the age group of 6 to 59 months are anaemic. 53.7 percent of pregnant women under the age of 35 are anaemic. Food fortification is consideration to be one of the most valuable ways to put a stop to malnutrition. Food fortification is a low-cost method that has been shown to provide health, economic, and social benefits. Rice is the most effective vehicle for reaching the poorest people and one of only two staples that can contain a spectrum of minerals and vitamins when properly enriched. Rice fortification activities are most successful when collaborations are developed between the civic and private sectors, as well as other parties who can help with sponsorship, management, capacity building, implementation, and regulatory oversight.

**Keywords:** *Malnutrition; fortification; anemia; rice fortification; food fortification; Andhra Pradesh.*

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## 1. INTRODUCTION

In low- and middle-income countries (lmics), maternal and child malnutrition account for 45 percent of all fatalities in children under the age of five [1]. hidden hunger, or a persistent deficiency of key vitamins and minerals in the diet, is a particularly common problem in lmics [2]. deficiencies in one or more micronutrients,

such as iron, zinc, and vitamin a, limit millions of people's physical and cognitive abilities. micronutrient deficiencies are projected to account for 7.3 percent of the universal saddle of disease, with iron and vitamin a deficiency ranking among the 15 top causes of global disease burden [3], contributing to the deaths of nearly one million children each year [1].

**Table 1. Statistics of andhra pradesh, source: nfhs-5**

Indicators	Nfhs-5 (2019-Nfhs-4 (2015-20)			
	Urban	Rural	Total	Total
<b>Child feeding practices and nutritional status of children</b>				
75. Children under age 3 years breastfed within one hour of birth <sup>15</sup> (%)	51.6	52.2	52.0	40.0
76. Children under age 6 months exclusively breastfed <sup>16</sup> (%)	61.4	70.4	68.0	70.2
77. Children age 6-8 months receiving solid or semi-solid food and breastmilk <sup>16</sup> (%)	67.3	45.4	50.8	56.1
78. Breastfeeding children age 6-23 months receiving an adequate diet <sup>16, 17</sup> (%)	15.2	5.8	8.2	6.5
79. Non-breastfeeding children age 6-23 months receiving an adequate diet <sup>16, 17</sup> (%)	19.5	7.8	12.1	11.9
80. Total children age 6-23 months receiving an adequate diet <sup>16, 17</sup> (%)	16.7	6.3	9.3	7.6
81. Children under 5 years who are stunted (height-for-age) <sup>18</sup> (%)	23.1	34.2	31.2	31.4
82. Children under 5 years who are wasted (weight-for-height) <sup>18</sup> (%)	17.6	15.5	16.1	17.2
83. Children under 5 years who are severely wasted (weight-for-height) <sup>19</sup> (%)	6.4	5.8	6.0	4.5
84. Children under 5 years who are underweight (weight-for-age) <sup>18</sup> (%)	25.1	31.4	29.6	31.9
85. Children under 5 years who are overweight (weight-for-height) <sup>20</sup> (%)	3.0	2.6	2.7	1.2
<b>Nutritional status of adults (age 15-49 years)</b>				
86. Women whose body mass index (bmi) is below normal (bmi <18.5 kg/m <sup>2</sup> ) <sup>21</sup> (%)	11.9	16.2	14.8	17.6
87. Men whose body mass index (bmi) is below normal (bmi <18.5 kg/m <sup>2</sup> ) (%)	15.0	17.2	16.5	14.8
88. Women who are overweight or obese (bmi ≥25.0 kg/m <sup>2</sup> ) <sup>21</sup> (%)	44.4	32.6	36.3	33.2
89. Men who are overweight or obese (bmi ≥25.0 kg/m <sup>2</sup> ) (%)	37.7	28.0	31.1	33.5
90. Women who have a high risk waist-to-hip ratio (≥0.85) (%)	52.7	47.2	48.9	Na
91. Men who have a high risk waist-to-hip ratio (≥0.90) (%)	53.8	52.6	53.0	Na
<b>Anaemia among children and adults</b>				
92. Children age 6-59 months who are anaemic (<11.0 g/dl) <sup>22</sup> (%)	58.7	65.0	63.2	58.6
93. Non-pregnant women age 15-49 years who are anaemic (<12.0 g/dl) <sup>22</sup> (%)	57.8	59.5	59.0	60.2
94. Pregnant women age 15-49 years who are anaemic (<11.0 g/dl) <sup>22</sup> (%)	56.2	52.7	53.7	52.9
95. All women age 15-49 years who are anaemic <sup>22</sup> (%)	57.8	59.3	58.8	60.0
96. All women age 15-19 years who are anaemic <sup>22</sup> (%)	62.3	59.1	60.1	61.1
97. Men age 15-49 years who are anaemic (<13.0 g/dl) <sup>22</sup> (%)	13.8	17.3	16.2	27.0
98. Men age 15-19 years who are anaemic (<13.0 g/dl) <sup>22</sup> (%)	12.8	21.4	18.7	29.3

According to the world health organization (who), 42 percent of children under the age of five and 40 percent of pregnant women worldwide are anaemic [4]. Pregnant women with rigorous anaemia are twice as likely to pass away during or shortly after pregnancy as non-anemic women, and micronutrient deficiencies in the uterus can show the way to low birth weight and brain and spinal defects in their children [5.]

Malnutrition refers to energy and/or nutrient shortages, excesses, or imbalances in a person's diet. Malnutrition caused by a lack of micronutrients aid the body make enzymes, hormones, and other composites desired for usual growth and progress. In terms of global public health, iodine, vitamin a, and iron are the most vital; their scarcity poses a grim threat to the health and development of populations worldwide, predominantly children and pregnant women in low-income nations. [6,7,8].

### 1.1 Different types of Malnutrition

1. Micronutrient-related malnutrition, micronutrient deficits (a lack of key vitamins and minerals) or micronutrient surpluses are both possible. ; and
2. Overweight, obesity, and diet-related non-communicable infections (such as heart disease, stroke, diabetes, and some cancers).
3. Under nutrition can be divided into four categories: wasting, stunting, underweight, and vitamin and mineral deficiencies. Malnutrition makes children especially vulnerable to illness and death.

A low weight-to-height ratio is termed as wasting. It usually indicates that the person has lost weight recently and significantly due to a lack of food and/or an infectious disease, such as diarrhoea.

A young child who is moderately or severely wasted faces a higher chance of mortality, although treatment is possible. A lack of height for one's age is known as stunting. Chronic or recurrent malnutrition, which is commonly associated to poor socioeconomic situations, poor maternal health and nutrition, frequent illness, and/or inappropriate newborn and young child feeding, causes it.

### 1.2 Malnutrition's Cause

Malnutrition is caused by a array of factors, including paucity and food costs, dietary habits, and agricultural production, with many individual instances involving a combination of these.

Clinical malnutrition, such as cachexia, is a rigorous concern even in poorer countries.

### 1.3 Diseases of Malnutrition

Malnutrition can be caused by a range of health conditions, such as gastroenteritis or chronic sickness, such as the hiv/aids epidemic.

## 2. NEED OF RICE FORTIFICATION IN ANDHRA PRADESH, INDIA

In the indian state of andhra pradesh, micronutrient deficiencies are frequent among mothers and children. According to the nfhs-5 survey, 59.0 percent of non-pregnant women in the age group of 15-49 years in andhra pradesh are anaemic. 63.2 percent of children aged 6 to 59 months are anaemic. 31.2% of children under 5 years are stunted, 16.1% of children under 5 years are wasted, 29.6% of children under 5 years are underweight.

Anemia affects 53.7 percent of pregnant women under the age of 35. The findings are concerning and point to major issues. Rice is the mainly valuable vehicle for reaching the poorest people in andhra pradesh, and one of just two staples that, when fortified properly, may transport a spectrum of minerals and vitamins. Food fortification is thought to be one of the most effective ways to prevent malnutrition.

Food fortification (ff) is illustrated as the addition of one or more necessary nutrients to a food, whether or not they are typically present in the food, to avoid or correct a demonstrated nutrient deficiency in the common population or unambiguous demographic groups [1]. As a result, fortification is distinct from enrichment, which is the act of reintroducing nutrients to a portion of food that has been removed during refinement or production. Foods that are widely fortified with folic acid are commonly stapled foods. [8,9].

### 3. FOOD FORTIFICATION'S BENEFITS AND DRAWBACKS

Ff advantages: it does not demand a change in community food habits, may provide a significant portion of the essential dietary intakes for a range of micronutrients on a continual basis, and does not require human conformance. It can be easily integrated into the existing food production and delivery system, ensuring its long-term viability

If consumed on a regular and consistent basis, fortified meals will maintain body stores of nutrients more efficiently and effectively than infrequent supplements fortified meals are also better at minimizing the danger of multiple deficiencies, which is a significant benefit for growing children who require a consistent supply of micronutrients for growth and development, as well as pregnant and lactating mothers who require enough nutritional storage.

The limitations of ff are well known: when large numbers of the targeted population have little or no access to fortified food, whether due to poverty or location, when the level of micronutrient deficiency is too severe, or when the metabolic demand for micronutrients is increased by the presence of infections, ff alone cannot correct micronutrient deficiencies. A

range of safety, technological, and budgetary factors may limit ff interventions. [5].

### 4. DIFFERENT TYPES OF FOOD FORTIFICATION (FF)

Biofortification is the process of creating micronutrient-dense staple crops using traditional breeding techniques and/or biotechnology. Biotechnology (genetic engineering) is a relatively recent approach of biofortifying staple crops that has gotten a lot of press in recent years.

The most well-known example of this approach is the transgenic 'golden rice,' which has twice the normal levels of iron and significant amounts of beta-carotene.(2), (12).

#### 4.1 Methods of bio Fortification

Iron-bio fortification of rice, beans, cassava, legumes, and sweet potato is one method of bio fortification.

- biofortification of zinc in rice, beans, maize, sweet potatoes, and wheat.
- cassava, maize, and sweet potato have been fortified with provitamin a carotenoid.
- biofortification of cassava and sorghum with amino acids and proteins

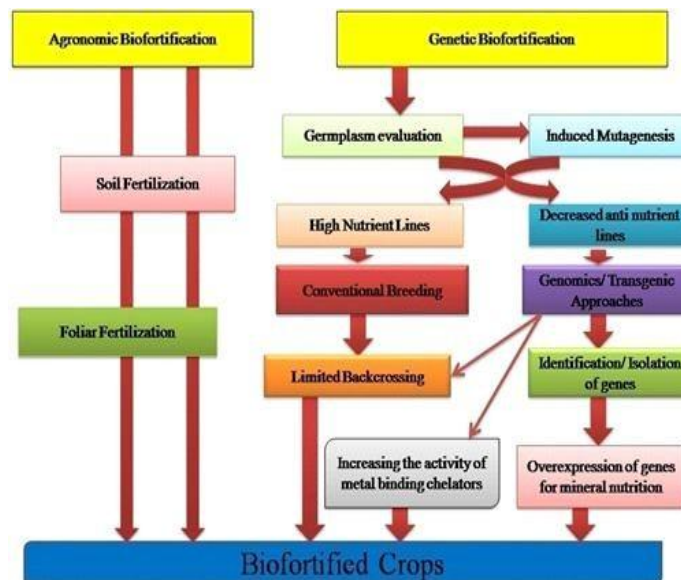


Fig. 1. different methods for biofortification (source: sharma et al., 2017)

Microbial biofortification entails the use of probiotic microorganisms (mainly lactic acid bacteria) that ferment to create -carotene in the human intestine or in the foods we eat [3].

Commercial and industrial fortification is the method of adding up micronutrients to commercially obtainable items such as flour, rice, cooking oils, sauces, and butter while they are being manufactured. Home fortification is on condition that deficient populations with micronutrients in the appearance of packets or pills that can be added to meals prepared at home (basically a merger of supplements and fortification).

Rice is a staple food in india, consumed by almost two-thirds of the population. In india, per capita, rice consumption is 6.8 kilograms per month. In andhra pradesh, all most all people consume rice in different forms. As a result, fortifying rice with vitamins is a viable alternative for supplementing the poor's diet. To put it another way, rice fortification is the addition of micronutrients to normal rice. Micronutrients are provided under dietary needs.

The macronutrients are carbohydrates, fat, and protein. They are the nutrients that you consume the most. "macronutrients are the nutritional components of food that the body needs for energy and to keep its structure and processes in good working order."

Rice can be fortified using a variety of methods, including coating and dusting. Extrusion is regarded as the greatest technology for rice fortification in india. This entails utilizing an extrusion machine to make fortified rice kernels (frks) from a combination. To make fortified rice, the fortified rice kernels are combined with ordinary rice [10,11].

The extrusion method involves mixing dry rice flour with a micronutrient premix before adding water.

This mixture is then fed through a twin-screw extruder with heating zones, which creates rice-like kernels. For use, these kernels are dried, chilled, and packed. The shelf life of frk is at least 12 months. The shape and size of the fortified rice kernel should "resemble the standard milled rice as closely as possible," according to ministry of consumer affairs, food, and public distribution rules. The grain length and width should be 5 mm and 2.2 mm, respectively, according to the specifications. 10 g of frk must be blended with 1 kilogram of normal rice, according to ministry specifications. Iron (28 mg-42.5 mg), folic acid (75-125 microgram), and vitamin b-12 are all present in 1 kilogram of fortified rice, according to fssai standards (0.75-1.25 microgram). zinc (10 mg-15 mg), vitamin a (500-750 microgram re), vitamin b-1 (1 mg-1.5 mg), vitamin b-2 (1.25 mg-1.75 mg), vitamin b-3 (12.5 mg-20 mg), and vitamin b-6 (1.5 mg-2.5 mg) can all be added to rice per kilogramme.

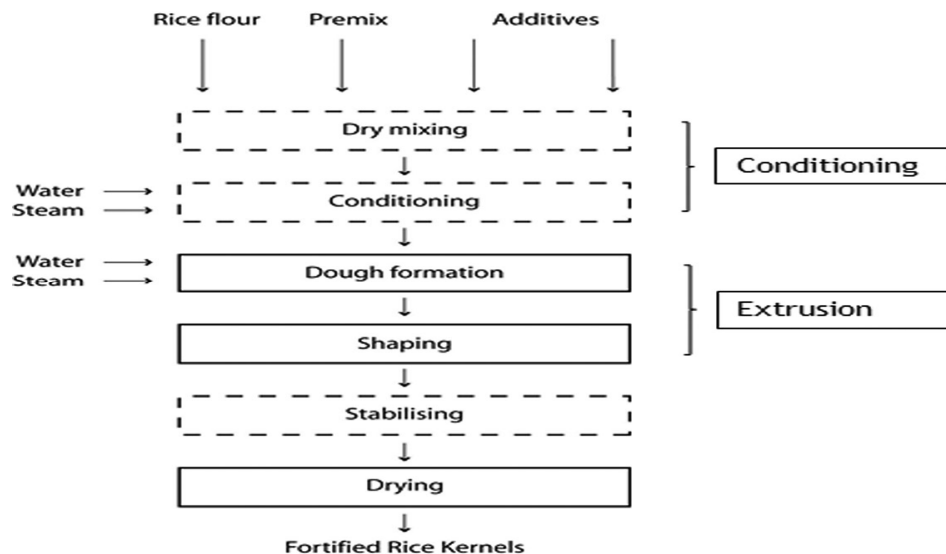


Fig. 2. process of producing fortified rice kernels (frk) using extrusion technology

## 5. CONCLUSION

The covid-19 pandemic has posed a threat to global food systems since march 2020, with an estimated 100 million people facing hunger and food insecurity. Large-scale food fortification offers a potent, evidence-based, and cost-effective strategy to reduce hunger by delivering critical nutrients to entire populations. Many fortification programs are under jeopardy, and progress on anaemia prevention is slowing, due to disrupted supply chains, programming obstacles, and competing financial and political demands. In the indian state of andhra pradesh, micronutrient deficiencies are frequent among mothers and children. In response to this situation, the prime minister's office announced the national nutrition mission in early 2018, which focuses on staple food fortification as a cost-effective way to combat vitamin and mineral deficiency. Rice is the most effective vehicle for reaching the poorest people in andhra pradesh, and one of just two staples that, when fortified properly, may transport a spectrum of minerals and vitamins. The government's three primary food supplementation programs: (1) mid-day meal scheme (mdm), (2) integrated child development scheme (icds), and (3) public distribution system, distribute it to the most nutritionally vulnerable people (pds). Government should encourage ngo's and other social service organizations to promote about fortified rice in rural and urban areas and distribute fortified rice to people with lesser price. Corporate industries should concentrate on developing awareness about malnutrition and fortified rice, and make available to poor and needy people. Government should encourage private organizations to prepare and sell fortified rice through neighborhood shops

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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