# Recent advances in food sciences-Fortified Rice

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***Abstract:*** **In human growth and development Vitamins and minerals play a vital role. Though they are required in trace amounts their deficiency results in physical and mental underdevelopment of children. As per records one in ten people have these deficiencies and responsible for about 0.5% of deaths in India .According to the recent analysis of FSSAI preventable micronutrient deficiency is a prime public health concern In India deficiencies of vitamin A, vitamin B12, vitamin D, iodine, iron, and folic acid are most common Over the past few decades Indian government has launched numerous programs to improve the nutrition levels and health of the masses and also encourages people to use fortified food to boost nutritional levels and improve overall wellness. Fortification of Food is the new research area, that gives a high promise to overcome the micronutrient deficiencies and develop a strong younger generation without any mental and physical illness. This study focuses on the various methods of food fortification and the types of food fortified.**

***Keywords*****: Micronutrients, Vitamin deficiencies, Food fortification, Healthy food Rice fortification**

**Introduction:**
Food is essential for life. the substances of food are classified into Micro and Macro Nutrients Through the normal diet most of us get the macronutrients. Though the requirement of micronutrients is very less, they play crucial role in the development of living organisms. Usage of various chemicals in the name of fertilisers and pesticides resulted in the loss of soil fertility and lead to loss of micronutrients in the food. Apart from this the various food processing method also contribute to the loss of vitamins and minerals. Deficiency to theses micronutrients lead to many diseases like Night blindness, Berry Berry, Scurvy Rickets, Goitre, Brittle bones, Anaemia and retarded growth. To overcome this food fortification or food enrichment is become essential in past few decades.

**Fortified food:**
Fortified food is either added with extra nutrients or nutrients that are not normally present in those foods. They contain micronutrients, such as vitamins, minerals, and essential nutrients. This helps us to gain these nutrients and to avoid deficiency disorders.
Examples: Milk added with vitamin D and salt added with iodine.

**Enrichment of food**:
Addition of nutrients that are lost during the agricultural processes and food processing Such as trimming, heating and drying. This method helps us to regain the lost micronutrients.

**Fortification of Food:**
**The** method of deliberately increasing the nutritional quality of food is called as Food fortification. In this process foods are mainly added with essential vitamins and minerals.

**Types of food Fortification**
Food fortification is classified into three types based on the stage at which food manufacturers add micronutrients.
1. Industrial or commercial fortification
2. Bio-fortification
3. Home-fortification

**Industrial or commercial fortification:** Industrial economical process of addition of huge amount of nutrients to food. Common Commercial fortified foods include
- Wheat flour
- Cereals
- Cooking oil
- Corn meal
- Iodized salt
- Milk
- Juices

- Sliced Bread- Fortified Folic Acid

**Bio fortification:**
This term denotes the breeding and genetic modification of plants and animals to increase their nutritional values.
- Eggs with omega -3 Fatty acids
- New variants of Poultry
- Broccoli
- Tomatoes
- Kiwi
- Almond milk with Calcium, Vitamin A and Vitamin D
- Rice - Fortified with Iron and folic acid
- Orange Juice- Fortified with Calcium and Vitamin D

**Home fortification:**
Costliest method of food fortification. It includes the addition of
- Micronutrient powder
- Vitamin D drops
- Soluble tablets to normal diet

**Rice fortification**: India is the second large producer of rice. According to the Department of Agriculture Cooperation and Farmers Welfare, India, 1.43 percent of rice production has increased at Compound Annual Growth Rate (CAGR) of during 2005-06 and 2016-17(Food fortification resource centre)
Rice loses its nutrients during milling and polishing process. Fortification of rice increases or regains the lost nutrients and is done in the post –harvest stage. this is a cost effective and appropriate method to address the micronutrient deficiency in developing countries. The cost of fortification is determined by the structure and capacity of the rice industry, the complexity of the supply chain, the policy and regulatory environment and the scale of the relevant programme.

**Research and development in Rice fortification**
A lot of studies were carried out in national and international level in Rice fortification which enables Central government to insist the Food and Civil supplies department of each state that empanels a number of rice millers in each district for regular supply of rice to the FCI, from which it is distributed to the social safety net schemes

**Studies in India**
Rice Fortification Pilot Study in Gadchiroli, Maharashtra, the district prevalent with 104 Anaemic women, adolescent girls and children in 2018 – 2020 by TATA Trusts to analyse the impact of Rice fortification. The implementation of fortified rice intervention in this group through the public distribution system (PDS) resulted in the reduction of anaemia for about 21.4% within a year (11)
Rice Fortification Study was conducted among 973 children aged 6 to 12 year in School in Gujarat, 2018 – 2019 to evaluate the effect of a multiple micronutrient fortified rice intervention among the school children for about 8 months through Mid-day meal scheme. The provided fortified rice had approximately 10% of iron; 25–33% of vitamin A, thiamine, niacin and vitamin B6; and 100% of folic acid and vitamin B12. This study proved that the fortified rice increased average haemoglobin by 0.4 g/ and reduced anaemia prevalence by10% (5)
In 2014 a study was conducted for 6 months in Indian Schoolchildren revealed an increase in e in Haemoglobin and serum ferritin and a significant decrease in total iron binding capacity in the subjects consumed iron-fortified. This study concluded that providing micronutrient fortified rice in school mid-day meal scheme could reduce the large burden of ID, IDA and VAD among children in developing countries. (3)
In 2010 a study was conducted in Bangalore among 258 children aged 6 to 12 year to determine the efficacy of multiple micronutrient fortified rice. After 6 months there is significant increase in plasma vitamin B12 homocysteine as well as physical performance in the children.(12)
184 children aged 6 to 13 year of Franciscan School, Bangalore, Karnataka were subjected to a study to evaluate the efficiency of iron as micronized ground ferric pyrophosphate Fortified Rice in 2005. The study concluded by stating that there was a significant increase in body iron storage and decrease in iron deficiency anaemia from 30% to 15% in the group that consumed fortified rice. (6)
Apart from these many international works like Multiple Micronutrient Fortified Rice in School Lunch Program, Thailand, 2010(9) Fortified Rice in Child Day Care Centres, Brazil, 2012.(7) Fortified Rice in Public Child Day Care Centers, Brazil, 2013(1) Fortified Rice in Public Schools in Brazil, 2013.(8) Clinical impact study of micronutrients fortified rice for teen girls, Indonesia,2016(2), proved that the consumption of fortified rice significantly reduces the percentage of iron deficiency and anemia .

**Rice fortification technology**
Rice fortification can be done in 2 ways.
1. Coating and Extrusion
2. Blending

Production of Fortified rice can be done by two-step process as illustrated in Figure 1. At first Fortified kernels are produced

by coating or extrusion technology and then the fortified kernels are blended with non-fortified rice at a ratio of 0.5% to 2% to result in fortified rice.

**Step 1: Coating and Extrusion**

**Option 1: Coating technology for production of fortified kernels**

Rice grains are coated with micronutrients (liquid fortificant mix) as layers by the help of waxes and gums. This is done in large rotational drum or pan coating machines. The fortified kernels are rinse –resistant to ensure micronutrient retention (4)

**Option 2 Extrusion technology for production of fortified kernels**

Extruded fortified kernels are Produced by combining formed by combining water and a Micronutrient mix with non-contaminated broken rice and grinded to form a dough which is then passed through an extruder to form fortified kernels that look alike non fortified rice grain. In this the micronutrient is equally distributed. These kernels are then dried to reduce the water content and increasing the storage stability the amount of starch in these kernels influences colour, texture and stability during soaking and cooking.

There are 2 methods in extrusion

1. Cold extrusion (30°C–50°C
2. Hot extrusion (60°C–80°C) (4)

**Figure :1 Two-step process of rice fortification through coating or extrusion technology**

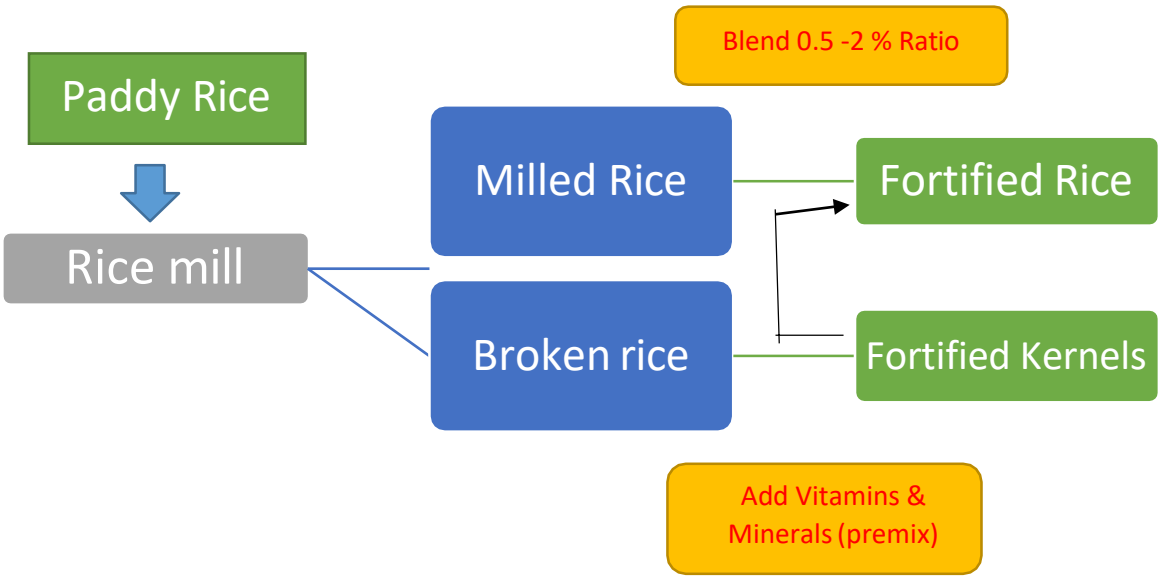


**Figure 2: Basic Extrusion steps**

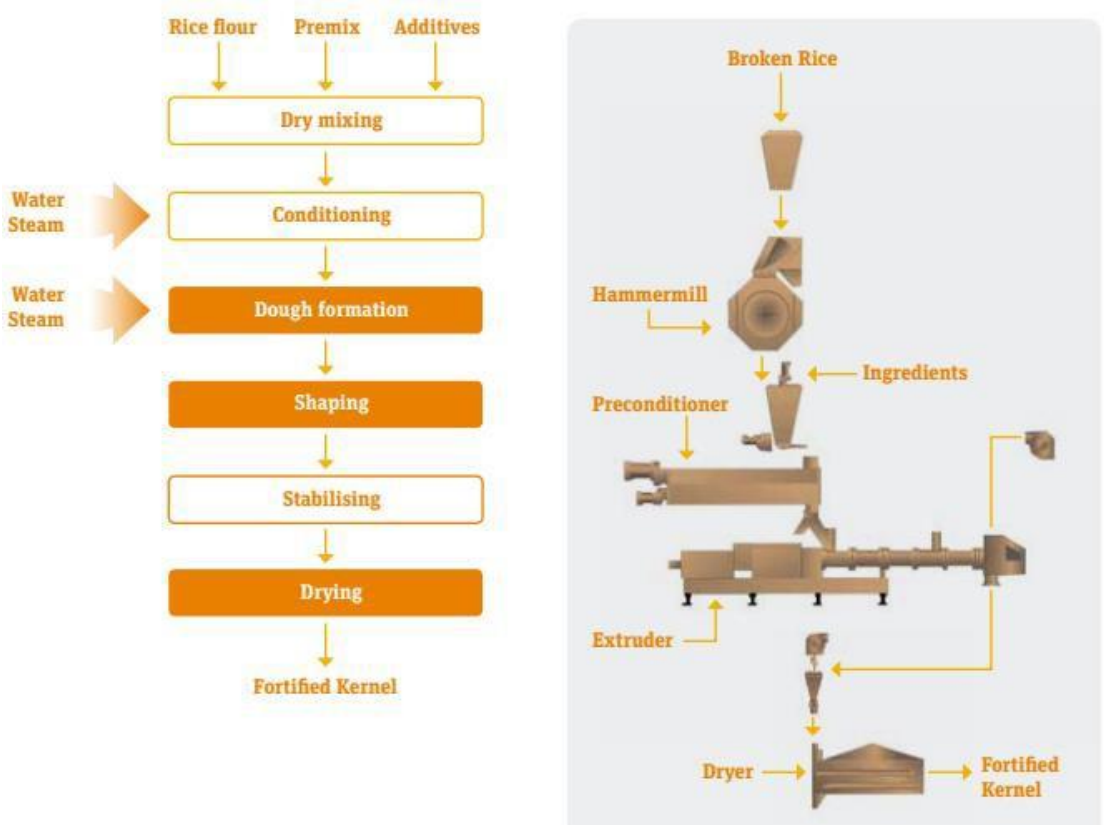
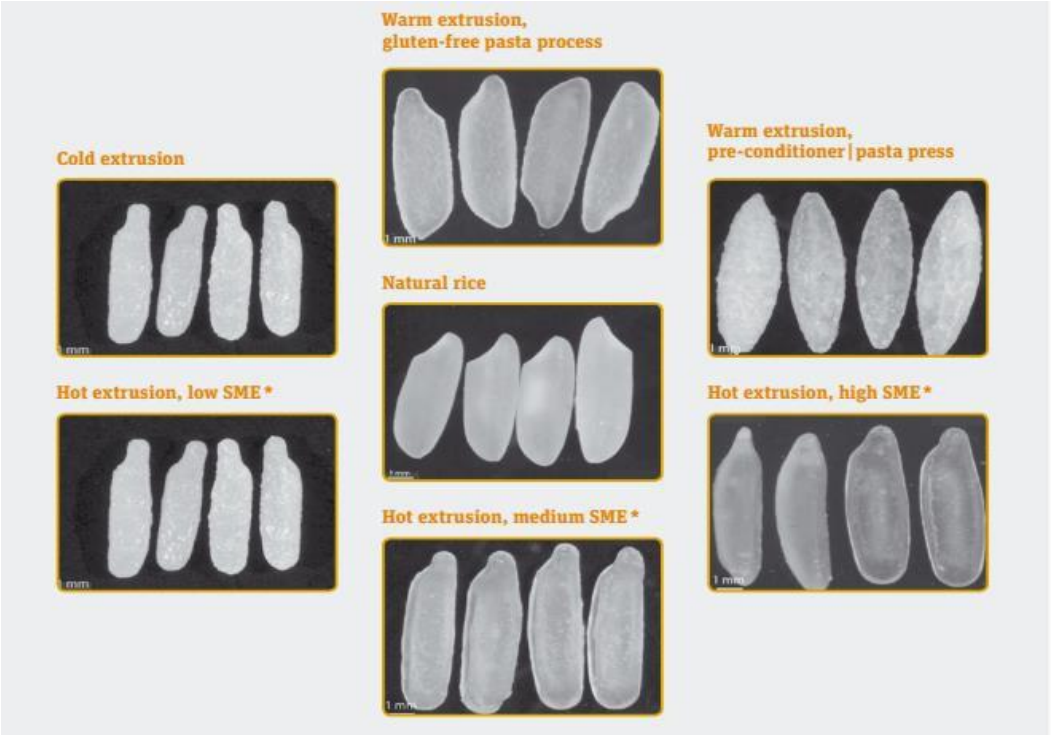



**Figure 3: Visual appearance of natural rice grains and extruded rice kernels produced with cold, warm and hot extrusion**

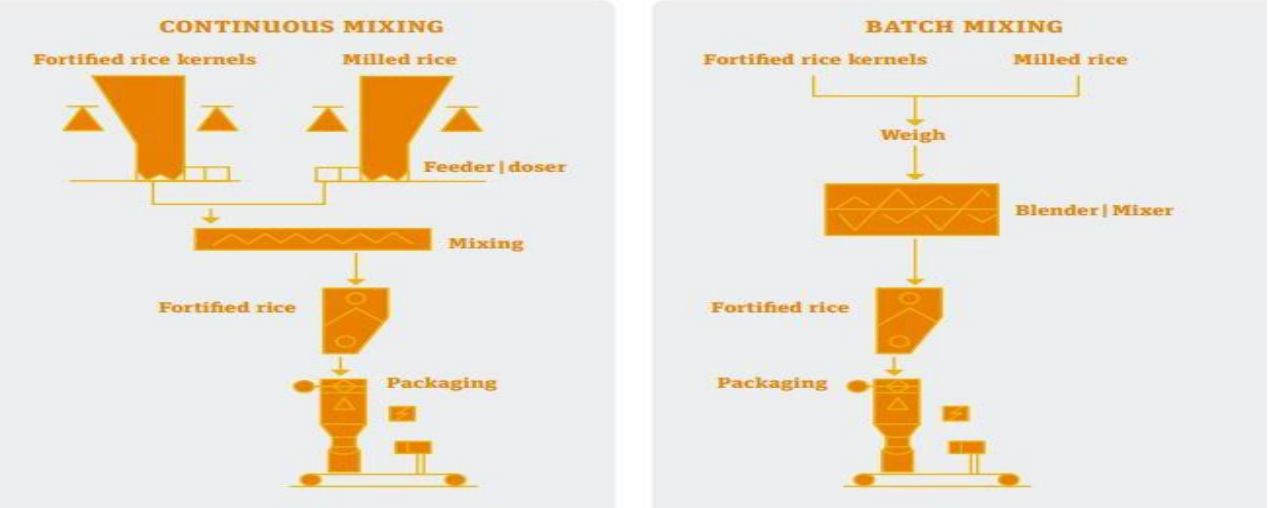



**Step 2: Blending of fortified kernels and non-fortified rice**

The coated or extruded fortified kernels are blended with non-fortified rice through a continuous or batch mixing process (Figure

4). The blending ratio, typically between 0.5% and 2%, depends on the nutrient content of the fortified kernels and the desired level of fortification. Quality assurance and quality control are needed to ensure uniform blending at the correct ratio. (4)

**Figure :4 Production methods for batch and continuous blending to produce fortified rice**




**Overview of commonly used fortification in rice**

Micronutrients added for fortifying rice should address the target population's nutrient gap in addition to those removed during processing. Micronutrient deficiencies often coexist in low- and middle-income countries. Fortificant selection depends not only on their bioavailability, stability, and sensory acceptability, but also on the fortification technology utilized

The most commonly used micronutrients and their fortificants are

- **Iron**: Different forms of iron fortificants recommended for wheat and maize four fortification.
- **Selenium** in the form of sodium selenite.
- **Vitamins**: vitamins B1 (thiamine), B3 (niacin), B6 (pyridoxine), B9 (folic acid), and vitamin B12 (cobalamin).
- **Zinc in** the form of **Zinc** oxide.
- **Lysine:** Rice is a good source of amino acids except for lysine; therefore, fortification with lysine can increase the biological value of rice protein. The majority of lysine in extruded fortified kernels is retained during washing and cooking. (10)

**Benefits of fortified Rice**

- **Prevent nutritional deficiency-induced ailments** such as rickets due to vitamin D deficiency, anaemia (iron deficiency), osteoporosis (calcium and vitamin D deficiency), or reproductive and nervous system ailments due to zinc deficiency
- **Beneficial in pregnancy:** There is a link between zinc deficiency and high mortality and morbidity rates in mothers and new-borns. Folate deficiency can cause faulty neural development in babies in the womb. Therefore, consuming fortified food during pregnancy can lower the risks of numerous congenital deformities in babies and improves the mother and baby's health.
- **Help in children's growth and development:** It is an evident-based fact that deficiency of iron, zinc, and vitamins A and D causes growth problems. Therefore, including fortified foods or micronutrient supplements in the growing phase have a positive physical and mental growth response among children.
- **Fulfil dietary requirements:** People who are strict vegetarians, vegans, lactose- intolerant, or other diet-related conditions have poor micronutrient levels, adding fortified foods to regular diet can fulfil the nutrients requirement and improves overall health.
- **Helpful for elderlies:** With aging, our digestive system absorbs fewer nutrients, causing a nutritional deficiency. Adding fortified food to the diet help maintain healthy nutrient levels for stronger bones, better digestion, and healthy organ functioning.

**Limitations of fortified foods:**

- Consuming fortified foods with unprocessed food may increase the risk of nutrient overdose.
- Eating only fortified food and ignoring fruits and vegetables can cause low nutrition. Unprocessed foods contain antioxidants and plant-based bioactive compounds, which protect us from various chronic diseases and inflammatory conditions.
- Fortified foods contain higher calories than whole foods. Therefore, processed fortified food can cause overeating and gradual weight gaining.

**Conclusion**: People in developing countries are highly prone to nutrient deficiencies due to lack of good food while people from developed countries have the same due to their food styles. Assuring required nutrients in required level in our diet is very important for proper mental and physical health. In that aspect Fortified foods especially Rice is a boon to those who are deficient in micronutrients. Fortified foods can fulfil our body's nutrient demand for healthy well-being. But, it is not the only way to get nutrients. we must include these foods without compromising healthy food items such as consuming fruits, nuts, vegetables, and seeds.

**REFERENCES:**


1. Arcanjo FP, Santos PR, Leite ÁJ, Mota FS, Segall SD. Rice fortified with iron given weekly increases hemoglobin levels and reduces anemia in infants: a community intervention trial. Int. J. Vitam. Nutr. Res. 2013;83(1):59-66.
2. Hardinsyah, I., Briawan, D., Budianto, S., Hustina, P., Ghifari, N. and Suhandono, S., 2016. Production and clinical impact study of micronutrients fortified rice for teen girls in Islamic boarding school in Medan, Indonesia. Final report. West Java: Food and Nutrition Society of Indonesia (Perhizi Pangan Indonesia).
3. Hussain, S.Z., Singh, B. and Rather, A.H., 2014. Efficacy of micronutrient fortified extruded rice in improving the iron and vitamin A status in Indian schoolchildren. International Journal of Agriculture and Food Science Technology, 5(3), pp.227-238.
4. Jennifer Rosenzweig, Judith Smit (2020) World Food Programme Regional Bureau for Asia, Rice fortification in Latin America pg. 159-164
5. Mahapatra S, Parker ME, Dave N, Zobrist SC, Shajie Arul D, King A, Betigeri A, Sachdeva R. (2021). Micronutrient-fortified rice improves haemoglobin, anaemia prevalence and cognitive performance among schoolchildren in Gujarat, India: a case-control study. International Journal of Food Sciences and Nutrition. Vol 9: pg 1-4.
6. Moretti D, Zimmermann MB, Muthayya S, Thankachan P, Lee TC, Kurpad AV, Hurrell RF. (2006). Extruded rice fortified with micronized ground ferric pyrophosphate reduces iron deficiency in Indian schoolchildren: a double-blind randomized controlled trial. The American Journal of Clinical Nutrition. 1;84(4):822-9.
7. Nogueira Arcanjo FP, Roberto Santos P, Arcanjo CP, Amancio OM, Braga JA (2012). Use of iron-fortified rice reduces anemia in infants. Journal of tropical pediatrics. 1;58(6):475-80.
8. Placido F, Arcanjo N, Santos PR, Segall SD. (2013) Ferric pyrophosphate-fortified rice given once weekly does not increase hemoglobin levels in preschoolers. Rice Research: Open Access. 19.
9. Pinkaew S, Winichagoon P, Hurrell RF, Wegmuller R (2013). Extruded rice grains fortified with zinc, iron, and vitamin A increase zinc status of Thai school children when incorporated into a school lunch program. The Journal of nutrition. 1;143(3):362-8.
10. Steiger G, Muller-Fischer N, Cori H et al, (2014). Fortification of rice: technologies and nutrients. Ann N Y Acad Sci; 1324:29–39.
11. TATA Trust, 2020.Rice fortification pilot study in Gadchiroli, Maharashtra. Endline evaluation & impact assessment report.
12. Thankachan P, Rah JH, Thomas T, Selvam S, Amalrajan V, Srinivasan K, Steiger G, Kurpad AV. Multiple micronutrient-fortified rice affects physical performance and plasma vitamin B-12 and homocysteine concentrations of Indian school children. The Journal of nutrition. 2012 May 1;142(5):846-52.