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An approach towards fortification of rice

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India is one of the largest producers of indigenous crops like rice, millets, wheat, maize and pulses. Inspite of having million of tonnes of production, people of different age group are suffering from the micronutrient deficiency diseases. National Family Health Survey (NHFS-4) shows that about 58 per cent of children, 53 per cent of women and 23 per cent of men are anemic and about 78 per cent of pregnant women are given iron and folic acid (IFA) pills in 2015-2016. However, only 30 per cent of pregnant women take pills at least for first 100 days of pregnancy (NFHS-4, 2016). The medium of providing iron and folic acid medication can be supported by intake of fortified rice due to its high consumption in India. About 104 million tonnes of rice produced in 2014-2015 and only 10 per cent of rice is exported and rest is consumed in India. Therefore, rice can be promoted as fortified indigenous crop to address micronutrient deficiency and will help in reducing anemia and pregnancy complications in women. Food regulatory authorities of India are also promoting the fortification in rice and wheat. This study investigates the effectiveness of various rice fortification techniques, advantages, disadvantages and recommendation for the promotion of fortified rice in rural and urban India. It elaborates the rice fortification through the process of parboiling, dusting, coating and extrusion processing.

Key Words : Micronutrients, Iron, Folic acid, Fortification, Parboiling

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INTRODUCTION

Majority of population in India cannot afford nutritious food. It leads to nutrient deficiency disease in children and pregnant women. National Health Family Survey (NHFS-4) shows that in year 2015-2016, Indian population has micronutrient deficiency of iron and folic acid. Indian population consumes mostly wheat and rice as staple food which is not rich in micronutrient. However, Government of India is providing micronutrients rich food through Integrated Child Development Scheme (ICDS) and free tablets of iron and folic acid to government school children and pregnant women. But it is not sufficient to address the deficiency disease which requires fortification of staple food; most acceptable option is rice fortification considering the high production and consumption (NFHS-4, 2016).

Rice fortification could be the possible solution. India is the second largest producer of rice in the world and about 90 per cent of total production consumed in India. Commonly, milled rice and handpounded (brown form) rice are consumed. Rice is good source of carbohydrate and low in vitamins and minerals. Approximate nutritional value of milled and handpound rice are compared.

The milled cooked rice does not able to retain all the nutrients. Some of the vitamins lost during milling and remaining while soaking in water and cooking .The

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vitamins and mineral are present in the aleroune layer of the rice which is outer coating of rice. This layer is removed through the process of milling and brown rice converted in milled or conventional termed as polished or white rice. Polished rice is preferred in India over brown rice due to its cooking appearance. However, brown rice is more nutritious in terms of vitamins and minerals.

National security mission has targeted to increase the production of rice by 10 million in 11th plan 2007-08. The basic strategy was to promote and extend improved technology which also includes micronutrients. Bringing Green Revolution to eastern India (BGREI) Scheme in 2010-11 implemented in seven state of eastern India to address the challenges for rice productivity. Rice production of India in 2014-2015 was 104 million tonnes and in 2015-2016 was 105 million tonnes (4th advance estimates) (Annual Report, 2017). 70-80 per cent of children, 24 per cent of men and 70 per cent of pregnant women are suffering from iron deficiency diseases. Top 10 rice producing states constitutes about 80 per cent of total rice production of India and NFHS-4 shows in these states Iron and Folic Acid (IFA) given or bought about 83 per cent of women (age15-49 years) during pregnancy. Therefore, Rice fortification will be the viable options reduce iron and folic acid deficiency (NFHS-4, 2016).

Medium of fortification:

The deficiency of iodine has been catered through the introduction of iodine in salt which is consumed on daily basis. Indian has made significant progress through this way of iodine fortification. Similarly the deficiency of iron and folic acid has to be targeted to make it available to consumer in staple food. Rice is one such crop which is preferred by the significant population of India. Rice is majorly consumed among wheat, barley and maize as staple food over Asia and Pacific region. A method can be designed for fortified rice with suitable process which could retain nutrients at the serving table of consumer. Process must to tolerate the barrier of cooking so that maximum nutrients wiil be available to consumer. Different fortification techniques are used namely fortification with parboiling, dusting, extrusion technology and coating (Nishaanthini *et al*., 2014).

Methods of rice fortification:

Fortification with parboiling:

It is process of treating rice with water under the action of soaking in hot water, steaming, drying and milling. Parboiling process gelatinsed the starch and create void in the endosperm of the rice which give toughness to the rice. It removes the chalkiness of rice which usually occurs when rice is harvested at high temperature. The tough kernel become resistant to the breakage during milling. Parboiling also inactivates the lipase and dextrified the starch improving the shelf life. Most importantly, parboiled rice has better nutritional value as the micronutrients get migrate from the aleurone layer toward the endosperm and automatically leads to reduction of nutrients during milling.

The micronutrient shows better retention after parboiling given appropriate soaking time. The diffusion of micronutrients occurs due of moisture gradient generated between rice and surrounding. It has been observed that the soaking time and milling are the major factor in folic acid and iron fortification. Also the washing step prior to cooking could adversely affect the concentration of iron. Folic acid get lost during parboiling in soaking water due to gradient of moisture with soaking water. Iron content shows better retention after soaking. Milling process of rice removes the bran layer of rice which leads to loss of fortified nutrients.It makes imperative to optimize the milling time for minimizing loss (Nishaanthini *et al.*, 2014).

Dusting:

It is the method of introducing fine particles of micronutrients with rice through blending. It act on the principle of electrostatic force between rice surface and micronutrients. Over washing and cooking with excess water could significantly reduce the micronutrients content (Georg *et al.*, 2014 and Piccoli *et al.*, 2012).

Coating:

Rice is coated with water resistant edible coating. The coated rice is blended with rice in ratio of 1:50 to 1:200 and solution or suspension of micronutrients are added through spraying. A rotating drum is used in which the solution is sprayed through nozzle. Different coating have been used as waxes, gums, starches, cellulosic polymers and ethyl cellulose and micronutrient get concentrated on the surface of the rice. Rice coating premixes need to be stable during cooking. These techniques are used in Philippines and United sates of America (Georg *et al.*, 2014 and Piccoli *et al.*, 2012).

Extrusion processing:

It is a continuous process which combines different step of mixing, degassing, thermal and mechanical heating, moulding and expanding (Georg *et al.*, 2014 and Piccoli *et al.*, 2012).

There are two types of extrusion processing:

Rice flour production using Hammer mill (Broken or low quality rice can be used)

⇩

Dough is prepared using water, binding agent, emulsifiers, fortificant mix and steam

⇩

Dough is passed through the single or twin –screw extruder using high temperature(70-100°C)

⇩

Gelatinized dough is cut into grain shape kernel of rice called as rice analogue or extruded rice

⇩

Rice kernel are dried

⇩

Rice has similar shine and transparency

⇩

Extruded rice kernel which are fortified with vitamin and mineral are added to normal rice in ratio 1:50 to 1:200

Fig. A: Hot extrusion

Rice flour production using Hammer mill (Broken or low quality rice can be used)

⇩

Dough is prepared using water, binder, emulsifiers, Vitamin/mineral premix

⇩

Dough is passed through the pasta type extruder or mixture using low temperature

⇩

Mix is cut into grain shape kernel of rice called as rice analogue or extruded rice

⇩

Rice kernel are dried (it involve limited heating caused by mechanical energy input)

⇩

Rice kernels are opaque and slightly off colour

⇩

Extruded rice kernel which are fortified with vitamin and mineral are added to normal rice in ratio 1:50 to 1:200

Fig. B: Cold extrusion

Recommendation for the promotion of rice fortification in India :

The government has started various schemes to fulfill the nutritional requirement of different age group of people like Mid Day Meal, Integrated Child Development scheme through the Anganwadi centre, Public Distribution system. These schemes for rice fortification could cover a large population of school going children including anemic girls and boys, pregnant women and lactating mother. Odisha successfully completed a pilot project in the Gajapati district under the world food programme. Under this project rice fortification is introduced through the mid day meal and many school children get benefits. Interview report of auxillary nurse mid-wife at gumma Gajapati, confirms improvement in the health of children, from end of year 2012 to early of year 2015. The cases of anemic has reduced considerably and children are stronger with better cognitive and learning ability. This project shows that the existing government schemes can be planned for the rice fortification to address the deficiency of micronutrients (World Food Programme, 2017). Accepting the current deficiency of iron and folic acid, government should design policy to find definite solution. Food safety regulatory body of India, Food safety and standard authority of India (FSSAI) has made Food Safety and Standards (Fortification of Foods) Regulation 2016

Table 1 : Proximate principles : Common rice

All values are per 100 g of edible source

	Moisture (g)	Protein (g)	Fat (g)	Minerals (g)	Crude fibre (g)	Carbohydrate (g)	Energy (Kcal)	Iron (mg)	Folic acid - total (microgram)
Rice parboiled handpounded	12.6	8.5	0.6	0.9	-	77.4	349	2.8	-
Rice, parboiled, milled	13.3	6.4	0.4	0.7	0.2	79	346	1	11
Rice raw handpounded	13.3	7.5	1	0.9	0.6	76.7	346	3.2	-
Rice,raw, milled	13.7	6.8	0.5	0.6	0.2	78.2	345	0.7	8

Source: Nutritive value of Indian Food by C.Gopalan, B.V.Rama Sastri and S.C.Balasubramium

Table 2 : Rice production in India 2014-2015 and 2015-2016

Top rice producing states	Million tonnes of rice production[1]		% of women given or bought IFA (2015-2016)[2]
	(2014-2015)	(2015-2016)	
West Bengal	14.68	15.75	91.1
Uttar Pradesh	12.17	12.51	62.7
Andhra Pradesh and Telangana	11.67	10.45	91
Punjab	11.11	11.82	88.9
Orissa	8.28	5.88	90.4
Bihar	8.30	6.49	89.6
Chhattisgarh	6.32	6.09	55.8
Tamil Nadu	5.73	7.98	94.4
Assam	5.22	5.14	85.2
Haryana	4.01	4.15	83.3
Total of Above states	85.57	86.26	Average (83.24)
All India	104.32	105.42	77.7

Source: [1]Agriculture statistics at a glance, Directorate of economics and Statistics [2]National Family Health Survey (NHFS-4) 2015-2016

for wheat flour, rice, edible oil, milk and salt. Fortified rice shall, contain added iron, folic acid and vitamin B12 at the given level: Iron: Fortified in form of Ferric pyrophosphate, sodium iron (III), Ethylene diamine tetra acetate, Trihydrate with 20 mg/kg; Folic acid: Folic acid with 1300 µg/kg; Vitamin B12- Cyanocobalamine, Hydroxycobalamine with 10 µg/kg (Food Safety and Standards, 2016). Government partnering with private industries for rice fortification but there is long way to go ahead. It is a better way to incorporate the nutrition by making it mandatory considering the current scenario of micronutrient deficiencies and high production of rice in India. In some countries it is mandatory to fortify rice like Panama, Costa Rica, Philippines, Papua New Guinea and Nicaragua (World Food Programme, 2017).

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