Biofortification of Rice; An Approach to Combat Malnutrition

Background

Mostly deficiency disorders, like protein energy malnutrition and vitamin A deficiency are specifically common in countries in which rice is the staple food. In accordance to the devastating effect of malnutrition and vitamin A deficiency, this generally includes blindness in adults and malnutritional death in children. Attainment of self-sufficiency in food grains at national level, especially cereals is one of the major achievements of the green revolution in mid-sixties in India. The nation’s food grains production increased remarkably from 50.82 million tons in 1950-51 to 277.5 million tons during 2017-18, and a similar trend has been reported for the production of food grains since past decade. Despite the adequate production of food grains, the 2018-Global Hunger Index (GHI) report ranked India as 103 comprising 25% of world hungry population amongst the top 119 countries. According to rapid survey on children (2013-14) conducted by Ministry of Women and Child Development, Government of India (GOI), about 18.6% of newborn, 34.6% of children up to 3 years, and 62.5% of adolescent girls are suffering from malnutrition [1-3]. The government of India has made several interventions to address malnutrition; however, the incidence of malnutrition among women and children remains severe. The issue of malnutrition in the country is compounded not only by the access to quality of foods but also by the social-and cultural-issues. Conventional strategies to combat malnutrition include dietary supplements and food fortification programmes. Efforts are now being made to fortify rice and wheat flour for iron (Fe), vitamin B12, and Folic acid. Some of the constrains with these interventions include poor disseminations to the target populations especially those residing in the rural areas; sustaining them over a period of time and addressing the symptoms rather than the actual cause of the problem. Dietary diversification is the ideal solution to alleviate malnutrition but not viable in Indian situation considering the inadequate purchasing power of the poor people. With the record 277.40 million tons production of food grains during 2017-18, India is breaking its own earlier records for production.

Biofortification

Biofortification is done to improve the nutritional value by breeding crops. Fortification is an enrichment process in which micronutrients like essential trace elements and vitamins to food, whose main purpose is to reduce the dietary deficiencies among the people, which occur due to the qualitative loss of micronutrients generally occurred during the food processing. But Biofortification is quite different from normal fortification process in Biofortification preference is given to the production of more nutritious plant food as the plants are growing, rather than adding nutrition during processing [4]. So Biofortification is considered to be one of the solutions to deal with the micronutrient deficiencies in some countries.
which can also add protein content to rice. Human body can't produce all the amino acids required for the protein formation that are essential for our body. So, the protein rich food is important for better health. But in India most of the people are dependent on low protein rice as their staple food. As human body can't produce all the amino acids some amino acids to be provided through dietary supplement are dubbed to be essential amino acid. Not only in India but about 50% of global population is dependent on rice of about 70% of Indian population. Though rice have less proteins comparison to maize and wheat but this protein is good due to the proper balanced amino acid content and digestibility. So, the protein content of the rice should be improved to overcome the protein energy malnutrition, which is found 80% in Asia, 5% in Latin America and 15% of Africa. In India most cases are seen in children less than 5 years, which are known to be undernourished or malnutritioned [5]. As their protein intake is less than 13 - 19 g/day/child. This case is mostly seen in the bellow poverty lines when the child does not get the proper food which can provide them 1000-1400 calorie of energy per day among which 150 - 450 cal are to be provided by protein. As in the poverty region they don't get other qualitative food to fulfill the energy requirement they directly depend on rice. Excluding starch, protein is found mostly from the plant products of the legumes and cereals and oilseeds, so the most important constituent of protein ‘nitrogen’ can be obtained from these but in the form of nitrate or ammonium by nitrogen fixation [6,7]. But the nitrogen stored in the leaves is remobilized to the developing seeds during the grain filling stage, depending upon the genotype. So, to improve the protein content of the rice, nitrogen mobilization efficiency can be increased for which nitrogen content of the rice should be increased. But as this is dependent on genotype, quantitative improvement of this type can yield high amount of rice of this variety. Large amount of storage proteins like glutelins, albumins and prolamins are found in rice of this variety. But this protein amount varies so not only quantitative but also qualitative improvement is very important. Now several researches specifically aim the, (I) physiological, biochemical and molecular basis of qualitative improvement. (II) Diversity of the rice germplasm collection at ICAR-NRRI Cuttack. (III) Improvement of high yield varieties with more protein through different process like bulk pedigree and backcross methods. Nitrogen is the most important constituent of proteins but even plants cannot take them directly from the atmosphere. So, storage of nitrogen in plants is done by several steps such as uptake by roots, assimilation, translocation and remobilization to the growing seeds of the plant. But rice is grown in water logged condition so nitrogen is specially taken up as ammonium ions as they require less energy for metabolism than nitrate ion. The uptake of ammonium ion is done by the root hair through the ammonium transporter present in its plasma membrane and then translocated to other parts of plants. The nitrogen taken by the plants cannot form all amino acids except glutamate and glutamine. By glutamine synthetase they form glutamine which carries two atoms of nitrogen.

High protein-nutrient rich rice developed by ICAR-NRRI to combat malnutrition

Using a high grain protein content donor (ARC 10075) several introgression lines in high yielding varieties such as Swarna and Naveen were developed by ICAR-National Rice Research Institute, Cuttack and tested in multi-locations. Most of them had significantly higher level of lysine, threonine, leucine, isoleucine, valine, phenylalanine, alkaline, proline, glutamic acid, arginine and total amino acid as compared to recurrent high yielding parents. Among them a high yielding (4.5t ha−1) variety in Naveen background, CR Dhan 310 has been released as the first biofortified high protein (10.2%) rice variety by central variety release committee (CVRC) and notified for cultivation in Odisha, Madhya Pradesh and Uttar Pradesh. Subsequently, another nutrient rich variety CR Dhan 311 (Mukul) with high protein (10.1%) and moderately high Zn (20 ppm) content has been released by state variety release committee (SVRC), Odisha and notified by Govt. of India in 2019.

REFERENCES


