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Breeding Rice for Quality Grain: The Way to A Healthy Life

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Rice (*Oryza sativa*) is the most important food crop in the world, which meets about 21% of the calorific requirements of the global population and up to 76% of the calorific intake of the people of South East Asia. The characteristics of the grain determine market value and have a crucial effect in the acceptance of new varieties in nations where rice is consumed. (Fitzgerald et al., 2008). According to market research, attempts to create varieties with better cooking and eating quality have a significant economic payoff. (Son et al., 2014). Although grain quality has a significant impact on rice's market value (Dalton, 2004), it has received less attention in varietal improvement programmes as compared to yield. Grain yield and essential grain quality attributes work best together. However, there hasn't been much historical success in breeding cultivars with both greater yield potential and enhanced grain quality attributes. High-yielding varieties without premium qualities typically have lower end-consumer acceptability than low- to moderate-yielding cultivars with the best organoleptic characteristics. The IRRI mega-varieties, which were developed from the late 1960s to the 1980s and are still in demand today, are examples of them. (Leung et al. 2002). Therefore, breeding must take use of contemporary scientific developments to produce rice that is suitable for cooking and eating, and through marker-assisted selection, introduce these genetic areas (reflected by grain quality and preferences for sensory evaluation) into high-yielding varieties.

Classification and importance of rice quality

The term "rice grain quality" is used both narrowly and broadly. When used narrowly, it typically relates to eating or palatability quality. In general, rice grain quality includes milling quality, appearance quality, and cooking and sensory quality, as well as nutrition and hygiene quality (Fig-1) Differed people have varied interpretations of the word "rice quality." It may be used to describe the quantity of whole grain rice (polished rice) that is left behind after milling. Others focus on the rice flour's aesthetic attractiveness, while still others consider the rice's flavour in relation to regional tastes.

Fig-1: Classification of rice grain quality traits

The amount of economic product recovered during milling, first for brown rice and later for white rice, is referred to as milling quality. The most common type of refined rice sold as a commodity is unbroken white rice. White rice rate (WRR), brown rice rate (BRR) and head rice rate (HRR) are all components of milling quality. The head rice yield, also known as the head rice rate, is the primary indicator of milling quality overall.

The term "appearance quality" relates to how polished rice appears, and encompasses things like color, form, chalkiness, and transparency. (Zhou et al. 2019). The primary characteristics that affect visual quality are grain form and chalkiness. Grain length, grain breadth, grain thickness, and length/width ratio are characteristics connected to grain shape, and chalkiness can be separated into white core, white belly, and white back in accordance with location.

The term "cooking and sensory quality" describes the thorough assessment of the flavor, palatability, palatability, color, form, and other sensory indicators following cooking under precise conditions. According to recent research, amylose content, protein content, fat content, gel consistency, gelatinization temperature, and cooking method are the primary factors influencing cooking and sensory quality.

Rice is primarily made of carbohydrates and contains very little additional nutrients. The additional nutrients in a staple diet, however, may be crucial for maintaining human health. It is widely acknowledged that lysine and protein are those essential nutrients. In regions with a dearth of trace elements, minerals and vitamins are also crucial nutrients. Eating white rice with lower milling extraction levels or, alternatively, brown rice, which retains more of the outer brown bran that is rich in fiber, vitamins, minerals, and amino acids, has health benefits because rice bran is rich in polyunsaturated fatty acids, crude fiber, and anthocyanins. People are becoming more aware of the advantages of some healthful chemicals, such as resistant starch and anthocyanins, as living standards and educational attainment rise.

Food safety is now a concern for consumers, and the safety of rice as a primary food ingredient is coming under closer scrutiny. While rice has a number of nutrients, it can also be contaminated with allergies, pesticide residues, and heavy metals like arsenic, cadmium, lead, and mercury.

Prospects of breeding high quality rice

The production of high-quality rice for value addition must be the primary goal of the rice breeding program, considering the rising demand and customer preferences. Selective breeding or genetic modification can be used to create nutrient-rich cultivars that provide high yields. (Gearing, 2015). The nutritional value of rice is now recognised to be influenced by genes and QTLs. Such an effort to create higher-quality, more productive rice cultivars could be influenced by genomics. To understand the allelic variation in the genes underlying the phenotypes, allele mining can be helpful. Additionally, cutting-edge genomic technologies, including SNP arrays, genome sequencing, genome-wide association mapping, transcriptome profiling, etc., could be strategically used to understand molecular mechanisms and their relationship between the genotypes and phenotypic traits, leading to the development of improved rice varieties. (Peng et al., 2016). Compatible previously mentioned QTLs and genes can be coupled to create a desired genotype that is superior in a variety of grain quality attributes. (Mahender et al., 2016). This can be accomplished by using marker-assisted selection to introduce nutrition-related QTLs and genes to increase the effectiveness of traditional plant breeding. (MAS).

Although various biotic, abiotic, and quality attributes in rice have been improved using MAS, this method is reliant on large-effect QTLs and genes and does not account for epistatic and genetic background effects. Many genes of minor effect and/or major genes are combined to govern the majority of qualities of interest to rice breeders rather than just a few large-effect genes.

An alternative to traditional MAS has been proposed: genomic selection (GS). Breeding efficiency can be greatly improved by GS by increasing gain per selection over time. (Spindel et al., 2015). Breeders can use genome-wide DNA marker data from GS breeding to choose the most attractive parents for the following generation. These parents are chosen based on the correlation between the phenotypes of the individuals being picked and the genome-wide markers. The main benefit of GS over MAS is that all available marker data are used to forecast breeding value rather than just a small subset of markers that target genes with significant effects. This lessens the chance of information loss. This lessens the chance of information loss. Using information from all the marker data, it is possible to identify and pick genes with minimal effects. As the price of genotyping continues to drop, GS will become a more efficient tool for boosting the effectiveness of rice breeding. (Spindel et al., 2015). Additionally, combining transgenic assisted breeding methods with traditional breeding may be a successful strategy going forward.

Conclusion

In light of the fact that humans consume rice mostly in cooked whole grain form, rice grain quality is crucial. Globally, various consumers have extremely particular requirements for various combinations and metrics of rice grain quality. Breeding for these particular customer expectations might be difficult because grain quality is phenotype using arbitrary, expensive biochemical assays. Therefore, marker assisted selection is an excellent choice when breeding for grain quality. Researchers have been able to pinpoint the genes responsible for the varied characteristics of grain quality thanks to the sequencing of the rice genome more than ten years ago. Grain size, fragrance, AAC, GT, and paste viscosity parameters are extremely effective functional molecular markers that have been created. Around the world, these markers are increasingly being employed in breeding for grain attributes that consumers like. Around the world, these markers are increasingly being employed in breeding for grain attributes that consumers like. Future rice breeding effort is advised to utilise genome-wide marker technologies that will care for genes with little effects and enable breeders to simultaneously select for grain quality, yield, and stress tolerance.

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