

Review Paper

# Breeding Low Glycemic Index Rice (*Oryza sativa* L.) Cultivars: Progress, Benefits, and Challenges

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## ABSTRACT

The study on low glycemic index (GI) rice cultivars is thoroughly reviewed in this review article. A significant portion of the glycemic load in the diet is contributed by rice, hence developing excellent low GI rice cultivars has become a research priority to reduce any adverse health effects. Low GI rice cultivars have been developed using conventional breeding techniques, but molecular breeding techniques, such as marker-assisted selection, genomics-assisted breeding, and transgenic methods, have become more popular. To pinpoint the genes and quantitative trait loci that cause low GI and comprehend the underlying mechanisms, genetic and genomic techniques have been used. Measurements of the glycemic index of rice cultivars are performed using *in vitro*, *in vivo*, and human intervention research. Low GI rice consumption is linked to better blood sugar regulation, diabetes management, weight management, and cardiovascular health. However, issues with consumer acceptance, intellectual property rights, and integration with sustainable agriculture still exist, in addition to the efficacy and safety of transgenic techniques. The development of better low GI rice cultivars has the potential to significantly improve global health outcomes, and molecular breeding techniques show promise in this regard. In order to create and implement low GI rice agriculture, which helps both human health and the environment, challenges must be overcome.

## HIGHLIGHTS

- Discussing the importance of breeding low glycemic index (GI) rice cultivars to mitigate the negative health consequences.
- Discussing the various breeding methods to develop low GI rice cultivars by identifying and manipulating genes and quantitative trait loci responsible for low GI.
- Identifying the different genetic and genomic approaches employed to identify genes and quantitative trait loci responsible for low GI.

**Keywords:** Diabetes, Glycemic index, Rice, blood sugar, Environment

Over half of the world's population relies on rice as a main food source, making it one of the most significant cereal crops in the world. For millions of people in Asia, Africa, and Latin America, rice, which has an estimated annual production of 500 million metric tonnes, is an essential source of carbohydrates, vitamins, minerals, and dietary

fiber (FAOSTAT, 2021). Although rice is widely consumed, high glycemic index (GI) values have

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been associated with an elevated risk of chronic diseases such as type 2 diabetes and cardiovascular disorders (Tobias *et al.* 2012; Slavin and Carlson, 2014).

According to Atkinson *et al.* (2008), the glycemic index (GI) measures how rapidly and significantly a diet containing carbohydrates raises blood sugar levels after intake. While low GI diets give a slower and more prolonged release of glucose into the bloodstream, which results in a gradual and more moderate increase in insulin secretion, high GI foods quickly raise blood glucose levels, causing a surge in insulin secretion (Brand-Miller *et al.* 2009). According to Barclay *et al.* (2008), eating meals with a high GI has been linked to a higher risk of developing chronic conditions like type 2 diabetes and cardiovascular diseases. In this setting, research on low GI rice cultivars has become crucial to reducing the harmful health effects of high GI rice intake.

Numerous studies have shown that eating low GI rice may have positive health effects. According to a Chinese randomized controlled experiment, switching from high GI to low GI rice improved glycemic control in people with type 2 diabetes (Wang *et al.* 2011; Billah *et al.* 2021). Consuming low GI rice significantly improved glycemic control and insulin sensitivity in people with type 2 diabetes, according to a systematic review and meta-analysis of 16 randomized controlled trials (Rivellese *et al.* 2019; Shashidhara and Shailaja Hittalmani, 2019b). Therefore, generating better low glycemic index rice cultivars through breeding could provide rice consumers a healthier option, especially for those who are at risk of acquiring chronic diseases. This can be done using conventional breeding techniques as well as molecular breeding techniques like genetic alteration and marker-assisted selection (Lal *et al.* 2021). These cultivars could potentially enhance glycemic control and lower the risk of chronic diseases linked to high GI diets by lowering the glycemic index of rice.

As a result, there is an increasing interest in creating excellent low glycemic index rice cultivars that can improve human health. This review paper will cover the variables influencing rice's glycemic index, the genetic foundation of glycemic index, methods for calculating rice's glycemic index, breeding procedures for cultivars with the low glycemic

index, and the nutritional and health advantages of low glycemic index rice. In order to fulfill the rising demand for healthier rice types, it will also cover the difficulties and potential outcomes of generating low glycemic index rice cultivars.

## FACTORS AFFECTING GLYCEMIC INDEX IN RICE

### Starch composition

One of the key elements influencing the glycemic composition of foods is the starch composition (Atkinson *et al.* 2008). A complex carbohydrate called starch is composed of long chains of glucose molecules. The glycemic response of starch is influenced by its structure and characteristics, which can also affect how rapidly it is absorbed and broken down by the body. The proportion of amylose to amylopectin in the starch is a significant component that influences the glycemic content of foods. Unlike amylopectin, which has a branched chain of glucose molecules, amylose is a straight chain. In comparison to foods high in amylopectin, foods high in amylose typically have a lower glycemic index (GI). Because of its linear form, amylose is more difficult to digest and releases glucose into the bloodstream more slowly (Atkinson *et al.* 2008).

The degree of starch gelatinization has an impact on the glycemic composition of foods as well. Granules of starch lose their crystalline structure as a result of the process of gelatinization, which involves the absorption of water and swelling. The degree of starch gelatinization in foods tends to rise with increased processing or cooking time, which may raise the glycemic response (Brand-Miller *et al.* 2009). The glycemic content of foods can also be impacted by the amount of other macronutrients like fat and protein. The digestion and absorption of glucose, for instance, can be slowed down when consumed with protein or fat, lowering the glycemic response (Nuttall *et al.* 1985).

### Grain shape and size

Rice and other grains' glycemic content can also be impacted by grain size and shape. The surface area to volume ratio, which impacts the rate of starch digestion and absorption in the body, can be influenced by the shape and size of the grains (Moon *et al.* 2011). For instance, smaller whole



grains often have a lower glycemic index (GI) than bigger grains with a higher surface area-to-volume ratio, such as broken rice grains. This is because smaller grains may absorb and digest starch more quickly due to their increased proportion of exposed surface area (Shah *et al.* 2015). The grains' glycemic response can also be impacted by their form. Long-grain rice varieties often have a lower GI than short-grain variants, according to studies. The difference between the two types of grains' amylose to amylopectin ratios is assumed to be the cause of this. Amylose, which is less digestible and causes a delayed release of glucose into the bloodstream, tends to be more prevalent in long-grain rice varieties (Calingacion *et al.* 2014). Other elements, such the technique used to prepare the grains, can also affect how they react glycemicly. Parboiled rice, for instance, which is partially cooked and dried before milling, has a lower GI than white rice because the starch becomes more resistant to digestion during the parboiling process (Mattei *et al.* 2015).

### Processing methods

The physical and chemical characteristics of the grains can be changed during processing, which can have an impact on how quickly the body absorbs and digests starches. For instance, milling eliminates the grain's germ and outer bran layer, which are both high in fibre and other nutrients. As a result, white rice has a higher glycemic index (GI) than brown rice, which still has the bran layer and germ. Additionally, resistant starch, a kind of starch that resists digestion and may have a lower GI, may be lost during milling (Kandylis *et al.* 2020). Cooking is another processing technique that has an impact on the glycemic response. The starch in the grains is more easily broken down and absorbed when they are overcooked, which can result in a higher GI. On the other hand, undercooking can result in a lower GI because the starch is still less easily digested. The GI can also be influenced by cooking techniques like steaming or boiling, with steaming having a lower GI than boiling (Brouns *et al.* 2005). Another processing technique that may impact rice's glycemic response is parboiling. Prior to grinding, the rice grains must be parboiled, which entails only a small amount of cooking. The starch granules get gelatinized as a result of this process, increasing

their resistance to digestion and lowering their GI in comparison to white rice (Wu *et al.* 2020).

The glycemic profile of rice and other grains can be significantly influenced by processing techniques as milling, heating, and parboiling. Understanding these variables can aid in the development of methods for the production of grains with reduced glycemic responses, which can have significant effects on the prevention and treatment of chronic illnesses like diabetes.

### Environmental factors

The growth and development of the grains can be impacted by elements like climate, soil quality, and water availability, which can then have an impact on their starch content and glycemic response. Temperature is one environmental component that has been demonstrated to affect the glycemic response of rice. According to research by Umemoto *et al.* (2008), high-temperature stress during the grain-filling stage has been shown to increase the quantity of quickly digested starch in the grains, raising their glycemic index (GI). Water availability during the grain-filling stage can also have an impact on the rice's glycemic response and starch content. A higher GI has been observed under conditions of water scarcity, whereas a lower GI has been observed under well-watered conditions (Wei *et al.* 2021).

The glycemic response of rice can also be influenced by the soil's characteristics. It has been discovered that nitrogen fertiliser application increases the percentage of amylose, a form of starch that is more difficult to digest, in the grains. Lower GI may arise from this. The growth and development of the grains can be impacted by additional soil parameters such soil pH and nutrient availability, which can then have an impact on the starch composition and glycemic response of the grains. Other environmental elements, such as light intensity and carbon dioxide content, can also have an impact on the glycemic response of rice in addition to climate and soil conditions. Understanding the intricate relationships between these environmental elements and rice's glycemic response can aid in the development of methods for producing grains with lower glycemic reactions, which can have significant effects on the prevention and treatment of chronic diseases like diabetes.

## BREEDING FOR LOW GLYCEMIC INDEX RICE

### Traditional breeding methods

Research is currently concentrating on breeding low glycemic index rice cultivars to lessen the harmful health effects of high glycemic index rice consumption. It has proven possible to create rice cultivars with better glycemic response by using traditional breeding techniques.

One of the traditional breeding methods used is phenotypic selection. This involves selecting rice plants with desired traits based on their physical appearance and performance. For example, selecting plants with higher amylose content, a type of starch that is more resistant to digestion, can result in rice with a lower glycemic index (GI) (Juliano and Perez, 1984; Shashidhara *et al.* 2013 and Shashidhara *et al.* 2017). Crossbreeding is an additional conventional breeding strategy. To produce a new cultivar with enhanced features, two separate rice cultivars with desirable traits are crossed. For example, breeding rice cultivars with various amylose contents together can produce offspring with intermediate amylose levels and less glycemic reactions (Kennedy *et al.*, 2003; Ashwini Samak *et al.* 2011a; Shashidhara and Shailaja Hittalmani., 2019a). Low glycemic index rice cultivars have been successfully created using traditional breeding techniques. These techniques, meanwhile, can be time-consuming and call for screening numerous plants. More recently, low glycemic index rice cultivars have been created with improved accuracy and efficiency using genetic engineering techniques like genome editing.

### Molecular breeding approaches

These methods make use of genetic engineering methods like CRISPR/Cas9, RNA interference, and genome editing. Genome editing entails employing designed nucleases to make precise alterations to a plant's DNA sequence. In order to lower the glycemic index of rice, this method has been utilized to change genes involved in starch production (Chen *et al.* 2022). Small RNA molecules are used in RNA interference to block the expression of particular genes. In order to lower the glycemic index of rice, this strategy has been employed to suppress the expression of genes involved in

starch production (Butardo *et al.* 2011; Shashidhara and Shailaja Hittalmani., 2019c). With the help of the potent genome editing technology CRISPR/Cas9, particular mutations in rice genes involved in starch synthesis have been introduced, leading to rice cultivars with reduced glycemic indices. In comparison to conventional breeding techniques, molecular breeding techniques have the ability to produce low glycemic index rice cultivars with improved accuracy and efficiency (Ashwini Samak *et al.* 2011b). The safety and legal problems related to genetically modified organisms are nonetheless also brought up by these strategies.

### Genomics-assisted breeding

Using this method, low glycemic index rice cultivars with better nutritional content have been created. Researchers have employed genome-wide association studies (GWAS) to pinpoint the genetic causes of rice's low glycemic index. A GWAS was carried out on a panel of 93 different rice accessions in a study by Pariasca-Tanaka *et al.* (2015), and numerous genes were discovered that are connected to low glycemic index. These genes included the alpha-glucan phosphorylases OsAGPL2, OsAGPL3, and OsAGPL5, which are necessary for the manufacture of starch. The creation of low glycemic index rice cultivars with better nutritional content could be sped up using genomics-assisted breeding (Kavurikalpana *et al.* 2018b). This approach can be used to identify and select plants with desirable traits at an early stage, thus reducing the time and cost associated with traditional breeding methods.

### Marker-assisted selection

In order to improve a variety of features, including low glycemic index, rice breeding programmes have used the potent method known as marker-assisted selection (MAS). In order to select plants with desirable features more effectively and precisely, MAS uses molecular markers connected to a particular trait.

In a study by Rabbi *et al.* (2020), rice cultivars with low glycemic index were created using MAS. The amylose concentration, which is inversely correlated with glycemic index, is controlled by genes, and the researchers used molecular markers linked to these genes. They chose plants with high levels



of resistant starch and low levels of amylose, which decrease the release of glucose and lower the glycemic index. Comparing the new cultivars to their original parent cultivars, they displayed a much lower glycemic index. Similar to this, Song and Li (2021) utilised MAS to create low glycemic index rice cultivars by choosing plants that have particular molecular markers connected to genes that regulate the production and breakdown of starch. Comparing the new cultivars to their original parent cultivars, they displayed a much lower glycemic index.

Rice breeding programs can benefit from using MAS to create cultivars with reduced glycemic index and better nutritional value. This strategy enables the early selection of plants with desirable qualities while cutting down on the time and expense involved with conventional breeding techniques.

### Transgenic approaches

Rice cultivars with low glycemic index have been created using transgenic techniques by adding genes related to starch metabolism. By increasing the amount of resistant starch and lowering the amount of quickly digested starch (RDS), it has been demonstrated that the introduction of the gene for the enzyme sucrose synthase (SuS) in rice reduces the glycemic index of rice (Hirose *et al.* 2008). Similar to this, it has been demonstrated that the insertion of the granule-bound starch synthase (GBSS) gene in rice increases the amylose content and lowers the glycemic index of rice (Fujita *et al.* 2006). By adding genes involved in starch branching and breakdown, this method has also been utilized to create rice cultivars with a lower glycemic index (Zao *et al.* 2020).

However, due to worries about potential adverse effects on human health and the environment, the use of transgenic methods in rice breeding programs for low glycemic index rice cultivars is still up for dispute. Therefore, additional study is required to evaluate the efficacy and safety of these techniques.

## GENETIC BASIS OF GLYCEMIC INDEX IN RICE

With the identification of genes and quantitative trait loci (QTLs) linked to low glycemic index, as well as the mechanisms behind this attribute, the genetic basis of glycemic index in rice has been

thoroughly explored.

### Identification of genes and quantitative trait loci

One of the key elements in enhancing the quality characteristics of rice varieties is starch biosynthesis, which is regulated by a network of different genes and gene combinations. However, the regulation of this complicated metabolic pathway is little understood. ADP-glucose pyrophosphorylase (AGPase), granule bound starch synthase (GBSS), starch synthase (SS), branching enzyme (BE), debranching enzyme (DBE), starch phosphorylase (PHO), and glucose 6-phosphate translocator (GPT) are among the genes and QTLs that have been linked to low glycemic index in rice. The waxy gene (GBSSI), which is essential for the production of long-chain amylopectin and amylose biosynthesis, and starch synthase IIa (SSIIa), which alters the structure of amylopectin and enhances grain quality, both provide significant contributions to the reduction of the glycemic index. Any structural changes within these genes will affect the rice grain quality parameters.

### Mechanisms underlying low glycemic index

The control of starch production and breakdown is one of the mechanisms generating low glycemic index in rice. For instance, increasing the amylose content and lowering the glycemic index of rice can be accomplished by overexpressing genes involved in starch syntheses, such as SBEIIb and GBSSI (Fujita *et al.* 2006; Zao *et al.* 2020). On the other side, rice's glycemic index can be lowered by downregulating starch breakdown genes such -amylase.

### Genome-wide association studies

Genetic variations linked to low glycemic index in rice have also been found by genome-wide association studies (GWAS). For instance, GWAS research on 179 rice accessions found numerous SNP markers close to the SBEIIa and Wx genes that were linked with a glycemic index (Zao *et al.*, 2020; Kavurikalpana *et al.* 2018a).

## TECHNIQUES FOR MEASURING GLYCEMIC INDEX IN RICE

The glycemic index assesses how rapidly food's carbohydrates are converted to glucose and

absorbed into the bloodstream, raising blood sugar levels. Understanding rice's effect on human health is crucial, especially for those who have diabetes or are at risk of developing it.

### ***In vitro* methods**

The GI of rice is frequently measured using *in vitro* techniques. The glucose release assay is one such technique, which entails soaking a sample of rice in digestive enzymes and monitoring the amount of glucose released into the solution over time. The starch hydrolysis assay is another technique for calculating the rate of *in vitro* starch hydrolysis. New *in vitro* techniques for determining the glycemic index of rice have been developed and validated recently, according to studies. For instance, a study by Edwards *et al.* (2019) created a microscale technique that employs a small quantity of rice samples and yields outcomes that are well associated with the conventional glucose release assay. Another study by Wang *et al.* (2022) evaluated the efficacy of a novel *in vitro* model that simulates human digestion and found that it accurately predicts the glycemic response of rice in humans.

### ***In vivo* methods**

Since they evaluate actual blood glucose levels in human participants after consuming the rice, *in vivo* methods are regarded as the gold standard for calculating the glycemic index (GI) of rice. The effects of rice on blood glucose levels in humans are better reflected by *in vivo* approaches, which also account for individual variations in digestion and metabolism.

The conventional oral glucose tolerance test (OGTT), which involves giving subjects a set quantity of glucose and monitoring their blood glucose levels over time, is the most widely used *in vivo* technique for determining GI in rice. Then, after consuming a test food—in this case, rice—participants' blood glucose levels are checked and the glucose response is compared. This makes it possible to determine the test food's GI. Stable isotope tracers and continuous glucose monitoring systems (CGMS) are two more *in vivo* techniques for assessing GI in rice. A tiny sensor is inserted beneath the skin as part of CGMS to track blood glucose levels over time following rice eating. While tracing the metabolism of glucose

in the body after eating rice, stable isotope tracers use isotopically labeled glucose.

The GI of rice can be measured more precisely using *in vivo* techniques, but they are also more expensive and time-consuming than *in vitro* techniques. Additionally, they demand the use of human subjects, which can raise ethical issues and restrict the size of the sample. Overall, considerations like cost, time, and resource availability influence the method chosen to determine the GI of rice. The production of low GI rice cultivars through breeding programs has been made possible by improvements in both *in vitro* and *in vivo* approaches brought about by technological and methodological advancements. Rice's GI has recently been measured and the impact of processing and genetic variables assessed using both *in vitro* and *in vivo* approaches. For example, a study by Jukanti *et al.* (2020) used both *in vitro* and *in vivo* methods to measure the GI of brown and white rice and evaluate the effect of milling and cooking methods on GI. According to the study, brown rice has a lower GI than white rice, and the GI can be further decreased by utilizing specific cooking techniques.

### **Human intervention studies**

Studies including human intervention are carried out to ascertain how humans react glycemicly to a particular diet, such as rice. In these trials, a group of individuals is given a specific amount of the food, and for a set amount of time, usually two to three hours, their blood glucose levels are evaluated at regular intervals. The area under the blood glucose response curve for the food item, in comparison to the response curve for a standard reference food, usually glucose or white bread, is then used to compute the glycemic index (GI).

Continuous glucose monitoring (CGM) devices have recently been used in various studies to test the glycemic response to rice and other foods in real-time. Since CGM systems may record variations in blood glucose levels throughout the day, including postprandial spikes and troughs, they can give a more precise and thorough picture of the glycemic reaction to a food item. The use of CGM devices to calculate the glycemic index of foods is still in its infancy, and additional study is required to confirm the precision and dependability of these gadgets.



The fact that human intervention studies are frequently carried out on healthy subjects has the drawback that people with type 2 diabetes and other metabolic illnesses may have a different glycemic response to rice and other meals. Therefore, it is crucial to carry out studies on these populations to ascertain how these people react glycemicly to rice and other diets.

## NUTRITIONAL AND HEALTH BENEFITS OF LOW GLYCEMIC INDEX RICE

Among the many nutritional and physiological advantages of low glycemic index rice are its effects on blood sugar regulation, diabetes management, weight management, and cardiovascular health.

People with type 2 diabetes have been proven to have better blood glucose control after consuming low glycemic index rice. According to a study by Chen *et al.* (2018), type 2 diabetics' glycemic control was dramatically improved when high glycemic index rice was replaced with low glycemic index rice. In a comparable manner, Nanri *et al.* (2010) observed in a randomized controlled experiment that people with impaired glucose tolerance who consumed low glycemic index rice had better glycemic control than those who consumed high glycemic index rice. Rice with a low glycemic index can help with weight control as well. According to a study by Hashimoto *et al.* (2022), eating low-GI rice reduced postprandial glucose and insulin responses, which may help curb appetite and promote weight loss. Additionally, rice with a low glycemic index has been linked to better cardiovascular health. According to Sacks *et al.*'s (2014) meta-analysis, eating foods with a low glycemic index, such as rice, was linked to a lower risk of cardiovascular disease.

## BEST VARIETIES OF RICE SUITABLE FOR DIABETIC PEOPLE

Numerous traditional rice varieties are farmed and eaten across virtually the whole nation of India. From the Chakra Samhita era, or between 400 and 700 BC, local rice types were cultivated for their therapeutic properties. When compared to hybrid rice variants, traditional rice cultivars are more nutritious. They have greater fiber content and are an excellent source of vitamins and minerals like niacin, thiamine, magnesium, riboflavin, vitamin

D, and calcium. These cultivars also reduce the glycemic and insulin response, which has a number of positive health effects like lowering the risk of type II diabetes, obesity, and cardiovascular diseases.

Black Kavuni rice from Tamil Nadu, Navara rice from Kerala, Rajamudi rice from Karnataka, Maapillai Samba rice from Tamil Nadu, KattuYanam rice from Tamil Nadu, and Kichili samba rice from Tamilnadu are some of the indigenous rice types of South India that are utilized in the management of diabetes. Rajamudi naan Karnataka is fortunate to have a diverse history of rice types. Red rice called Rajamudi is a native of Mysore, Karnataka. According to legend, the king would urge farmers who were unable to pay their taxes to give him some of this Rajamudi rice in their place, giving rise to the name Rajamudi. This rice type was well-known in antiquity, but it was pushed out of existence by the development and popularity of white rice. When compared to polished white rice, it offers better nutritional fibre and is packed with zinc and antioxidants. The body is protected from free radicals by antioxidants. Enhancing immunity and accelerating recovery and healing are two benefits of zinc. It was suitable for diabetics because it has a low glycemic index.

**Table 1:** Some popular varieties with low GI

Varieties	Glycemic Index (GI)
Sampada	51.17
Telangana Sona (RNR 15048)	51.72
Lalat	53.17
Chhattisgarh Madhuraj paddy-55 (CGMP-55)	<55
Savitri	68.85

There are thousands of different rice germplasms, landraces, and varieties accessible in both India and other countries. Due to the popularity of rice in South and Southeast Asia, numerous research organizations began dividing the cereal into three categories: low (GI 55), medium (GI 56–69), and high (GI 70). Sampada (51.7), Lalat (53.17), RNR-15048 (51.72), and Chhattisgarh Madhuraj Paddy (54) are some of the very popular varieties that are exclusively released from agricultural institutes for the consumption of diabetic and obese population



**Fig. 1:** (A) Black Kavuni rice of Tamil Nadu, (B) Navara rice of Kerala, (C) Rajamudi rice of Karnataka, (D) Maapillai Samba rice, (E) KattuYanam rice, (F) Kichili samba rice

based on the glycemic response of several tested varieties (Jayedi *et al.* 2022).

## CHALLENGES AND FUTURE PROSPECTS

Making transgenic rice with a low glycemic index safe and effective for ingestion is one of the main problems. In order to thoroughly assess the long-term impacts of genetically modified crops, including rice, on human health and the environment, further research is still required (Romero-Luna, 2022). Studies have been done to determine the safety of genetically modified crops, including rice. Gaining consumer acceptance of transgenic rice is another difficulty. Consumers may be concerned about the safety, possible health impacts, and moral implications of genetically modified crops, according to studies (Gaskell *et al.* 2013).

The creation of rice cultivars with low glycemic index raises further legal issues. Large businesses frequently have control over the creation and marketing of genetically modified crops, which can restrict small farmers' access to these technologies and diminish their advantages. Finally, it's critical to take into account how low glycemic index rice might be used in conjunction with sustainable agricultural methods. This involves fostering biodiversity in rice fields, reducing the use of poisonous fertilisers and pesticides, and creating rice cultivars that are resistant to climate change (Cassman *et al.* 2019).

## CONCLUSION

In order to mitigate the harmful effects of consuming high glycemic index rice on one's health, research is heavily focused on creating better low glycemic index rice cultivars. Rice's glycemic profile is influenced by a number of elements, including grain size and shape, processing techniques, environmental conditions, and starch composition. To create low glycemic index rice cultivars, traditional breeding techniques, molecular breeding strategies, and genomics-assisted breeding are all being used. *In vitro*, *in vivo*, and human intervention studies are all techniques for calculating rice's glycemic index. Among the many nutritional and physiological advantages of low glycemic index rice are its effects on blood sugar regulation, diabetes management, weight management, and cardiovascular health. However, challenges such as the effectiveness and safety of transgenic approaches, consumer acceptance, intellectual property rights, and integration with sustainable agriculture must be addressed in future research.

Future research should concentrate on creating low glycemic index rice breeding techniques that are both more productive and sustainable. Additionally, while resolving the aforementioned issues, research should attempt to improve the nutritional and health advantages of low glycemic index rice. Studies should also concentrate on creating fresh methods for calculating rice's glycemic index in order to get accurate and trustworthy results. We



can create superior rice cultivars that support health and wellbeing by addressing these issues and concentrating on the future.

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