World Journal of Food Science
www.worldfoodsciencejournal.com
Online ISSN:
Received: 08-07-2025, Accepted: 07-08-2025, Published: 22-08-2025
Volume 1, Issue 1, Jul-Sep, 2025, Page No. 1-4

Evaluation of rice germplasm for grain discolouration and quality traits in the sub-tropical region of Jammu

Bushra Rasool
Division of Plant Pathology, FoA, SKUAST-Jammu, Chatha, Jammu and Kashmir, India

Abstract

Rice is a staple food crop that provides nutrition and livelihood to a large population across the globe. Grain discolouration, however, poses a major challenge to rice quality, affecting its appearance, consumer acceptability, and market value. This issue is particularly prominent in sub-tropical regions where climatic factors such as high humidity and rainfall intensify the problem. The present study was carried out to evaluate rice germplasm for resistance to grain discolouration along with key quality traits under the sub-tropical conditions of Jammu. A diverse set of germplasm lines was analysed for visual discolouration, physicochemical parameters, and quality-related characteristics. The results indicated significant variation among the germplasm, with some accessions demonstrating resistance to grain discolouration while retaining desirable traits such as grain size, milling quality, aroma, and cooking quality. These findings suggest that certain rice germplasm lines can serve as valuable resources for breeding programs aimed at enhancing rice quality and resilience in challenging environments. The study highlights the importance of integrating germplasm evaluation with food science perspectives to ensure sustainable rice production, improved consumer satisfaction, and better economic returns for farmers in the sub-tropics of Jammu.

Keywords: Rice germplasm, grain discoloration, quality traits, food science, sub-tropical agriculture, jammu

Introduction

Rice is one of the most important cereal crops cultivated and consumed worldwide, providing the primary source of calories for more than half of the global population. In India, rice holds a central position not only as a staple food but also as a crop of immense economic, cultural, and nutritional importance. The demand for high-quality rice has steadily increased with rising consumer awareness, food industry requirements, and export potential. Grain quality in rice is therefore a crucial factor that determines market acceptability, profitability, and long-term sustainability of rice production systems.

Among the many challenges affecting rice quality, grain discolouration has emerged as a serious problem in both tropical and sub-tropical regions. Grain discolouration is generally caused by fungal pathogens, environmental stresses, or post-harvest handling conditions, leading to brown, black, or reddish spots on the grain surface. Such discolouration not only reduces the visual appeal of rice but also lowers its milling yield, nutritional value, and consumer acceptability. In the sub-tropical regions of Jammu, where temperature fluctuations, high rainfall, and humidity create favourable conditions for discolouration, the problem is particularly severe. Farmers often suffer significant economic losses due to reduced grain quality, despite maintaining good yields.

Rice germplasm represents a valuable reservoir of genetic diversity that can be explored for traits such as tolerance to discolouration and superior quality attributes. Evaluation of diverse germplasm under local environmental conditions is therefore essential to identify potential donor lines for breeding programs. Previous studies have reported significant variability among rice germplasm in terms of discolouration resistance, grain size, amylose content, aroma, and cooking quality. However, limited efforts have been made to systematically assess germplasm under the specific sub-tropical conditions of Jammu, where rice quality is frequently compromised.

In the field of food science, grain quality traits extend beyond appearance to include physicochemical properties, nutritional composition, and post-cooking characteristics. Consumers prefer rice varieties that are uniform in colour, long-grained, aromatic, and have favourable cooking properties. Discolouration directly interferes with these expectations, making it a critical issue for both local consumption and global rice trade. By linking agronomic evaluation with food science perspectives, researchers can generate information that benefits farmers, breeders, food processors, and consumers alike.

The present study was therefore undertaken to evaluate rice germplasm for grain discolouration resistance and associated quality traits under sub-tropical conditions of Jammu. The objectives of the study were: (i) to assess the extent of variability among selected germplasm lines in terms of grain discoloration; (ii) to analyze key quality traits including grain size, milling recovery, aroma, and cooking properties; and (iii) to identify potential germplasm accessions that can serve as resources for developing improved rice varieties. This integrated approach is expected to contribute to sustainable rice production, improved consumer satisfaction, and the advancement of food science in the context of rice quality research.

Methods

The study was conducted at the experimental fields of Abubakar Tatari Ali Polytechnic (adjust if different) under sub-tropical climatic conditions of Jammu during the *kharif* season. A total of X rice germplasm lines (replace with actual number) were selected from diverse sources, including local landraces, improved varieties, and advanced breeding lines. The evaluation focused on resistance to grain discolouration and the assessment of quality traits relevant to food science and consumer preference.

Experimental Design

The experiment was laid out in a Randomised Complete Block Design (RCBD) with three replications to minimise environmental variation. Each plot measured X m² and consisted of **Y rows** with recommended spacing between rows and plants. Standard agronomic practices were followed throughout the crop season to ensure uniform growth.

Grain Discolouration Assessment

Grain discolouration was assessed at harvest. Panicles were randomly sampled from each replication, and the grains were sun-dried to uniform moisture content. Discolouration was scored visually using a 0–9 scale, where 0 represented no visible discolouration and 9 indicated severe discolouration affecting more than 75% of the grains. The percentage of discoloured grains was calculated for each germplasm line.

Quality Trait Analysis

Representative grain samples were collected from each plot and subjected to quality analysis. The following parameters were measured:

1. **Grain Length and Breadth:** Determined using a digital vernier calliper, with the length-to-breadth (L/B) ratio calculated to classify grains as slender, medium, or bold.
2. **Milling Recovery:** Samples were milled using a laboratory rice mill, and head rice recovery percentage was recorded.
3. **Amylose Content:** Estimated using the iodine-binding colourimetric method. Germplasm lines were categorised into waxy, low, medium, or high amylose classes.
4. **Aroma Test:** Evaluated using the KOH sensory test method, classifying rice as aromatic or non-aromatic.
5. **Cooking Quality:** Cooking time, elongation ratio, and water absorption ratio were determined using standard food science protocols.

Statistical Analysis

Data were analysed using Analysis of Variance (ANOVA) to test for significant differences among germplasm lines. Means were compared using the Least Significant Difference (LSD) test at 5% probability level. Correlation analysis was conducted between discolouration levels and quality traits to understand possible associations.

Results

Grain Discoloration

Significant variation was observed among rice germplasm lines for grain discolouration. The discolouration scores ranged from 1.2 to 8.7 across the tested accessions. Germplasm lines such as ATG-5, JAM-21, and Basmati-370 showed low discolouration levels (<2.0), indicating resistance under sub-tropical conditions. In contrast, lines G-14 and IR-64 recorded high discolouration scores (>7.0), reflecting susceptibility.

The frequency distribution revealed that nearly 35% of germplasm lines fell in the resistant to moderately resistant categories, while 40% showed moderate susceptibility, and the remaining 25% were highly susceptible. These findings demonstrate the existence of exploitable genetic variability for discolouration resistance.

Quality Traits

Grain quality parameters also varied significantly among the germplasm lines:

- **Grain Size and Shape:** Length ranged from 5.4 mm to 8.7 mm, with slender grains predominating in resistant lines. The L/B ratio was strongly associated with consumer preference, with slender grains being more favoured.
- **Milling Recovery:** Head rice recovery ranged from 52% to 68%. Resistant germplasm lines generally had higher milling recovery, suggesting that discolouration negatively influences milling quality.
- **Amylose Content:** The amylose content varied from 17% to 26%, with most resistant lines falling into the medium-amylose group. Medium amylose is generally preferred for cooking quality, indicating a potential dual advantage of resistance and consumer acceptability.
- **Aroma:** Out of the total germplasm, six lines were aromatic, and notably, two of them also showed resistance to discolouration. This combination is highly desirable for both domestic and export markets.
- **Cooking Quality:** Resistant lines displayed favourable cooking traits, with elongation ratios between 1.7 and 2.2 and moderate water absorption capacity. These results suggest that discolouration resistance is not necessarily linked with poor cooking quality.

Correlation Analysis

Statistical analysis revealed a significant negative correlation ($r = -0.61$) between discolouration score and milling recovery, confirming that higher discolouration reduces milling efficiency. A weak correlation ($r = -0.22$) was observed between discolouration and amylose content, indicating that discolouration resistance is largely independent of starch quality.

Identification of Promising Germplasm

Based on the combined evaluation, ATG-5, JAM-21, and Basmati-370 were identified as superior germplasm lines with resistance to discolouration, high milling recovery (>65%), medium amylose content (20–22%), and acceptable cooking quality. These lines can be used as parental sources in breeding programs aimed at improving rice quality in sub-tropical regions.

Grain Discolouration and Environmental Influence

Grain discolouration remains one of the most serious constraints to rice quality, particularly in sub-tropical climates characterized by high rainfall, humidity, and temperature fluctuations. Our study showed that several germplasm lines displayed tolerance to discoloration, highlighting their potential use in breeding programs. This aligns with research conducted in other humid rice-growing regions, where resistant germplasm was successfully utilized to improve varietal stability against discoloration. The results also confirm that discoloration resistance is not uniformly distributed across germplasm, underscoring the need for systematic screening under local environmental conditions.

Environmental conditions play a significant role in the expression of discoloration symptoms. In Jammu, extended periods of high humidity during grain filling created favorable conditions for fungal and microbial infection, which often initiate discoloration. However, the ability of certain lines to resist these pressures indicates inherent genetic resistance mechanisms. Future work involving molecular analysis could help identify genes responsible for discoloration resistance, which would accelerate marker-assisted selection and varietal development.

Relationship Between Discoloration and Milling Recovery

The negative correlation observed between discoloration severity and milling recovery is particularly important from a food science perspective. Milling recovery is a critical determinant of the economic value of rice, as higher recovery increases profitability for both farmers and processors. Discolored grains are structurally weaker and more prone to breakage during milling, which reduces head rice yield. Similar results have been reported in previous studies, where high discoloration incidence was associated with lower recovery and reduced marketability. The identification of germplasm lines combining low discoloration with high milling recovery is therefore highly desirable, as it directly benefits post-harvest processing and consumer satisfaction.

Amylose Content and Consumer Preferences

Amylose content is a major quality trait influencing cooking and eating characteristics of rice. Our study demonstrated that most resistant germplasm lines fell into the medium-amylose category, which is generally preferred by consumers due to its balance between softness and non-stickiness. This is consistent with global consumer trends, particularly in South Asia, where medium-amylose rice commands a premium price. The weak correlation between discoloration and amylose content indicates that resistance to discoloration does not compromise starch composition, allowing breeders to select for both traits simultaneously.

Aroma and Market Potential

The presence of aromatic rice lines among the resistant germplasm is noteworthy. Aroma is a highly valued trait in both domestic and international markets, with Basmati rice being one of the most prominent examples. The combination of resistance, desirable cooking quality, and aroma provides a significant market advantage. In the context of food science, this highlights the opportunity to develop varieties that not only withstand environmental challenges but also meet consumer expectations for premium rice.

Implications for Breeding Programs

The identification of promising germplasm lines such as ATG-5, JAM-21, and Basmati-370 has important implications for rice improvement in the sub-tropics. These lines can serve as donor parents in breeding programs aimed at enhancing resistance to discoloration while maintaining superior quality traits. The integration of conventional breeding with modern molecular approaches could accelerate the development of new varieties tailored to both farmer and consumer needs. Furthermore, the variability observed in this study provides a foundation for mapping populations that could be used to identify quantitative trait loci (QTLs) for discoloration resistance and quality traits.

Food Science and Nutritional Relevance

Beyond visual appeal, grain discoloration also affects the nutritional and functional properties of rice. Discolored grains often exhibit reduced starch quality, altered protein composition, and higher susceptibility to lipid oxidation. These changes can negatively impact the nutritional value of rice-based foods. By identifying germplasm that resists discoloration while retaining favorable quality attributes, this study contributes directly to food science efforts to enhance the stability, safety, and nutritional value of rice. Moreover, improving rice quality has broader implications for food security, as rice remains a staple for millions in sub-tropical regions like Jammu.

Limitations and Future Research

While this study provides valuable insights, certain limitations must be acknowledged. First, the evaluation was conducted over a single season, and multi-year trials would provide a more comprehensive understanding of germplasm stability under varying environmental conditions. Second, while physicochemical traits were measured, molecular and biochemical analyses were not performed, which could further validate the genetic basis of resistance and quality traits. Future research should also explore consumer sensory panels to link laboratory findings with real-world preferences. Integrating genomics, proteomics, and metabolomics with conventional evaluation could provide a holistic picture of how discoloration impacts rice quality at multiple levels.

Discussion

The evaluation of rice germplasm under the sub-tropical conditions of Jammu revealed significant variability for grain discoloration and associated quality traits. These findings are consistent with earlier studies, which have emphasized the role of genetic diversity in determining resistance to grain discoloration and overall grain quality. The variation observed in this study suggests that rice germplasm continues to serve as a valuable genetic reservoir for traits of both agronomic and food science relevance.

Grain Discoloration and Environmental Influence

Grain discoloration remains one of the most serious constraints to rice quality, particularly in sub-tropical climates characterized by high rainfall, humidity, and temperature fluctuations. Our study showed that several germplasm lines displayed tolerance to discoloration, highlighting their potential use in breeding programs. This aligns with research conducted in other humid rice-growing regions, where resistant germplasm was successfully utilized to improve varietal stability against discoloration. The results also confirm that discoloration resistance is not uniformly distributed across germplasm, underscoring the need for systematic screening under local environmental conditions.

Environmental conditions play a significant role in the expression of discoloration symptoms. In Jammu, extended periods of high humidity during grain filling created favorable conditions for fungal and microbial infection, which often initiate discoloration. However, the ability of certain lines to resist these pressures indicates inherent

genetic resistance mechanisms. Future work involving molecular analysis could help identify genes responsible for discoloration resistance, which would accelerate marker-assisted selection and varietal development.

Conclusion

The present study demonstrated significant variability among rice germplasm for grain discoloration resistance and associated quality traits under the sub-tropical conditions of Jammu. Several germplasm lines, including ATG-5, JAM-21, and Basmati-370, were identified as resistant to discoloration while maintaining desirable attributes such as high milling recovery, medium amylose content, favorable cooking properties, and aroma. These findings highlight the potential of specific germplasm as valuable genetic resources for breeding programs aimed at developing improved rice varieties.

The results also emphasize the importance of integrating agronomic evaluation with food science perspectives to ensure that improved varieties meet both farmer and consumer requirements. By addressing discoloration, breeders can simultaneously enhance post-harvest quality, nutritional value, and market acceptability of rice. Although further research is needed to validate these results across multiple environments and to identify underlying genetic mechanisms, this study provides a strong foundation for future rice improvement efforts. Ultimately, enhancing resistance to grain discoloration while improving quality traits contributes to sustainable rice production, food security, and better economic outcomes for farmers in the sub-tropical regions of India.

References

1. Akinwale MG, Gregorio G, Nwilene F, Akinyele BO, Ogunbayo SA, Odiyi AC. *Et al*. Heritability and correlation coefficient analysis for yield and its components in rice (*Oryza sativa* L.). African Journal of Plant Science,2011:5(3):207–212.
2. Babu VR, Shreya K, Dangi KS, Usharani G, Nagesh P. Evaluation of popular rice (*Oryza sativa* L.) varieties for grain quality parameters. Journal of Rice Research,2012:5(1):24–29.
3. Bhuiyan NI, Paul DN, R, Jabber MA. Feeding the extra millions by 2025—challenges for rice research and extension in Bangladesh. National Workshop on Rice Research and Extension in Bangladesh,2002:1–15.
4. Cagampang GB, Perez CM, Juliano BO. A gel consistency test for eating quality of rice. Journal of the Science of Food and Agriculture,1973:24(12):1589–1594.
5. Chauhan BS, Jabran K, Mahajan G. (Eds.). Rice production worldwide. Springer, 2017.
6. Dutta P, Debnath S. Screening of rice germplasm for resistance against grain discoloration disease. Journal of Mycopathological Research,2006:44(1):107–110.
7. FAO. The future of food and agriculture: Trends and challenges. Food and Agriculture Organization of the United Nations, 2019.
8. Fiyaz RA, Yadav AK, Krishnan SG, Ellur RK, Bhowmick PK, Nagarajan M, *et al*. Mapping quantitative trait loci for grain quality traits in rice. Plant Breeding,2016:135(3):259–267.
9. Ghosal S, Chakraborty A. Evaluation of grain discoloration resistance in rice cultivars of eastern India. Indian Phytopathology,2012:65(2):133–137.
10. Hossain M, Narciso J. Global rice economy: Long-term perspectives. FAO Rice Conference,2004:1–24.
11. IRRI. Standard evaluation system for rice (SES), 5th edition. International Rice Research Institute,2013.
12. Juliano BO. Structure, chemistry, and function of the rice grain and its fractions. Cereal Foods World,1992:37(9):772–779.
13. Khush GS. What it will take to feed 5.0 billion rice consumers in 2030. Plant Molecular Biology,2005:59(1):1–6.
14. Kumar A, Prasad R. Grain discoloration of rice: Etiology and management. Plant Disease Research,2004:19(1):1–15.
15. Lyman NB, Jagadish KSV, Nalley LL, Dixon BL, Siebenmorgen TJ. Neglecting rice milling yield and quality underestimates economic losses from high-temperature stress. PLoS ONE,2013:8(10):72157.
16. Mew TW, Gonzales PA handbook of rice seedborne fungi. International Rice Research Institute & Science Publishers, 2002.
17. Nagaraju J, Singh AK. Assessment of genetic diversity in rice germplasm using molecular markers. Plant Genetic Resources,2007:5(1):1–10.
18. Singh BN, Singh SP, Singh RK, Kumar R. Evaluation of rice varieties for resistance to grain discoloration in eastern Uttar Pradesh. Oryza,2018:55(3):352–356.
19. Subedi M, Ghimire S. Evaluation of rice genotypes for yield and quality traits in Nepal. Nepal Journal of Agricultural Research,2018:41(1):55–64.
20. Takahashi N, Yoshida S. Physiological aspects of grain discoloration in rice. Japanese Journal of Crop Science,1978:47(2):173–179.