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Application of Molecular Markers for Trait-Specific Breeding of Aroma Accumulation in Rice

Suvarna Rani Chimmili, K. Varadhan, Kanakachari Mogilicherla, P. Ranjith, K. Sruthi, V. Manasa, K. Basavaraj, Satyaswara Jasudasu Gomp, K. Suneetha, S.K. Mangrauthia, S.V. Sai Prasad, R.M. Sundaram and M. Srinivas Prasad

Abstract

The translation of genetic variation into breeding gain relies on an integrated and sequential pipeline comprising high-quality DNA extraction, precise locus amplification and sequencing, accurate variant discovery, conversion of polymorphisms into diagnostic markers, high-throughput genotyping, and systematic integration into crossing and selection programs. This chapter presents a comprehensive framework for the development and application of molecular markers for aroma improvement in rice, with broader relevance to yield and stress-resilience traits in *Oryza sativa*. Rice aroma, a premium grain quality trait influencing consumer preference and market value, is primarily associated with the accumulation of 2-acetyl-1-pyrroline (2-AP), which results from loss-of-function mutations in the BADH2 gene. Advances in molecular genetics have enabled the identification of functional polymorphisms within BADH2, facilitating the development of robust functional and linked markers that ensure high selection accuracy, codominant discrimination, and environmental stability for marker-assisted selection (MAS) and marker-assisted backcross breeding (MABB). The deployment of high-throughput SNP and KASP genotyping platforms further accelerates early-generation selection, rapid aroma introgression into elite cultivars, and gene pyramiding with other agronomic traits.

Keywords Aromatic rice, 2-AP, BADH2, Molecular markers, Trait-specific breeding

1 Introduction

Oryza sativa L. (rice) is the staple food for more than half of the global population, playing a central role in food security, cultural heritage, and agricultural economies, particularly in Asia [1]. Beyond yield and adaptability, grain quality traits have become decisive factors in varietal acceptance and market value [2, 3]. Among these traits, aroma is especially important, as it defines premium rice types such as Basmati and Jasmine, which command