Development of dry milling suitable rice cultivar to invigorate rice processing products

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Abstract

Rice consumption has been continuously decreasing as the eating habits of Koreans have become westernized and diversified. The per capita annual rice consumption in Korea has dropped sharply from 136.4 kg in 1970 to 61.9 kg in 2016. The Korean government, therefore, has been trying to promote rice consumption by invigorating the processed food industry using rice flour. To facilitate the market for processed rice foods, it is essential to develop proper milling technology in terms of flour particle size and damaged starch content to produce high quality rice flour at competitive cost. Dry milling and wet milling are the two major processes used to produce rice flour. Although the dry milling process is relatively simple with a lower production cost, damaged starch content increases because of the high grain hardness of rice. In wet milling, the quality of rice flour is improved by reducing flour particle size as well as damaged starch content through soaking procedures. However, the production costs are high because of the additional expenses associated with the disposal of waste water, sterilization and drying of the wet flour. Recently developed technologies such as jet milling and cryogenic milling also require expensive investment and production. Therefore, developing new rice cultivars with dry milling adaptability as well as good processing properties is an important goal of rice breeding in Korea. ‘Suweon 542’ is a floury endosperm mutant line derived from sodium azide treatment on a high-yield, early maturing, and non-glutinous japonica rice cultivar, ‘Namil’. Compared with the wild type, after dry milling process, the grain hardness of ‘Suweon 542’ was significantly lower because of its round and loosely packed starch granules. Also, the flour of ‘Suweon 542’ had significantly smaller particles and less damaged starch than ‘Namil’ and other rice cultivars and its particle size distribution was similar to a commercial wheat cultivar. Recently, through collaborations with nine universities and food companies, a total of 21 kinds of processed prototypes, using the dry milling flour of ‘Suweon 542’, were evaluated. In the production of major rice processing products, there was no significant quality difference between the flours prepared by wet milling and dry milling. Although the amount of water added to the dough was slightly increased, it was confirmed that the recipe applying the wet flour could be used without significant change. To efficiently transfer the floury endosperm characteristics of ‘Suweon 542’ to other commercial rice cultivars, it is essential to develop DNA marker tightly linked to the target gene. Association analysis using 70 genome-wide SSR markers and 94 F2 plants derived from ‘Suweon 542’/‘Milyang 23’ showed that markers on chromosome 5 explained a large portion of the variation in floury grains percentage (FGP). Further analysis with an increased number of SSR markers revealed that the floury endosperm of ‘Suweon 542’ was directed by a major recessive locus, flo7(t), located in the 19.33–19.86 Mbp region of chromosome 5, with RM18639 explaining 92.2% of FGP variation in the F2 population. Through further physical mapping, a co-segregate and co-dominant DNA marker with the locus, flo7(t) was successfully developed, by which, thereby, breeding efficiency of rice cultivars having proper dry milling adaptability with high yield potential or useful functional materials would be improved. ‘Suweon 542’ maintained the early maturity of the wild type, Namil, which can be used in rice-wheat double cropping systems in Korea not only for improved arable land but also for sharing flour production facilities. In addition to the high susceptibility against major rice diseases, nevertheless, another possible drawback of ‘Suweon 542’ is the high rate of viviparous under prolonged rainfall during the harvesting season. To overcome susceptibility and vivipary of ‘Suweon 542’, the progeny lines, derived from the crosses ‘Suweon 542’ and ‘Jopyeong’, an early maturing rice cultivar with multiple resistance against rice blast, bacterial blight, and rice strip virus, and ‘Heugjinju’, a anthocyanin pigment containing black rice cultivar, were intensively evaluated. As the outputs, three dry milling suitable rice elite lines, ‘Jeonju614’, ‘Jeonju615’, and ‘Jeonju616’ were developed.

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