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Dissection of candidate genes for grain texture in common wheat

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Motivation and Aim: Grain texture (grain hardness) is a key trait that influences the milling and baking quality of wheat. Previously, it was shown that the Ha locus on 5DS, containing the *puroindoline a*, *puroindoline b* and *GSP-1* genes, has a crucial role in endosperm texture. Although *puroindoline* genes are considered to be major determinants of common wheat grain texture, a number of studies have demonstrated the complex nature of the trait. However, no specific genes were proposed to be involved in grain hardness organization.

Methods and Algorithms: There were 92 varieties adapted to the environments of the Siberia region used in this study. We estimated two parameters for grain texture in two years: flour particle diameter (FPD, μm) and flour particle specific surface (FPSS, cm^2/g). SNP genotyping was performed using the Illumina Infinium 15 k Wheat platform by TraitGenetics GmbH. The population structure was analysed using the R-based STRUCTURE-like inference algorithm LEA. For association analysis, a mixed model approach implemented in the R package "GENESIS" was used. The resulting mixed linear model considered fixed effects of SNPs and population structure and random effects for kinship. To estimate the expression of genes in the detected loci, we used data of the common wheat cultivar Azhurnaya developmental time course.

Results: Analysis of the flour particle size and flour particle specific surface of wheat varieties cultivated in different environments demonstrated high heritability (0.79–0.8) and strong repeatability of the traits. The genotyping with gene-specific primers demonstrated that twenty-three varieties had allele *Pina-D1k*, which lacked both *Pina* and *Pinb* genes (double null allele).Association analysis with the use of SNP genotyping (Illumina 15 K Wheat) and 2-year phenotyping confirmed the key role played by *puroindoline* genes (5D) in determining the grain texture of Russian wheat varieties. The analysis also detected significant SNPs on the 1B, 3A, 5B, 6A, 6D, 7B, 7D chromosomes. The most promising were SNPs on chromosomes 5B and 7B. These MTAs demonstrated the highest significance after FDR correction. We dissected a number of candidate genes and proposed a possible mechanism for their contribution to endosperm texture determination. These genes are involved in the metabolism of galactolipids (DGDG) and carbohydrates (1,3-β-glucan).

Conclusion: Wheat grain texture is a complex trait. The crucial role of puroindoline genes in grain texture determination was confirmed. New loci, highly associated with the trait, were identified and dissected.

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