Genetic loci for grain protein and gluten content in Russian spring wheat varieties

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The nutritional value of wheat and the quality of flour are largely dependent on the grain protein content (GPC). The development of high-quality wheat varieties, identification of new genetic loci for GPC remains a main task for modern wheat breeding.

The aim of this study was analysis of composition of Russian spring bread wheat varieties on genetic loci controlling GPC and gluten content.

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Materials and Methods

The plant material included 95 varieties and breeding lines of spring bread wheat, created by eight breeding companies of the Russian Federation (Table). A panel of wheat varieties was phenotyped at the two localities of Western Siberian region during four years (2016 – 2019). Genotyping was carried out with the help of the Illumina Infinium 15 K array of TraitGenetics GmbH (www.traitgenetics.de), which included 13,007 SNP markers mapped in the wheat genome. Analysis of protein and gluten content was performed using an OmegaAnalizer G (Bruins Instruments, Germany). The varieties were genotyped with markers developed for alleles of high molecular weight glutenin loci (*Glu-A1*, *Glu-B1*, *Glu-D1*). For association analysis, a mixed model approach implemented in the TASSEL software was used.

Table. Number of wheat varieties used in this study

Originator	**Number of varieties**
Samarskii NIISKH	14
NIISKH Severnogo Zauralya	15
Sibirskii NIISKH	18
SibNIIRS	17
Kemerovskii NIISKH	10
Altaiskii NIIZIS	10
Krasnoyarskii NIISKH	11

Results

The GPC of the varieties varied from 12.9% to 17.5% while gluten content changed from 21.3% to 39.3% of the total protein content (figure 1). Heritability of the GPC and gluten was ~0.62, confirming that environment strongly influence the traits, however the genetic component was also high. Summarizing the results of the marker analysis, it was concluded that 27 of 95 varieties contain combinations of Ax2, Dx5 and Dy10 subunits positively effect on baking qualities (figure 2).

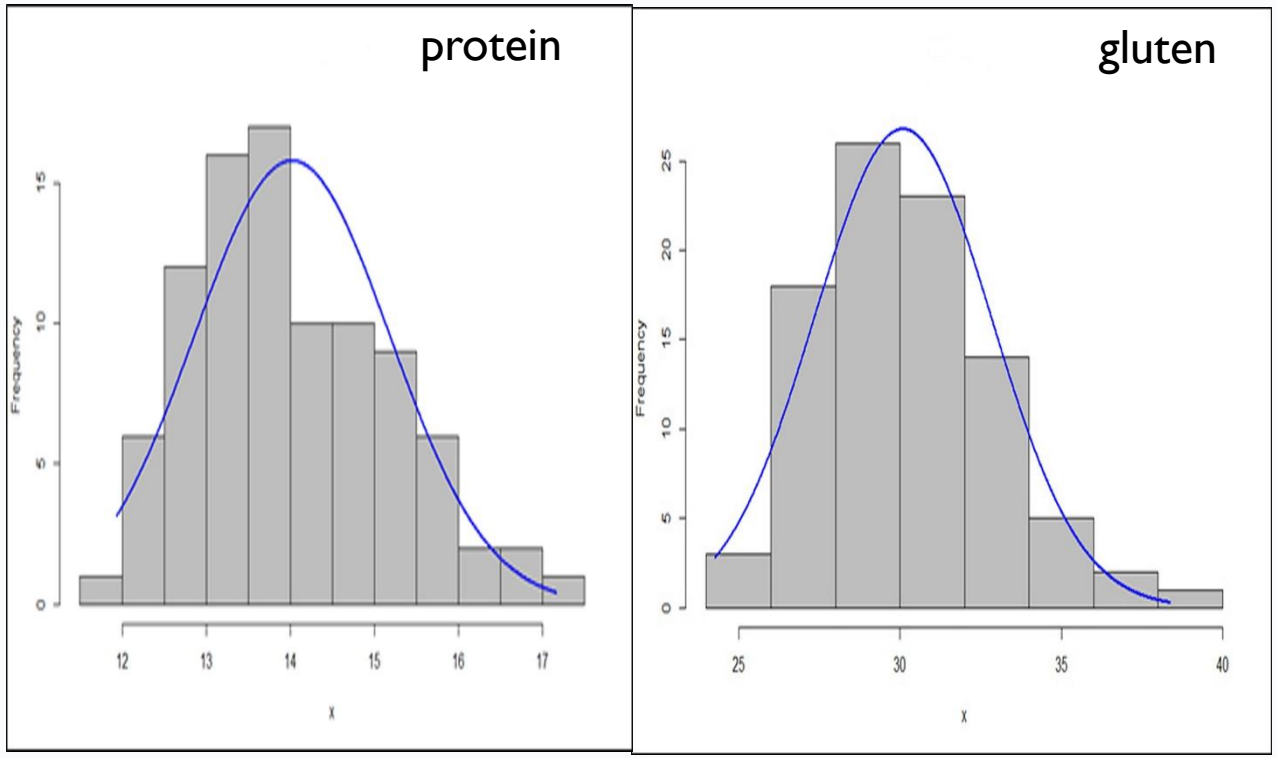

Figure 1. Distribution of wheat varieties by protein and gluten content

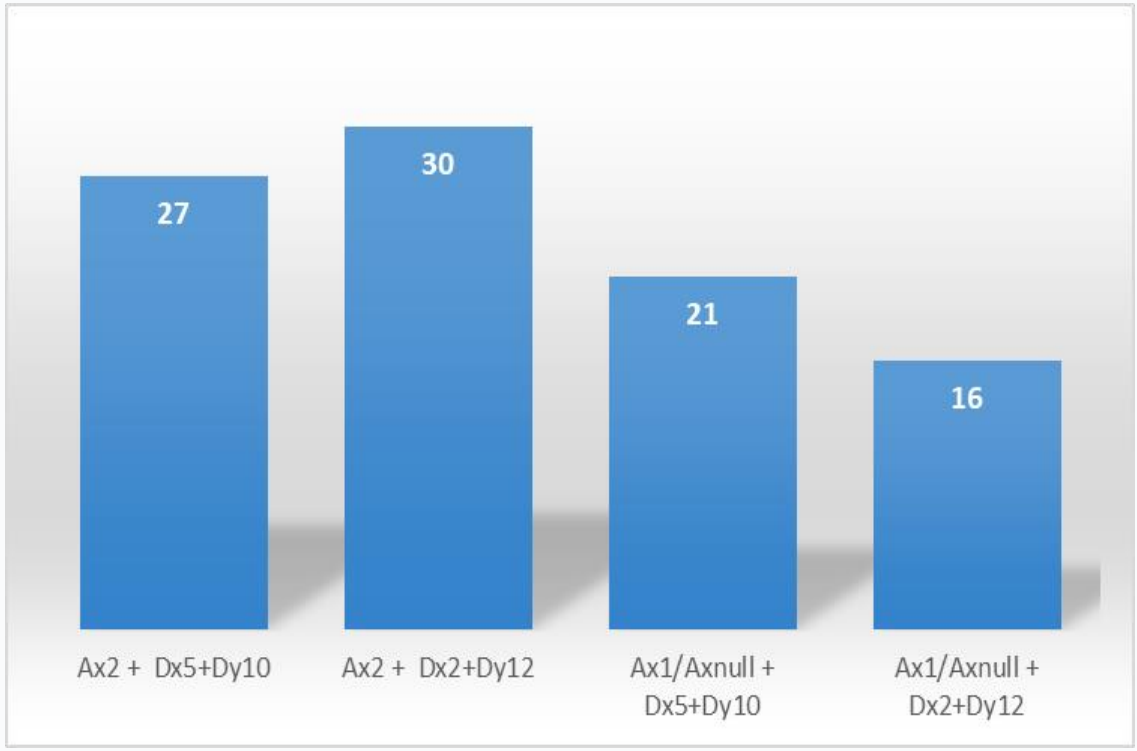

Figure 2. Distribution of wheat varieties by the composition of the alleles of high molecular weight glutenin

Genome-wide association study performed by MLM model revealed SNP markers in 6A, 7B, and 4A chromosomes significantly associated with both protein and gluten content (figure 3). The obtained results also suggest the presence of new genetic factors that affect the GPC and gluten content in the genome of the bread wheat varieties.

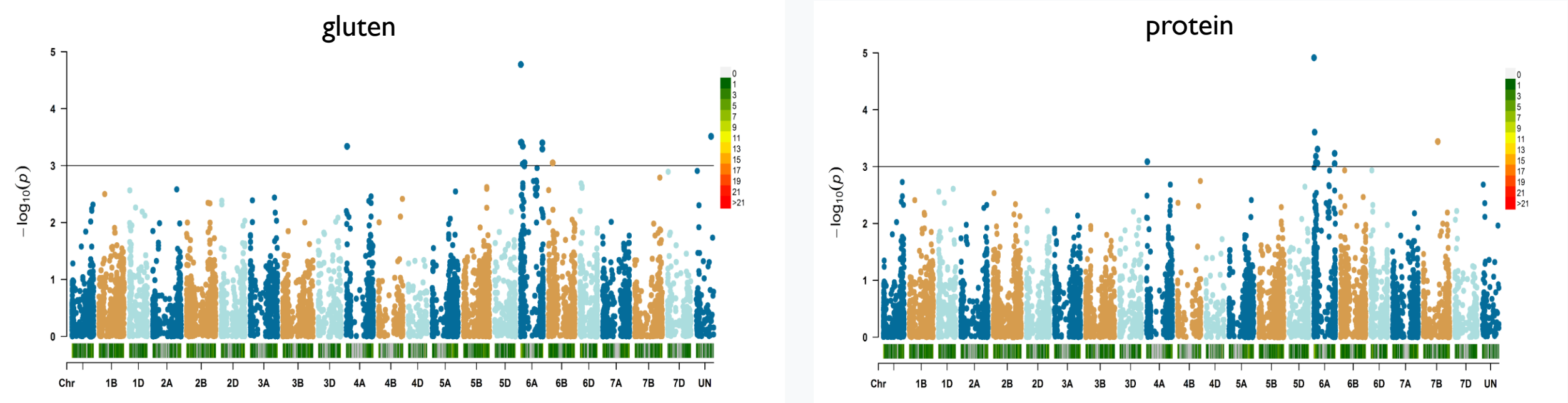

Figure 3. Manhattan plots for grain protein and gluten content. Bar under every chromosome corresponds to marker density.

Conclusions

- The varieties with combination of Ax2, Dx5 and Dy10 subunits can be used as sources of high molecular weight glutenin loci.

- SNPs, mapped at 6AS chromosome may be linked with NAM-A1 (GPC-1) loci - a key factor determining protein and gluten content in common wheat.