Effects Of High Molecular Weight Glutenin On Wheat Quality

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important food grains in the world. Wheat dough has the unique rheological properties for bread making. High-molecular-weight glutenin subunits (HMW-GS) play an important role on wheat quality. HMW-GS are encoded at *Glu-A1*, *Glu-B1* and *Glu-D1* loci on the long arms of group 1 chromosomes. At each locus, there are two genes encoding x and y type subunits. However, not all subunits are always expressed. Variations of those subunits strongly affects wheat qualities. Subunits *Ax1* or *Ax2** are positively correlated with bread making quality compared with null subunit at *Glu-A1*[1]. Positive effects on bread making were also reported for subunit pairs *Bx7+By8*, *Bx7+By9*, *Bx14+By15*, *Bx17+By18* at *Glu-B1*[2-3]. The subunit pair *Dx5+Dy10* had more significant effects on mixing time, SDS-sedimentation, dough strength, and loaf volume than *Dx2+Dy12* at *Glu-D1* [1-4]. Additionally, interactions among those subunits also affect wheat qualities[4]. Sodium-dodecyl-sulphate polyacrylamide gel electrophoresis (SDS-PAGE) is the traditional method to detect HMW-GS. However, a number of functional markers have been developed to determine the HMW-GS, which make it more convenient[5-6]. In this study, a large set of breeding lines developed at Kansas State University were investigated for quality traits and HMW-GS with molecular markers.

OBJECTIVES

☐ Estimate the composition of HMW-GS in the breeding lines
☐ Determine the effects of the HMW-GS on wheat quality
☐ Develop prediction models for wheat quality

MATERIALS AND METHODS

☐ **Materials**
● 458 wheat breeding lines developed at Agricultural Research Center-Hays, Kansas State University
☐ **Wheat quality evaluation**
● Flour protein, ash content, flour yield, water absorption, mixing time, loaf volume, and grain score were determined by standard AACCI methods.
☐ **Genotyping using functional markers**
● Leaf tissues were collected at two-leaf stage and DNA were extracted by CTAB method.
● Function markers for subunits *Ax2**, *Bx7*, *Dx2*, *Dx5*, *Dy10* and *Dy12* were analyzed.
☐ **Statistical analysis**
● *t* test was used to determine the effects of HMW-GS on wheat quality.
● Regression was used to construct prediction models.

RESULTS AND DISCUSSION

☐ **Composition of HMW glutenin subunits (Table 1)**
➢ *Ax2**, *Bx7*, *Dx5,* and *Dy10* were the prevailing subunits
➢ *Dx5+Dy10* was the prevailing subunit pair at *Glu-D1* locus

Table 1. Composition of HMW-GS in 458 wheat breeding lines

Subunit	*Ax2**	*Bx7*	*Dx2*	*Dx5*	*Dy10*	*Dy12*	*Dx2+Dy10*	*Dx2+Dy12*	*Dx5+Dy10*	*Dx5+Dy12*
%	68.6	97.8	20.9	87.9	88.8	20.5	10.2	20.3	87.1	10.0

☐ **Effects of HMW-GS on wheat quality (Figure 1)**
➢ *Ax2** had significantly positive effects on loaf volume.
➢ *Dx5, Dy10,* or *Dx5+Dy10* had significantly positive effects on mixing time and loaf volume, but negative effects on flour yield.
➢ *Dx2, Dy12,* or *Dx2+Dy12* had had significant positive effects on flour yield, but negative effects on mixing time and loaf volume.
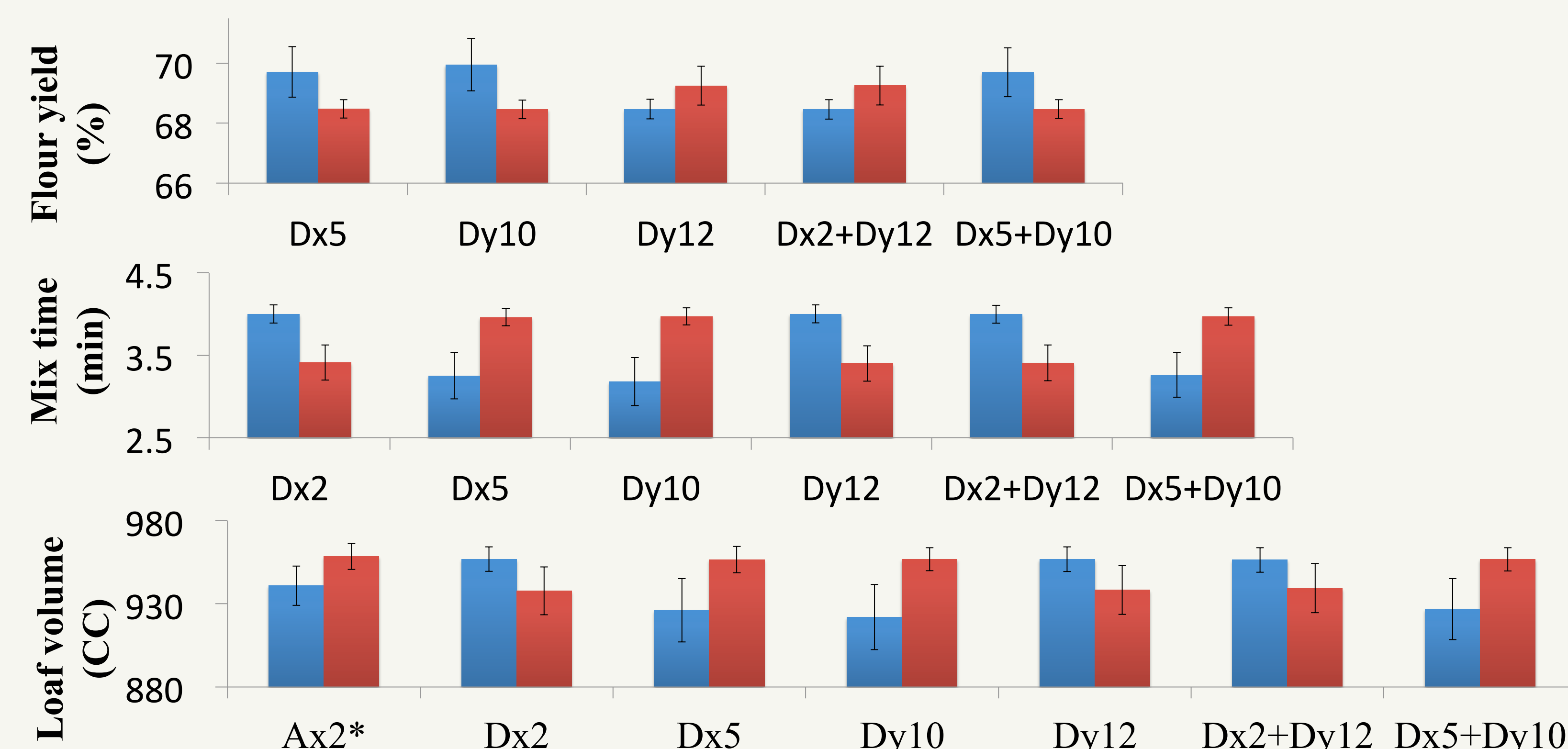
Figure 1. Effects of HMW-GS on wheat quality
*Blue bar is the mean of breeding lines without the subunit, and red bar is the mean of breeding lines having the subunit.

☐ **Prediction model for wheat quality (Table 2)**
➢ Prediction models were developed for flour yield, mixing time, and loaf volume.
➢ Protein quantity had significant effects on wheat quality and it was included in prediction models.
➢ Interaction between HMW-GS also affect wheat quality: flour yield was affected by the interaction between *Bx7* and *Dy10* while mixing time was affected by the interaction between *Dx2* and *Dy10*.

Table 2. Prediction models for wheat quality based on flour protein and HMW-GS

Quality Trait	Prediction Model
Flour yield (%)	$y = 56.059 + 1.150 \cdot FP - 1.563 \cdot (Bx7 \times Dy10)$
Mixing time (min)	$y = 5.523 - 0.192 \cdot FP + 0.807 \cdot Dy10 - 0.357 \cdot (Dx2 \times Dy10)$
Loaf volume (CC)	$y = 508.731 + 33.242 \cdot FP + 14.699 \cdot Ax2^* + 35.523 \cdot Dy10$

$\times$: interaction between two subunits
FP: flour protein content

SUMMARY

☐ *Ax2**, *Bx7*, *Dx5* and *Dy10* were the prevailing HMW subunits in the breeding lines.
☐ HMW glutenin subunits had significant effects on flour yield, mixing time and loaf volume, but not on water absorption and grain score.
☐ Protein quantity and interaction between certain HMW-GS also played an important role on wheat quality.

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