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Evaluation of Grain Protein Content in *Triticum turgidum* ssp. *turgidum* Landraces from Southwest China

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Abstract: The grain protein contents of 84 *Triticum turgidum* ssp. *turgidum* landraces from Southwest China, including Sichuan, Shanxi, Gansu, Henan and Jiangsu provinces, were investigated. Higher variability for protein contents was observed. Based on analysis of variance (ANOVA), it was found that the genotype and year had significantly effects on the protein content. The negative significant correlation between grain protein content and 1000-grains weight was detected. Significant differences of the protein contents within the groups of landraces from Gansu, Sichuan and Henan were observed, whereas no significant differences within the group of landraces from Shanxi. However, there was no significant difference between the groups of landraces from Gansu, Sichuan, Henan and Shanxi. Cluster analysis indicated that the landraces from different province could not be distinguished. According to protein content, the landraces could be divided into 6 groups. These results could be useful for the genetic resources conservation and the improvement of wheat quality.

Key words: Protein content, *Triticum turgidum* ssp. *turgidum*, landrace

Introduction

Wheat is one of the most widely grown crops in China and the wide geographic area of wheat production in China might also lead to dramatic differences in grain quality (He *et al*., 2002). The wheat landraces and varieties in Southwest China had the unique characteristics with higher grains weight per spike, less spike numbers per hectare and lower protein content (Yu, 1998). Successful breeding for higher yields had made the modern wheat cultivars with lower grain protein content than their predecessors (Austin *et al*., 1980; Ortiz-Monasterio *et al*., 1997). Wheat grain yield has been increased in the last century in China, whereas the wheat quality was not significantly improved (He *et al*., 2002; Liu *et al*., 2001). The genetic diversity among wheat cultivars has been largely reduced due to the narrow genetic base in the breeding programs (Wei *et al*., 2000). The development of wheat varieties needs various genetic resources as a source of quality genes. The primary genetic resources of such genes are landraces, weedy species and wild relatives of wheat. The evaluation of wheat genetic resources could provide information for the further improvement of wheat quality.

Triticum turgidum ssp. *turgidum* (2n = 4x = 28; AABB), had been widely cultivated in some countries and areas, including Spain, France, Italy and China. It was grown in wide areas of China before 1950s. However, since 1980s, its cultivation area had been gradually reduced and only cultivated in Southwest China (Dong and Zheng, 2000). It is easy to transfer genes from these genetic resources

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to bread wheat. The *turgidum* wheats from China have been characterized on C-banding (Dou and Chen, 2003), Wax subunits (Liang *et al*., 2001), gliadin and HMW-glutenin (Zhang *et al*., 2003), esterase (Lan *et al*., 2003), the crossability with rye (Liu *et al*., 1998) and microsatellite markers (Li *et al*., 2006). However, the performance of protein content of *turgidum* wheat, especially the landraces from Southwest China, was still unknown. Grain protein content is one of the most important attributes in wheat quality (Faqir *et al*., 2002; Acuña *et al*., 2005). Therefore, information on the protein content performance of *turgidum* wheat is of interest not only to genetic resources evaluation, but also to the genetic improvement of Chinese wheat. The objective of this study was to estimate the protein content of *turgidum* wheat landraces from Southwest China.

Materials and Methods

In 2003 and 2004, the protein contents of 84 *turgidum* wheat landraces from Southwest China, including Sichuan, Shanxi, Gansu, Henan and Jiangsu Provinces, were investigated. The protein content of grains at maturity was evaluated by micro-Kjeldahl method (Büchi, Uzwil, Switzerland) with three replications. The 1000-grains weight for each landrace was detected in 2004. Based on protein contents, the Genetic Distance (GD) was estimated according to the formula:

$$D_{ij} = \sqrt{\sum (x_i - x_j)^2},$$

where i and j are the genotypes. Dendrogram was constructed using the UPGMA (unweighted pair group with arithmetic average) method and all data analysis was performed under the software DPS (Data Proceeding System) version 6.10 (Tang and Feng, 2001).

Results

Higher variability for the protein contents of *turgidum* wheat landraces from Southwest China was observed. In 2003, the protein content varied from 13.64% (AS2322) to 25.81% (AS2256), with the mean of 17.42%. In 2004, the protein content varied from 9.90% (AS2353) to 22.01% (AS2256), with the mean of 14.34%. The protein contents in 2004 were lower than those in 2003. The coefficient of variance in 2003 and 2004 were 13.02 and 14.96%, respectively. The analysis of variance for protein contents in two years (2003 and 2004) showed that genotype ($F = 2.56$, $p<0.01$) and year ($F = 145.95$, $p<0.01$) had the significant effects on the performance of protein contents.

In 2004, the 1000-grains weight varied from 12.50 g (AS2238) to 36.50 g (AS2318), with the mean of 21.74 g. The correlation coefficient between 1000-grains weight and protein content was negative significant ($r = -0.2640$, $p<0.05$). It suggested that the *turgidum* wheat landraces with lower 1000-grain weight might have higher protein contents.

Statistical analysis revealed that the variations of the protein contents within the groups of landraces from Gansu, Sichuan and Henan were significant, whereas no significant difference within the group of landraces from Shanxi was observed (Table 1). However, there was no significant difference between the groups of landraces from Gansu, Sichuan, Henan and Shanxi (data not shown).

Table 1: Protein contents in the landraces from different provinces

Province	No.	SS	F-value	Mean (2003) (%)	CV (%)	Mean (2004) (%)	CV (%)
Gansu	24	186.79	3.503**	16.98	13.2	14.28	16.3
Hennan	4	38.94	17.109*	18.43	11.1	15.61	19.8
Shanxi	21	64.13	0.802	17.97	11.8	14.18	11.6
Sichuan	30	255.67	3.548**	17.08	14.5	14.18	16.1

No. = Number of landraces; SS = Sum of Squares; CV = Coefficient Variance. '*' and '**' represented the significant at 0.05 and 0.01 level, respectively

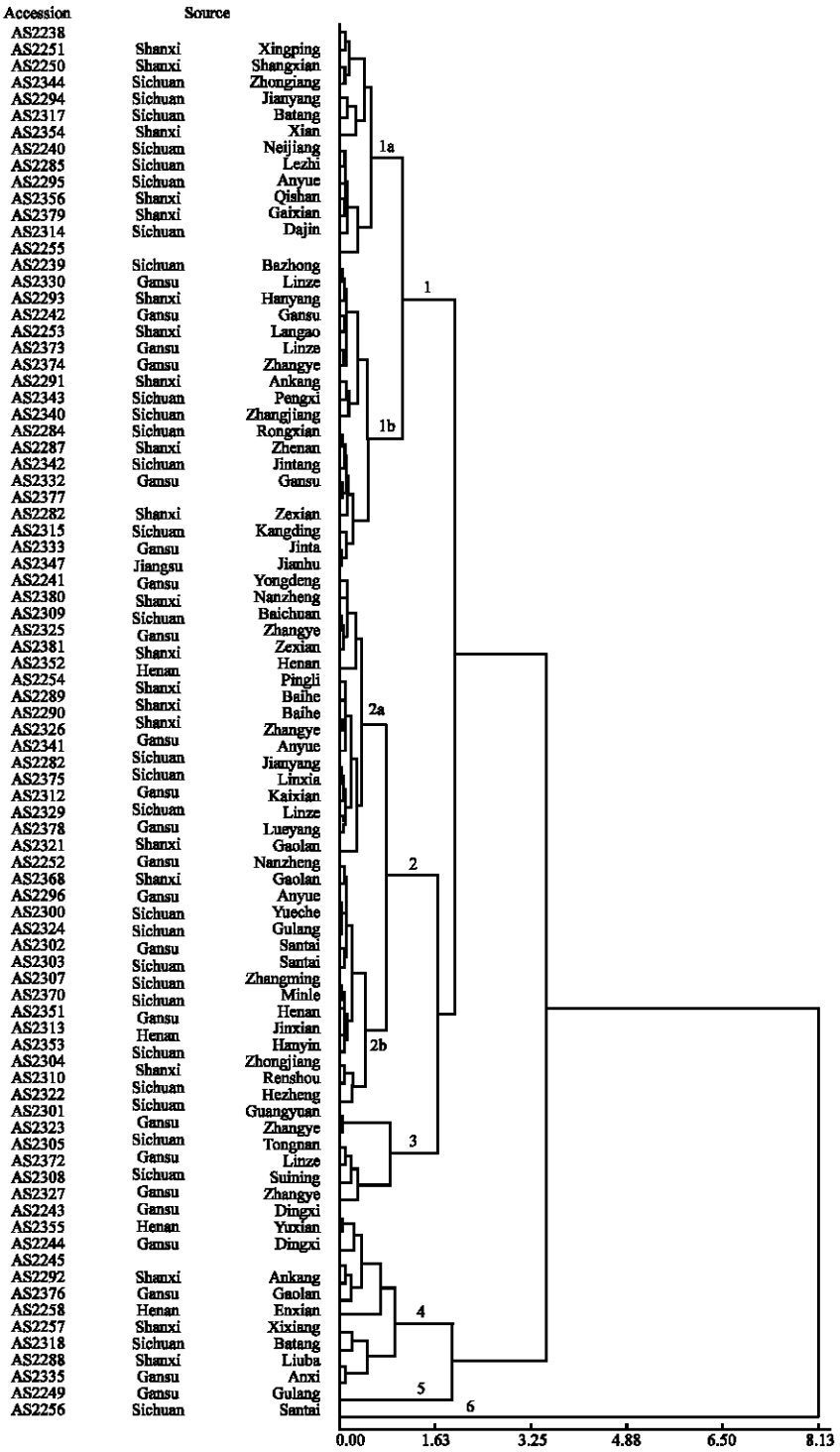

Fig. 1: Dendrogram of 84 *T. turgidum* L. ssp. *turgidum* based on protein content

Based on the protein contents, the Genetic Distance (GD) among *turgidum* wheat landraces were calculated. The mean Genetic Distance (GD) for all landraces was 3.02. A dendrogram, showing the genetic relationships among the *turgidum* wheat landraces, was constructed based on the GD matrix (Fig. 1). The landraces could be clustered into 6 groups. Two landraces, AS2249 from Gansu and AS2256 from Sichuan, were more divergent with the other landraces and clustered into groups 5 and 6, respectively. There were 33 and 32 landraces in groups 1 and group 2, respectively. Most of the landraces from Sichuan were clustered into groups 1 and 2. The landraces from Shanxi and Gansu were mainly divided into groups 1 and 2, respectively. The protein contents in each group were varied in the following rank: group 6 > group 5 > group 4 > group 1 > group 2 > group 3. It indicated that the landraces in groups 5 and 6 had the highest protein contents, whereas the landraces in group 3 had the lowest protein contents. The clustering results also suggested that the landraces from different provinces of Southwest China could not be distinguished.

Discussion

Evaluation of genetic diversity is an essential component in germplasm characterization and conservation in order to effectively establish breeding programs. An understanding of the extent and distribution of genetic variations within endemic populations is a key work for germplasm preservation and subsequent distribution of material to breeders. In the present study, the protein content of the *turgidum* wheat landraces from Southwest China was evaluated and genotype and year had the significant effects on the performance of protein contents. The genotypic effects were higher than that of year. It was in agreement with the previous studies (Peterson *et al*., 1992; 1998; Graybosch *et al*., 1996; Mikhaylenko *et al*., 2000; Zhang *et al*., 2005). Liao and Yang (1999) reported that the mean grain protein in 16 Sichuan *turgidum* wheat landraces was 10.68%. However, in this study, the higher protein contents of Sichuan *turgidum* wheat landraces were observed in two years (17.42% in 2003 and 14.34 % in 2004).

In the present study, the mean 1000-grains weight was 21.74 g in 84 Chinese *turgidum* wheat landraces. The correlation analysis between 1000-grains weight and protein content suggested that the landraces with lower 1000-grains weight had higher protein contents in *turgidum* wheat landraces from southwest China. Dou and Chen (2003) also found that *turgidum* wheat landraces had lower 1000-grains weights.

Clustering analysis indicated that the *turgidum* wheat landraces from difference provinces could not be distinguished based on the performances of protein content. In cluster analysis, 6 groups were recognized. The genetic variations of protein contents among *turgidum* wheat landraces were not associated with their geographic distributions. Using microsatellite markers, the similar results were obtained (Li *et al*., 2006).

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