Short Communication

Relation between Seed Storage Proteins and Japanese Noodle Viscoelasticity in Wheat

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The electrophoretic pattern of seed storage proteins was compared between Kanto 107, a wheat (*Triticum aestivum* L.) line with a high score of noodle viscoelasticity ranging from 21.0 to 23.0, and Norin 61, a wheat cultivar with a standard score of viscoelasticity ranging from 17.5 to 18.5.

A protein band with a molecular weight of 53 kD was detected in Kanto 107, but not in Norin 61. A band with a molecular weight of 129 kD was detected in Norin 61, but not in Kanto 107. When Kanto 107 was cultivated as winter crop on drained paddy field, the viscoelasticity was found to decrease, and the 53 kD subunit disappeared from the electrophoretic pattern while the 129 kD subunit appeared. These subunits thus seemed to be related to the noodle viscoelasticity.

KEY WORDS: wheat, *Triticum aestivum* L., seed storage protein, subunit, viscoelasticity.

Introduction

Wheat (*Triticum aestivum* L.) seed storage proteins consist of glutenin, gliadin, globulin and albumin. Glutein and gliadin account for about 80% of the total seed storage protein content, and the composition of these proteins is closely related to the bread-making quality (PAYNE *et al.* 1984), flour hardness (NAKAMURA *et al.* 1990) and Chinese noodle-making quality (HUANG *et al.* 1988). In Japan, the noodle-making quality is associated with the degree of viscoelasticity. Noodle viscoelasticity consists of two components: viscosity and elasticity. The good taste of the Japanese noodle is attributed to a high degree of viscoelasticity. Japanese noodle making-quality may also be associated with the seed protein composition. In this study, the electrophoretic pattern of seed storage proteins was compared between a wheat line and a cultivar differing in noodle-making quality, so as to analyze the relation between the seed storage protein subunits and the degree of noodle viscoelasticity.

Materials and Methods

Kanto 107, a wheat line with a high degree of noodle viscoelasticity and Norin 61, a cultivar with a standard degree of viscoelasticity were used. Four Kankei lines obtained by crossing with Kanto 107 as a maternal parent were also used. The materials were cultivated three times in 1989 to 1991 in an upland field and a paddy field in combination with rice cropping.

Flour (5 mg) was suspended in the sample buffer (2% sodium dodecyl sulfate (SDS), 10%

Received June 10, 1993.

Accepted September 22, 1993.

Fig. 1. SDS-PAGE patterns of Norin 61 (lanes 1~4) and Kanto 107 (5~8).

Lane 1; Norin 61 cultivated in an upland field in 1989.

Lane 2; Norin 61 cultivated in a paddy field in 1989.

Lane 3; Norin 61 cultivated in an upland field in 1990.

Lane 4; Norin 61 cultivated in a paddy field in 1990.

Lanes 5 to 8; Kanto 107 cultivated in the same fields as Norin 61.

glycerol, 5% 2-mercaptoethanol and 0.25M Tris-HCL pH 6.8) and shaken for 2 hr. The slurry was heated at 95°C for 3 min and centrifuged at 15,000×g for 3 min. The supernatant was subjected to SDS-polyacrylamide gel electrophoresis (PAGE) (NAKAMURA *et al.* 1990). Noodles (10 g) were boiled in water for 20 min. The degree of noodle viscoelasticity was estimated based on the sensory test described in the Ministry of Agriculture, Forestry and Fisheries issued by the noodle quality test manual. A full score of 25.0, indicated a very high degree of noodle viscoelasticity. Norin 61 produced in 1991 is standard, its score is 17.5. The decrease of the score was associated with the decrease of degree of noodle viscoelasticity. Protein content was analyzed by the Kjeldahl method. Amylose content (per wheat flour quantity) was analyzed using a Technicon auto-analyzer II (KURODA *et al.* 1989).

Results and Discussion

Figure 1 shows the SDS-PAGE patterns of seed storage proteins from Norin 61 (lanes 1~4) and Kanto 107 (lanes 5~8). A subunit with a molecular weight of 53 kD was detected in Kanto 107 cultivated in an upland field, but not in Norin 61 cultivated in both upland and paddy fields. In contrast, the high molecular weight glutenin subunit with a molecular weight of 129 kD was found in Norin 61 in both upland and paddy fields, but not in Kanto 107 cultivated in an upland field. Table 1 shows the results of quality tests performed in Kanto 107, Norin 61 and Kankei lines cultivated under different conditions. Kanto 107 in the upland field produced noodles with a high score of viscoelasticity ranging from 22.5 to 23.0, while Norin 61 produced noodles with a low score of viscoelasticity ranging from 17.5 to 18.5. Based on the experiments conducted in 1989 and 1990, when Kanto 107 was cultivated in a paddy field, the 53 kD subunit disappeared and the 129 kD subunit appeared. The degrees of viscoelasticity of these materials apparently decreased. However, in the experiment conducted in 1991, the protein subunits and the viscoelasticity of Kanto 107 cultivated in the paddy field were identical with those of Kanto 107 in the upland field. The protein content in 1991 was slightly higher than that in 1989 and 1990, but the relationship between the amount and composition of protein has not yet been clear.

Table 1. Results of quality tests performed in Kanto 107, Norin 61 and Kankei lines cultivated under different conditions

Cultivar or Line	Field condition	Year of harvest	129kD subunit	53kD subunit	Noodle viscoe- lasticity score	Protein content (%)	Amylose content (%)
Kanto 107	Upland	1989	—	+	23.0	11.0	20.3
do	do	1990	—	+	23.0	10.4	18.9
do	do	1991	—	+	22.5	10.3	19.2
Kanto 107	Paddy	1989	+	—	18.0	6.4	20.8
do	do	1990	+	—	17.0	7.7	19.5
do	do	1991	—	+	21.0	8.1	19.3
Norin 61	Upland	1989	+	—	18.0	12.0	24.8
do	do	1990	+	—	18.0	11.0	24.5
do	do	1991	+	—	18.5	10.3	23.4
Norin 61	Paddy	1989	+	—	18.0	6.8	24.7
do	do	1990	+	—	18.0	7.9	25.3
do	do	1991	+	—	17.5	9.0	23.8
Kankei w376	Upland	1991	+	+	19.0	10.9	21.6
do	Paddy	1991	+	+	18.0	7.7	22.1
Kankei w378	Upland	1991	—	+	23.0	9.5	19.2
do	Paddy	1991	—	+	21.0	7.7	19.6
Kankei w385	Upland	1991	—	+	21.0	10.4	21.4
do	Paddy	1991	—	+	21.0	7.1	22.1
Kankei w386	Upland	1991	—	+	21.0	10.1	23.3
do	Paddy	1991	—	+	21.0	7.9	23.7

Paddy field; Winter cropping on drained paddy field

+, Present, —, Absent

Viscoelasticity; full score = 25.0

The change of electrophoretic pattern in different conditions as observed in the 129 kD and 53 kD subunits has not been known so far in the wheat seed storage proteins. The reason why the compositions of seed storage proteins detected by electrophoresis vary depending on the environmental conditions remains to be investigated.

It is generally recognized that a low amylose content is associated with a high degree of noodle viscoelasticity (TAKADA 1987). In this study, the amylose content of Kanto 107, Norin 61 and Kankei lines was determined. The content of Kanto 107 was low (18.9~20.8%), while that of Norin 61 was high (23.4~25.3%). Regarding the experiments conducted in 1989 and 1990, when Kanto 107 was cultivated in a paddy field, the amylose contents were low (20.8 and 19.5%, respectively) and the scores of noodle viscoelasticity were low (18.0 and 17.0, respectively). In the wheat Kankei lines, there was no relationship between the degree of noodle viscoelasticity and amylose content.

Furthermore, in the investigations carried out in the wheat Kankei lines, it was found that

when the 53 kD subunit was present, but not the 129 kD subunit, the viscoelasticity scores were relatively high ranging from 21.0 to 23.0. These findings suggest that the 53 kD and 129 kD subunits are related to the noodle viscoelasticity.

Acknowledgements

The author is grateful to Dr. H. HIRANO for his advice and discussion. The author thanks my colleagues of the Wheat Breeding Laboratory, National Agriculture Research Center for supplying wheat samples.

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小麦種子貯蔵タンパク質と日本めんの粘弾性との関連

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ゆでめんの粘弾性に優れる(めん適性が良い)コムギ関東107号とゆでめんの粘弾性が標準的な(標準的なめん適性)コムギ農林61号の種子貯蔵蛋白質をSDS-ゲル電気泳動により分析した。

その結果、関東107号は53 kDサブユニットを有したが、農林61号には53 kDサブユニットはなかった。一方、農林61号は129 kDサブユニットを有したが、関東107号にはこのサブユニットはなかった。

しかし、関東107号を水田後作で栽培した時(1989, 1990年産)、ゆでめんの粘弾性は低下し、53 kDサブユニットは消え、129 kDサブユニットが現われた。一方、1991年産の水田後作の関東107号は、畑作の関東107号と同様であった。

関東107号を母本とする関係番号系統(関係w 376, 378, 385及び386)についても同様に調べた結果、53 kDサブユニットを有し、129 kDサブユニットがない系統では、ゆでめんの粘弾性が優れていた。蛋白質含量及びアミロース含量とゆでめんの粘弾性との関連は、今のところ明らかではなかった。

以上の結果から、圃場条件が影響しているものの、小麦種子貯蔵蛋白質の129 kD, 53 kDサブユニットが、ゆでめんの粘弾性の良否に関連していることが推察された。