

IMPORTANCE OF STARCH PROPERTIES IN QUALITY ORIENTED WHEAT BREEDING

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Introduction

While wheat gluten proteins have been considered to be the main determinants of wheat quality for several decades, the role of starch was unknown for a long time and it was considered to be "inert filler" in wheat endosperm. This view was exploded when the quality of the starch was found to be the primary factor determining Japanese noodle quality (Oda *et al* 1980, Iriki *et al* 1987). Noodle quality is estimated from the appearance, texture and taste of the noodles. Wheat varieties with this so called waxy or partially waxy character are of great interest in breeding programmes.

Starch is a major component of wheat flour, accounting for 65-70% of the dry weight of the wheat grain. Starch is composed of two types of polymers: the mainly linear amylose (20-30%) and the highly branched amylopectin (70-80%). The ratio of amylose and amylopectin determines many of the physico-chemical properties of the starch and thereby affects the end-use of the wheat flour. The 60 kDa Granule-Bound Starch Synthase (GBSS) is the key enzyme involved in the production of amylose and is the product of the *waxy* gene. The quantity of amylose is determined by the presence of these *waxy* alleles. When the starch is amylose-free it is referred to as *waxy*, while lines with one or two null-alleles are called "partially waxy" lines and have reduced amylose content (Yamamori *et al* 1994, Nakamura *et al* 1993). Parameters derived using a Rapid Visco Analyser (RVA) are able to show the difference between normal and fully *waxy* genotypes, but differences observed between varieties of non-waxy wheat are often small (Boggini *et al* 2001).

Starch is an important determinant of water absorption and could thus have a place in breeding programmes. During milling the starch may be damaged, after which it absorbs more water than undamaged starch. Hard wheat kernels produce coarser textured flour during milling than soft wheat, with higher levels of starch damage. Broken starch granules absorb more water, and thus hard wheat tends to be better suited for bread making. The presence of different storage proteins also affects water absorption as there is competition between wheat gluten proteins and starch for water and this competition causes changes in the mixing properties of the dough (Batey 2000).

In the present study the starch properties of different varieties commercially grown in Hungary are studied, including a comparison of the gelatinisation and viscosity parameters and the damage of the starch.

Materials and methods

The starch properties of 20 selected varieties from Martonvásár (2005) with different baking properties were examined using the Rapid Visco Analyser (RVA), and the SDmatic instrument. Measurements were carried out in two replications.

Flour dough was washed using Glutomatic 2200 instrument (Perten Instruments AB, Sweden) to get the starch. The starch was frozen and freeze dried.

Starch pasting viscosities were measured using a Rapid Visco Analyser (RVA-4, Newport Sci. Pty. Ltd., Australia). The reproducibility of the measurements was about ± 5 RVU. A 20-minute pasting profile was used, consisting of a 2-minute hold at 50°C, a 6-minute heating period, a 4-minute hold at 95°C, a 4-minute cooling period to 50°C and a 4-minute hold at

50°C (Batey *et al* 1997). Silver nitrate (12 mM) was used as an enzyme inhibitor for flour and starch.

Chopin SDmatic instrument was used for the determination of starch damage. This amperometric method consists of measuring the amount of iodine absorbed by the starch granules in a solution at a temperature of 35 °C.

General statistical analysis and Hierarchical Cluster Analysis were carried out using Microsoft Excel and SPSS statistical software.

Results and discussion

The 20 selected wheat varieties from Martonvásár represents a mixture of genotypes having different baking quality. The protein content of these varieties ranged from 12.6 to 16.5%, while the gluten content (21-45%), the Zeleny sedimentation (33-67 ml), the hardness index (5-75), the water absorption (53-66 ml) and the falling number (162-451 s) also varied between broad limits.

The starch properties of these varieties were also studied. Changes in the viscosity of flour and starch suspensions as the result of temperature changes were measured with an RVA instrument. The starch viscosity values of the varieties ranged between broad limits (Table 1.). The peak viscosity value indicates the water-binding capacity of the starch and is often correlated with the final product quality. This is an equilibrium point between swelling and polymer leaching and rupture and polymer alignment. The viscosity of hold gives the ability of a sample to withstand the heating and shear stress, which is an important factor for many processes. Final viscosity is the most commonly used parameter to define a particular sample's quality, as it indicates the ability of the material to form a viscous paste or gel after cooking and cooling. Setback has been correlated with the texture of various products.

All the parameters and the differences between the minimum and the maximum values of pasting properties were lower for flour than for starch, as it was also found in a previous study (Rakszegi *et al* 2003), and it was found that there was a significant difference between the starch viscosity parameters of the varieties when all measured under the same conditions (Figure 1.).

Table 1. RVA-derived pasting properties and starch damage of the varieties

	Starch			Flour		
	Min-Max values	Mean	Standard deviation	Min-Max values	Mean	Standard deviation
Viscosity at peak [cP]	3236-4932	4058	467	2496-3436	3032	293
Viscosity at hold [cP]	2420-3923	3167	427	1540-1842	1653	90
Viscosity final [cP]	4706-6310	5562	526	3019-3776	3353	212
Breakdown [cP]	659-1364	891	218	850-1870	1380	315
Pasting Temp. [°C]	79.8-87.95	84.5	1.87	75.6-86.7	84	2.9
Peak Time [min]	9.5-10.5	10.1	0.32	9-9.6	9.3	0.16
Setback [cP]	1897-2767	2395	220	1479-1973	1700	139
Starch damage (UCDe)	-	-	-	10.5-20.5	16.17	2.3

Starch damage of the samples occurred between 10.5 and 20.5 values (Table 1), which results a big variability also in water absorption of the flour.

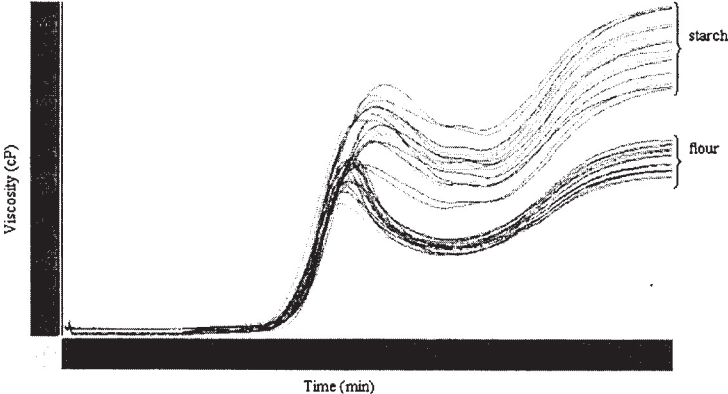


Figure 1. RVA pasting profiles of the varieties for flour and starch

Hierarchical Cluster Analysis (Figure 2.) showed that according to starch properties the distances between the different varieties are different. Basically three different groups could be distinguished based on the RVA and starch damage results. The first seven samples have middle, than eight samples have high and the last four samples have low starch damage values.

Conclusion

Great variability was observed in the starch properties of the studied normal winter wheat genotypes, as regards both the RVA viscosity values and the starch damage. With the help of these and further studies it will be possible to develop a selection system to be able to choose the appropriate genotypes for the processing industry.

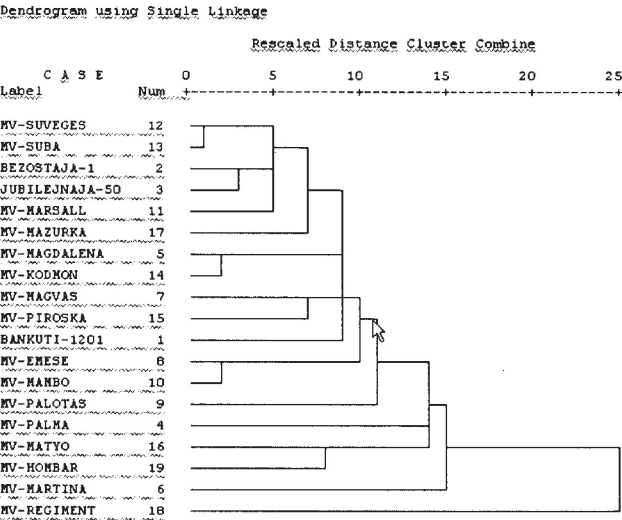


Figure 2. Hierarchical Cluster Analysis for starch properties

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