EFFECT OF THE SOWING DATE ON PHYSICOCHEMICAL AND FUNCTIONAL PROPERTIES OF NATIVE STARCHES EXTRACTED FROM EUROPEAN SOFT WHEAT (TRITICUM AESTIVUM L.).

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Abstract

The influence of wheat sowing dates on the starch properties was evaluated during several growing seasons (2002 to 2005). Some European wheat varieties were sown at 2 distinct dates, cultivated in the same growing conditions and simultaneously harvested. The comparison of the 4 harvest seasons shows globally the same observations and the results of 2005 harvest are presented in this paper. A significant impact of the sowing date on the starch properties are measured for most of the studied varieties. An appropriate selection of the wheat variety and its sowing date could be valorised to emphasize starch properties researched in industrial end uses. Furthermore, these variations between the starch characteristics could lead to processing or end-products quality problems.

1. Wheat samples

A large panel of wheat varieties were screened to evaluate the impact of the sowing date on different starch samples. Wheat samples were grown in the experimental field at Lonzée (Belgium). Sowing dates are in October and December, and the harvest was in August. Standard nitrogen fertilization was applied under solid form as NH_4NO_3 (40-65-75 kg/ha) and two fungicide protections. Each sample was grown in four different plots of 16 m^2 in a fully randomised block design. Wheat kernels from 4 different plots were mixed to reduce location effect and to increase the homogeneity of the samples.
Wheat grains were milled with a Quadrumat senior mill (Brabender, Duisberg, Germany). Starches were isolated by the 'Batter' procedure from 2.0 kg of white flour.

2. Starch isolation

Starches are isolated by 'Batter' procedure from 2.0 kg white flour (Figure 1).

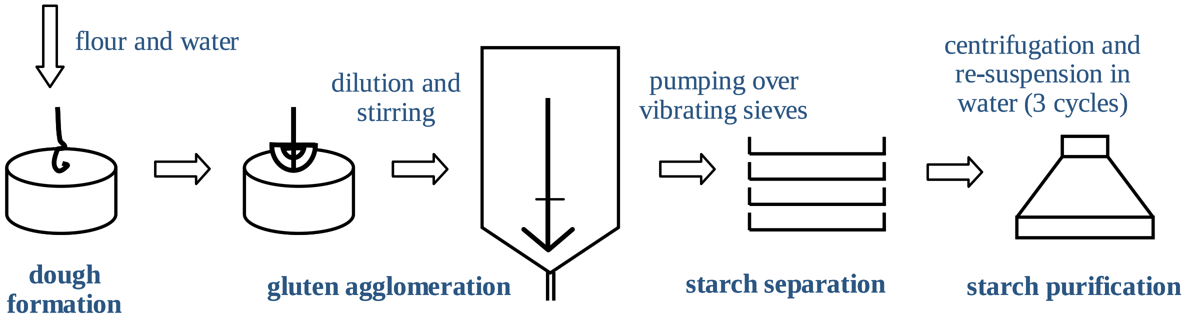

Figure 1: Starch isolation by the Batter procedure

3. Granule size distribution of starch

Wheat starch contains two types of granules: large A-type starch granules (10-35 µm), disk-like or lenticular in shape, and small B-type starch granules (1-10 µm), roughly spherical or polygonal in shape (figure 2).

Particles size characteristics of starches were determined by using a laser granulometer (Malvern, Worcestershire, UK), based on the principle of laser light scattering. Contribution of the B-granules population (<10 µm) to the total volume are given in Figure 3.

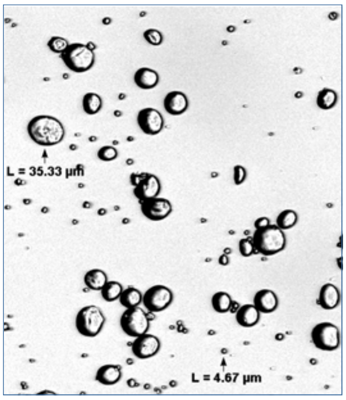

Figure 2: Wheat starch granules

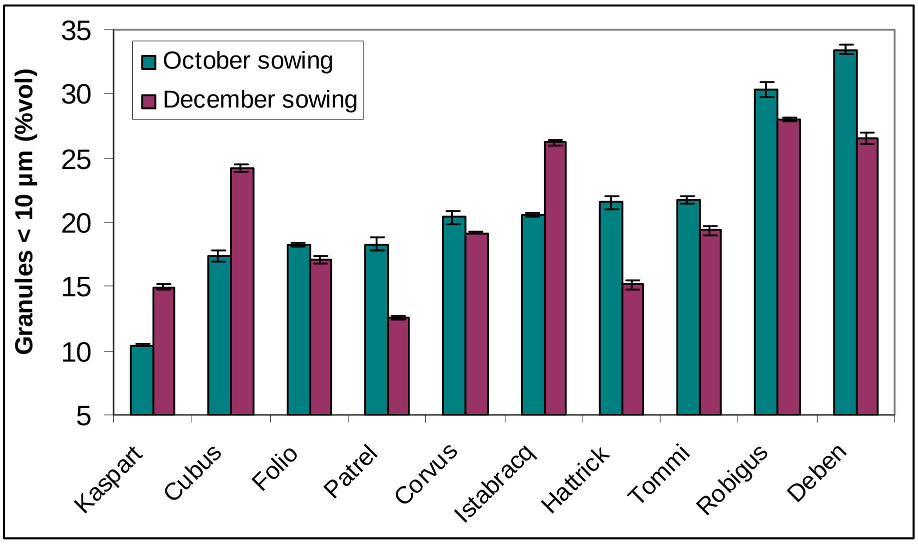

Figure 3: Proportion (in volume) of small B-granules in relation with the wheat variety and the sowing dates

An effect of the wheat sowing dates on the starch granule distribution is observed: for most of the varieties, the contribution of the small granules (<10µm) to the total volume is lower with later sowing dates (Figure 3).
The percentage volume of small granules ranges from 10 to 33%. These variations in relative proportions of the starch A- and B-granules may result in differences in chemical composition that affect the functionality of the starch. For example starch granule size has been related to the pasting properties of starch, alpha-amylases susceptibility of starch, rheological properties of dough, baking characteristics and compositional differences.
Furthermore, the lowest and highest values are associated with Kaspart and Deben, two varieties with a low bread-making quality. This specific criterion of wheat classification could not be associated automatically to a definite granule size profile of starch.

4. Amylose content of starch

Starch is constituted of two glucose polymers: amylose, essentially linear, and amylopectin, highly branched. The relative amounts of amylose and amylopectin are know to influence both nutritional and technological properties of the starch such as its susceptibility to enzymatic hydrolysis, and its gelling and pasting behaviour.
The apparent amylose content is determined by iodometric method.

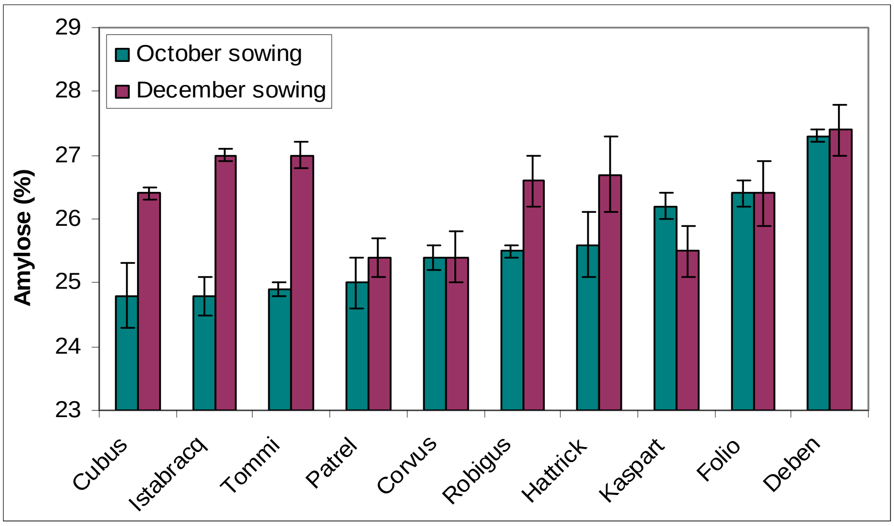

Figure 4: Amylose content in relation with the wheat variety and the sowing dates

Amylose contents vary from 25 to 27.5% between the different samples (Figure 4). The sowing dates influence slightly this starch characteristic: for most of the varieties, a higher amylose content is associated with later sowing dates. This is correlated to the lower proportion of B-granules found in these samples, confirming that amylose content is higher in large granules.

5. Damaged starch

Damaged starch values were determined amperometrically by the Chopin SD4 method (Villeneuve-la-Garenne, France) based on the absorption kinetics of iodine. The level of the damage varies with the intensity of grinding and the hardness of the wheat. Damaged starch granules hydrate rapidly and are more susceptible to enzymatic hydrolysis.

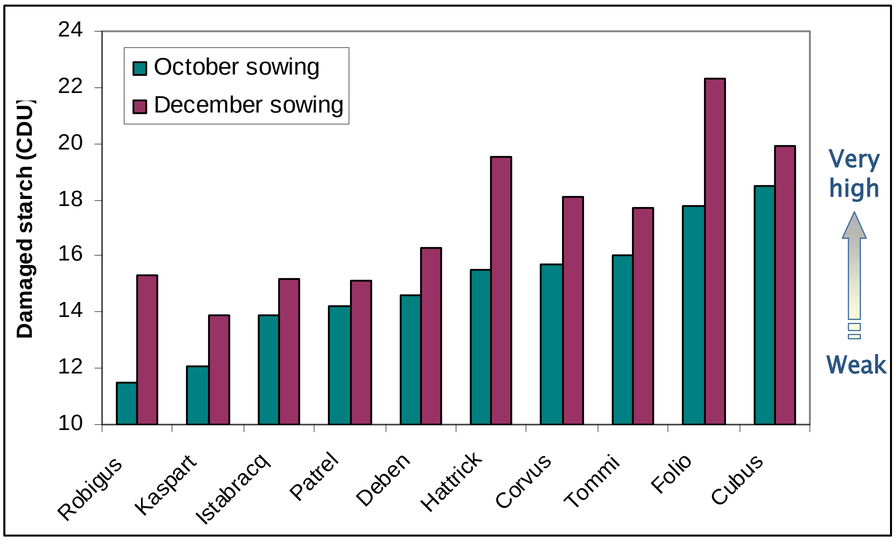

Figure 5: Damaged starch in relation with the wheat variety and the sowing dates

With the same milling conditions, the starch damage level ranges from 11.5 to 22.3 CDU (weak to very high). For all varieties, a clear impact of the sowing dates is observed on the starch damages: the values are higher with later sowing dates (Figure 5). These results are explained by a variation in the wheat hardness induced by different sowing conditions. They may be associated to the lower content of B-granules (small and more resistant than A-granules) and to the higher amylose content (linear and more accessible than amylopectin) in the starches from later sowing dates. The sowing dates influence also the protein content and probably the main binding forces between the starch and the proteins, which can also change the starch damage level.

6. Viscosity properties of starch

Starch viscosity behavior was evaluated with a micro visco-amylograph (Brabender, Duisberg, Germany). Starch suspensions (10% dry matter) were subjected to a time-temperature profile: linear increase from 30 to 95°C in 10 min, holding at 95°C for 10 min, linear decrease to 50°C in 10 min and final isothermal step at 50°C for 5 min. The measurements were realized with addition of 2mM $AgNO_3$ to remove the effect of alpha-amylase and allow comparisons between starch samples.

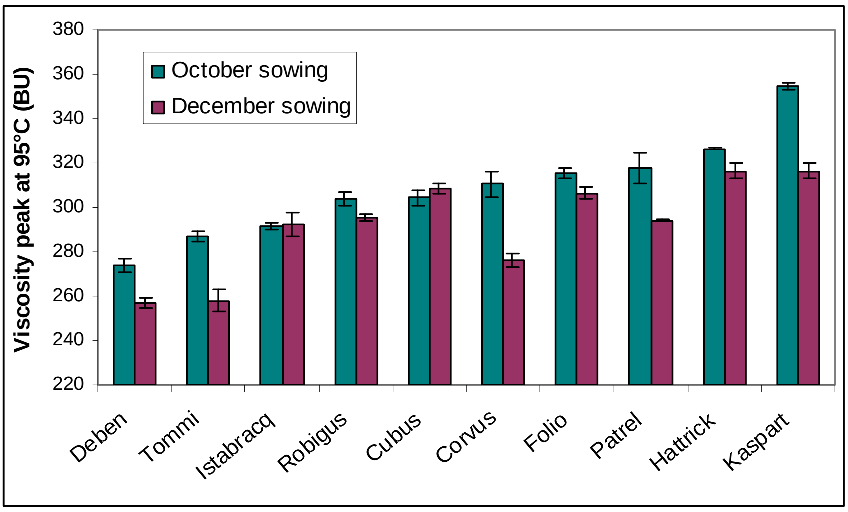

Figure 6: Starch viscosity peaks measured at 95°C with AgNO3, as related to the wheat variety and the sowing dates

The viscosity peaks at 95°C vary from 257 to 355 Brabender Units (Figure 6). An effect of the sowing date is observed on the viscosity properties of the starch: for the same variety, the measurements (at 95 and 50°C) are globally lower for the starch isolated from the later sown wheat.

Furthermore, the higher values are associated with Patrel, Hattrick and Kaspart, three varieties with a low bread-making quality. As a consequence, these varieties could not be used in the production of bread but could be valorized in suitable applications with the high viscosity properties of their starch.

Acknowledgments

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