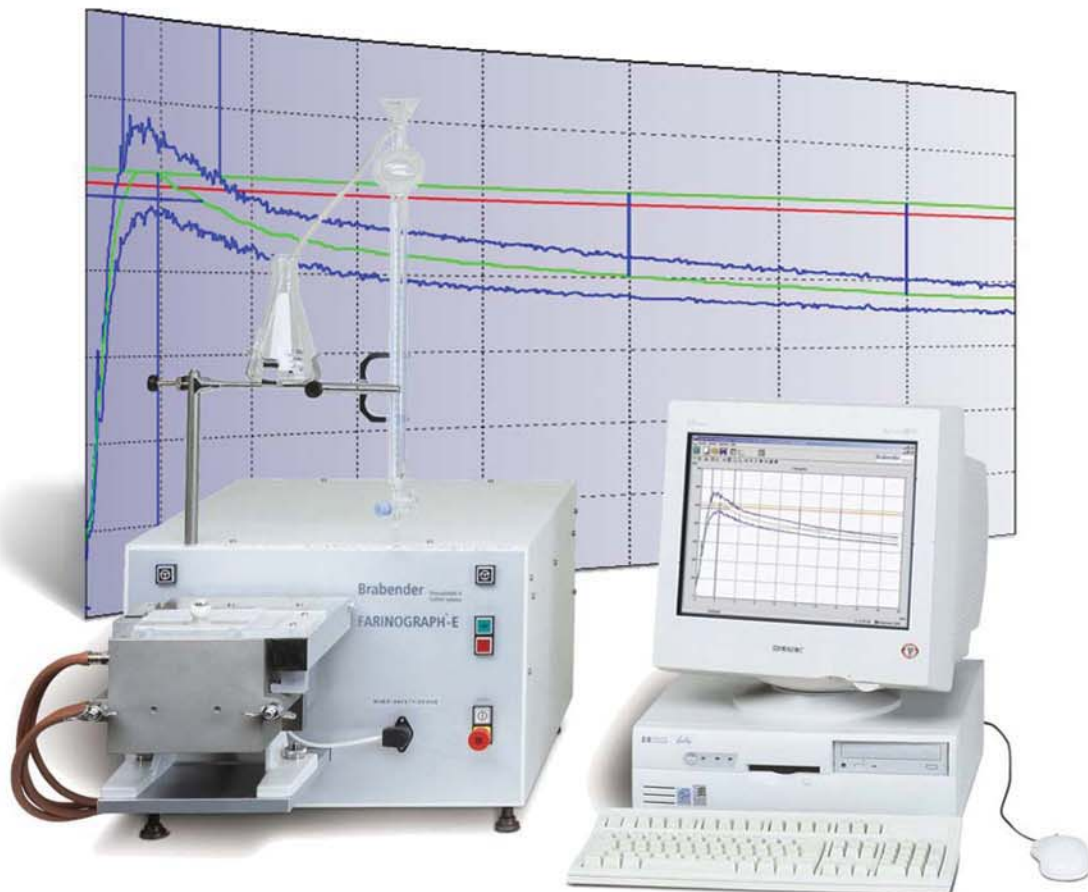




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Structural changes of wheat flour starch and gluten during heating and shear stress conditions using farinograph-E, Viscograph-E and light microscope.

J. DREISÖRNER (1), S. Iaquez (2). (1) Brabender GmbH & Co. KG, Duisburg, Germany; (2) C.W. Brabender Instruments, Inc., South Hackensack, NJ, USA.

Cereals and bread based food systems consist of protein and starch, as well as water. The information and data gathered concerning function, functionality and interaction ability of these three components during mixing, ripening, heating (baking) and storage of the final product are vital in determining the base for constant product quality. Through the use of a Farinograph[®], and following the protocol of AACC/ICC methods, information about the mixing stage of bread making water uptake, protein strength, and kneading performance can be obtained. Furthermore, when following standard procedures and guidelines described by the AACC/ICC, the Amylograph E and the Viscograph E, respectively, are used to determine the gelatinization properties of flour and starch and products containing starch. Both methods in combination enable the user to evaluate flours or whole meal samples and to estimate the values of the raw materials. In addition to the AACC/ICC standard procedures, the software of the Farinograph[®] E allows the operator to create individually defined speed ramps (0–200 rpm) and to set temperature ramps. In this study the well-known Farinograph[®] Sigma Blade S 50 mixer is closed after the standard test procedure (AACC, ICC) with a spherical lid; the speed is changed and heated to a temperature of 90°C. By using the additional options of the Farinograph[®] E, within one single experiment the results in respect to the standard procedures (standard S 50 mixer; water uptake, stability, quality number, degree of softening) can be obtained -- as well as additional information about the gelling properties under shear stress conditions.

Abstract:

In this brief study, the well-known Farinograph[®] Sigma Blade S 50g mixer is closed after the standard test procedure (AACC, ICC) with a spherical lid; the speed is changed and the mixer is heated to a temperature of 95°C. By using the additional options of the Farinograph[®] E, within one single experiment the well known results in respect to the standard procedures (AACC/ICC standard S 50 mixer; water uptake, stability, quality number, degree of softening) can be obtained -- as well as additional information about the gelling properties of doughs under shear stress conditions.

Introduction:

Cereals and bread based food systems mostly consist of water, starch and protein. The information and data gathered concerning function, functionality and interaction ability of these three components during mixing, ripening, heating (baking) and storage of the final product are vital in determining the base for constant product quality. Through the use of a Farinograph[®], and following the protocol of AACC/ICC methods, information about the mixing stage of bread making water uptake, protein strength, and kneading performance can be obtained. Furthermore, when following standard procedures and guidelines described by the AACC/ICC, the Amylograph[®] E or Visco/Amylograph[®] E, respectively, may be used to determine the gelatinization properties of flour and starch and products containing starch. Both methods in combination enable the user to

evaluate flours or whole meal samples and to estimate the values of the raw materials. In addition to the AACC/ICC standard procedures, the software of the Farinograph[®] E allows to create own setted individual speed ramps (0–200 rpm), combined with own temperature ramps. The objective of the following experiments was to see and verify visible changes in the torque values (curves) and the products at elevated temperatures.

Materials and Methods:

The use of the Farinograph[®]-E is following the protocol of the AACC/ICC methods (AACC 54-11/ ICC 115/1). The Amylograph[®] E is used to determine the gelatinization properties of the flour samples. Both methods, Farinograph[®] and Amylograph[®], both as ICC/AACC standard procedures, in combination enable the operator to evaluate flours or whole meal samples and to estimate the values of the raw materials. In addition to the AACC/ICC standard procedures, the software of the Farinograph[®] E allows the operator to create individually defined speed ramps (0–200 rpm) and to set own defined temperature ramps. Different speed ramps, combined with elevated temperatures, were used in the Farinograph[®] E after the standard AACC/ICC procedures to obtain information about the kneading behaviour during heating the dough sample in the Farinograph[®] S-50g mixing bowl. For this reason, after the standard Farinogram the S 50g Fariongraph[®] Mixer was closed with a sperical lid and heated up using a Julabo thermostate. The temperature was increased from 30°C to 90°C within 15 minutes. At the beginning and at the end all of the runs samples were evaluated under the microscope. As materials, a strong and a weak wheat flours were used to proof the methods in general. Malt flour was added in concentrations of 0.1% to the strong flour to see the influence and difference on the dough and on the gelling behaviour. All runs have been duplicated in order to prove the reprocibility of the methods in general.

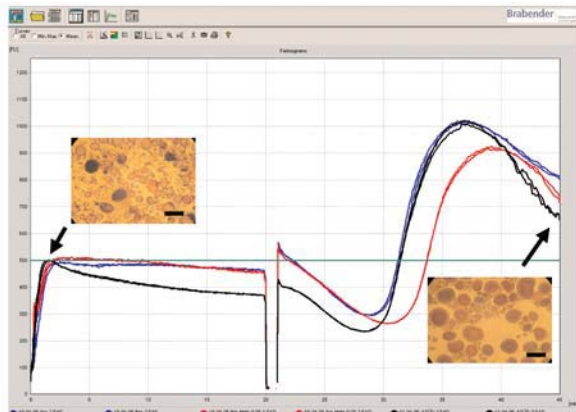


Figure 1: Extended Farinogram with speed and temperature profile; Bar= 50µm
Water absorptions: Strong flour 66,2%, weak flour 58,4%

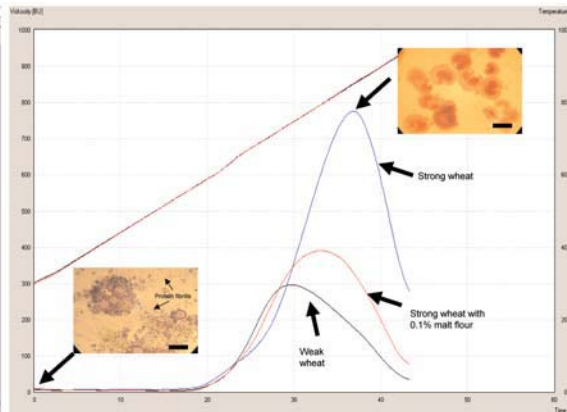


Figure 2: Standard Amylo-/Viscogram of the flours; Bar=50µm

In Figure 1 curves and exemplaric microscopic images are put together to show the results in one single graph. The microscopic pictures between the flours did not show very strong differences in general. The images shown here are taken from the weakest flour used.

1. Beside the standard Farinogram additional information can be obtained by heating the dough in the mixer while running. A spherical lid and a combination of speed and temperature profile can be used to measure further flour differences.

2. The shear stress in the Farinograph[®] mixer does not destroy swollen and/or gelatinized starch granules in the tested wheat samples. Even during heating and mixing, the granules remain nearly in their shape and appearance. The mixing in the Farinograph[®] may therefore be described as smooth and soft mixing.

3. Nearly all of the swollen starch granules remain in true typical shape but with increased size due to water uptake during gelling. After staining with Iodine greater amounts of the Amylose fraction can be located within the starch granules (Farinograph[®]).

4. Samples with lower water uptake (Figure 1) in the Farinogram do show as well lower gelling behaviour with higher setback values in the second, heating phase of the experiments.

5. Malt flour did show a strong influence on the mixing properties as well as on the properties of the gelling of the samples in the Farinograph[®].

6. In the Amylograph, the starch granules in the samples show after heating to the maximum a complete desintegration. The Amylose leached out nearly complete while the remaining unsoluble Amylopectin forms „wormlike“ structures after the maximum gelling points.

7. In comparison between Farinograph[®] and Amylograph /Viscograph[®] the latter instruments do provide more information about the complete gelling potential of the flour starches. The higher water/starch ratio in the Amylograph[®]/Viscograph[®] allows the Amylose to leach out of the granules, and the influence of the malt flour enzymes can be seen more clear.