Influencing the rheological properties of wheat dough – part 1

The properties of wheat dough are firstly the result of variety-specific genetic information. Secondly they result from so-called epigenetic effects of environmental origin due to soil, climate etc. which can, among other things, modify a variety's DNA.

From the baker’s viewpoint, the significant quality attributes of wheat are defined by a cereal’s proteins and their properties and by a cereal’s enzyme activity and grain hardness. It is these properties which, among other things, define the milling characteristics (flour yield, enzyme activity, protein amount and quality, proportions of hull/husk/bran etc.). Ultimately the baking properties are determined by rheological parameters such as dough extensibility, dough elasticity, cohesiveness and firmness, and equally by enzyme activity (to produce sugars for yeast fermentation among other things). These properties are based on the molecular structure and physical state of the constituents, e.g. morphology, crystallinity and starch grain solubility. Under certain conditions they generate the corresponding functional properties (e.g. elasticity or baking properties per se, see figure 1).

When considering the known, conventional technology of dough manufacture and processing, this technology is characterized by an interplay between tension (generating elasticity) and relaxation (dough resting). In principle it is a result of the existing and the resulting properties of wheat dough (see figure 2).

However, these properties can be influenced by technology and process conditions. For example dough properties can undergo a rather large change due to pressure variations in a mixing process and can, among other things, modify the dough more in a plastic or more in an elastic direction. Doughs mixed under positive pressure (e.g. 1 bar or more positive pressure) are so to speak impregnated with gas (also oxidized). They generate elastic properties, among other

**Author**
Prof. Dr. Klaus Lösche
Institute Director
Bremerhaven Institute for Food Technology and Bioprocess Engineering (BILB)
Am Lunedeich 12, 27572 Bremerhaven, Germany
www.ttz-bremerhaven.de
things, and subsequently a rather coarsely porous crumb (relatively large volume) in the baked product. On the other hand doughs mixed under partial vacuum are less oxidized, in particular they are de-gassed (high dough density). They produce distinctly plastic dough properties, higher water absorption and subsequently rather fine pore structures in the baked product and thus slightly smaller baked product volumes (see figure 3).

The problem: Elasticity – effect of dough gas pressure on gas volume, dough specific weight and rheology

\[
\text{% amount of gas} = \frac{\text{density (vacuum dough/dough containing gas)}}{\text{density vacuum dough}} \times 100
\]

Dough specific weight and gas amount in the dough in dependence of the gas pressure in the mixer (Elsner, Kuhn and Weisshaupt, 1991; modified according to Lösche)
Innovative extruder technology enables full continuity

**Innovation:**
+ Use of a special mixer that operates continuously and creates dough formation and development under pressure and/or vacuum, among other things
+ Installation and use of a special slit nozzle for the continuous mixing process
+ For the first time, dough is directly transferable from the continuous mixer to a laminating line without further molding processes!

**Advantages:**
+ Ensures full continuity
+ The dough sheet is always freshly produced and always has the same quality (process consistency, process optimization)
+ Extremely gentle processing is possible
+ Consistent machine operability
+ Consistent baked product quality features
+ Other

The possibility of using a special slit nozzle allows for the first time, for example a laminating line to be operated continuously (without dough resting).

The dough leaves the mixer completely “relaxed” (plastic) and can be worked and processed “stress-free” immediately without rest phases ...

If this knowledge is utilized, then for example a dough can be extruded from a special continuous mixer as a dough sheet (cf. CODEX) which can be fed into a laminating line in a fully relaxed state without damage occurring in and on the dough during lamination. The result is that for puff pastry doughs it is no longer necessary to adhere to the well-known 144 layers, since for the first time the dough and the fat (e.g. laminating margarine or butter) have rheological properties similar to one another (namely plastic), and therefore scarcely any dough damage (cracking due to shearing etc.) can occur, and results comparable to those with 144 layers are already possible with approx. 70 layers (see figure 4). Similar behavior occurs when dough is extruded from this continuously operating mixer (cf. CODEX) as a sheet directly into a baking pan with very high weight accuracy. This dough can then be taken directly to final proof without needing the intermediate stages that were previously necessary, e.g. dough resting, round molding, long molding, four pieces etc. A fully continuous, simplified sandwich-toastbread process with excellent process and product properties such as fine, pale porosity, no shadows etc. is possible as a consequence of such targeted influencing of the dough properties.

A dough’s properties behave similarly when the dough temperature is changed. Thus cold doughs (+5 or +10 °C) yield a very high water absorption capacity (approx. 10 parts higher compared to doughs at approx. +25°C). Moreover, such doughs are relatively dry and above all almost purely plastic, not elastic. Only at temperatures of approx. +15 °C and above does the dough’s water absorption become increasingly minimized.
and it has more surface moisture and increasing elasticity at the same time (optimum at approx. +25 °C, optimum of redox reactions), although this has a rather adverse effect on its machinability (see figure 5). It follows from this that the properties of a complex material such as dough, e.g. the “elasticity of a dough”, are entirely independent of external influences, and instead these properties can be influenced by technology. For example one need not simply accept the rheological properties of dough, on the contrary, one can proactively alter them in the required direction. That takes place partly even without this background knowledge. In relation to the fundamentally changed properties of novel wheat varieties that have been offered on the German market since approx. 1980, the baking industry has to some extent altered its previous method of manufacture to take into account the different properties of these new flours.

Whereas the wheat flours being processed up to that time were lower in protein and weaker in protein while being rich in enzymes, flours that were on the contrary richer in protein, stronger in protein and lower in enzymes than those used up to that time appeared to an ever increasing extent from 1980 onwards (see figure 6).

The paper will be continued in the next issue of baking+biscuit international.

Literature

2. Lösche, K.: Enzymes in Baking -Technology; Max Rubner Conference "Enzymes in Food Processing", Karlsruhe 2014

<table>
<thead>
<tr>
<th>Effect of variety and climate on the quality of wheat flours</th>
<th>1980</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw protein</td>
<td>13.0 %</td>
<td>13.0 %</td>
</tr>
<tr>
<td>Wet gluten</td>
<td>27.0 %</td>
<td>30.0 %</td>
</tr>
<tr>
<td>Sedimentation value</td>
<td>40 units</td>
<td>50 units</td>
</tr>
<tr>
<td>Falling number</td>
<td>270 sec.</td>
<td>330 sec.</td>
</tr>
<tr>
<td>Extension resistance</td>
<td>370 EE</td>
<td>470 EE</td>
</tr>
<tr>
<td>Elasticity</td>
<td>140 mm</td>
<td>150 mm</td>
</tr>
<tr>
<td>Energy</td>
<td>140 cm²</td>
<td>170 cm²</td>
</tr>
</tbody>
</table>

++ Change in the quality data of wheat flours (T. 550)
This is an article from the specialist journal baking+biscuit, which is published six times a year.

As a subscriber you will receive the specialist journal with reportage from actual practice, research and development reports, market analyses and company portraits immediately after publication. This will give you a soundly based, comprehensive overview of the current state of the art and of the baking sector.

Anyone who is interested can order a trial copy of the journal to get to know it, free of charge and without obligation, at

www.bakingbiscuit.com

In our archive on this home page you will also find all the reports as pdf files. You will find the specialist articles there, sorted by publication years; they can be searched using a full-text search.

++ Copyrights, quoting and using texts

Please note that the simple quoting of our texts is permitted, provided the length of the quotation remains within reasonable limits. In this respect we consider three sentences to be a good limit. Please link to our text. Please ask us beforehand at info@foodmultimedia.de only if you want to use the quotation for advertising or want to pass it on to third parties for commercial reasons.

The lengthy quotation or adopting of our texts is permitted only after agreement with f2m. The re-use of images from our texts and videos is permitted only after licensing with the holders of the rights.

Otherwise the usual copyright rule applies: We, the f2m food multimedia gmbh, reserve all rights to the contributions on our web site.

++ Please contact us if you have any further questions.