13.2 Modern Cereal Analysis by New Rheological Methods

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13.2.1 Introduction

For many years the cereal industry has been making efforts to predict processing quality as early, quickly and reliably as possible on the basis of commercial samples.

Over the past few decades, analytical values obtained by indirect methods have been used more and more to complement or even replace the results of baking trials. Fig. 68 gives an overview of the most commonly used testing methods for characterizing wheat and rye for bread baking.

The purpose of this chapter is to give an insight into the routine methods in general use at the present time. The tests are carried out on cleaned sample material and fall into the categories of physical, chemical and rheological methods and standard and basic baking trials. Standard baking trials are those whose procedure and evaluation have been specified by established national or international organizations, i.e. they are standardized.

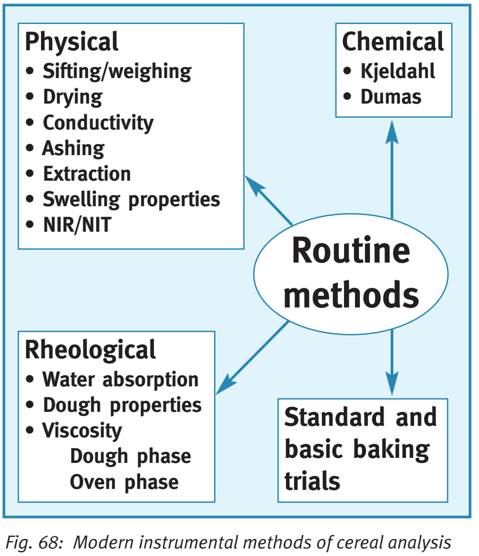

Fig. 68: Modern instrumental methods of cereal analysis

By basic baking trials we mean procedures that are not standardized but whose performance in the published manner is especially recommended so that they can be taken as a basis for further tests of one's own (Brümmer and Neumann, 2002).

Physical methods such as sifting and weighing determine sizes and masses. Drying and conductivity mainly give information on the moisture content, while ashing reveals mineral concentrations. In some countries these methods are used to determine levels in whole grains and also in milled products. Washing and swelling methods serve mainly to determine the (wet) gluten content and also the quality of the protein by means of the sedimentation value after Zeleny. Great progress has been made with the introduction of near-infrared techniques (see chapter 13.3). In these methods, calibration of the instruments is extremely important for precision and comparability. In Germany this is offered as an on-line service by the Association of Cereal Research (AGF) in Detmold.

Chemical methods are used chiefly to determine the overall protein content. Other methods are either no longer usual (maltose determination) or have not yet been introduced (pentosan content).

Rheological methods play a major role (see chapter 13.1.), and the more recent methods described here also complement mainly the rheological testing sector. This is a clear indication of the significance of rheological methods in the context of cereal analysis. The chapter does not deal with sensory methods. Their importance is still not fully recognized, although they involve very little work and the results they produce are very valuable and far-reaching.

As far as the indirect routine methods are concerned, their limitations and restricted ability to predict such aspects as baking properties have often been emphasized, and in fact correlation coefficients of $r = 0.5$ to 0.6 usually have to suffice in practice.

13.2.2 More Recent Rheological Methods and Newly Developed Equipment

As we have said, rheological methods involve more work but are often more relevant to the baking properties of the raw materials. There are several conceivable ways of improving these existing basic methods. Firstly, the depth and scope of the information yielded by the analyses can be increased, for example by combination; secondly, the work required can be reduced or faster and more reliable evaluations achieved by improving the software used for calculation.

This chapter is mainly concerned with methods that are at the development stage or currently being implemented in cereal laboratories. In no way do we wish to question the important benefits and achievements of established methods. The new developments should be regarded as complementing the older procedures, and the basic testing plan for bread wheat or rye, for example, is not likely to change in the near future.

Chopin Consistograph

125 The manufacturer has described important aspects in publications (Dubat, 1999 and 2000). The device was developed on the basis of the Chopin Alveograph Mixer and is fitted with a pressure sensor connected to a computer for performing measurements and processing the results. The sensor measures the pressure that builds up as the wheat dough forms during mixing. The mixing paddle was modified as compared to the earlier Alveograph Mixer. Doughs mixed in the Chopin Consistograph can then be tested further in the familiar manner in the Alveograph. The stages of the preliminary test and the main test give an overview of the procedure (Fig. 69).

126 In comparative tests we compared water absorption values measured in the Chopin Consistograph with those of the standard method using the Brabender Farinograph and calculated a correlation of r = 0.64. Although the scatter is still considerable, the positive impressions gained from the work predominate. After some familiarization it is very easy to operate the device, including its control unit and computer. In spite of the necessity for a preliminary test and a main test, the overall measuring time is not very long. After the preliminary tests the software shows the user the quantities to be weighed in and the required amount of liquid directly.

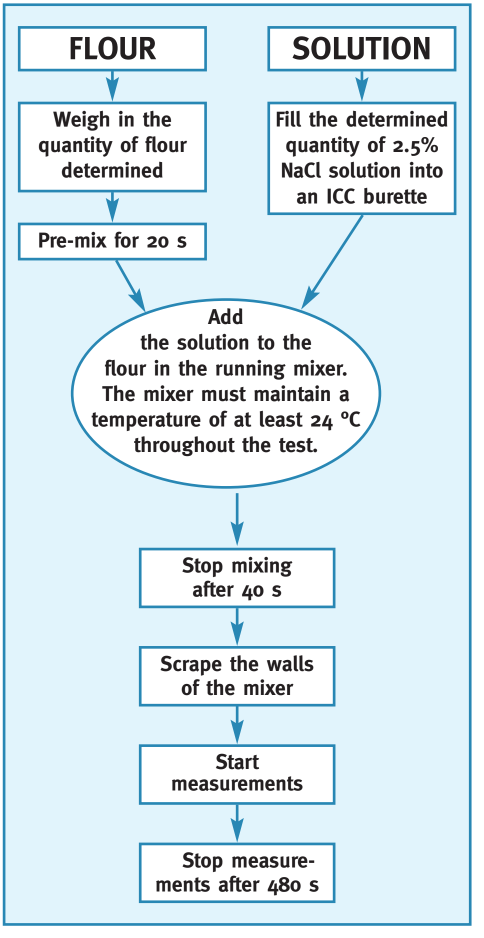

Fig. 69: Stages of the preliminary test and the main test in the Consistograph

Chopin Multigraph FFC

The purpose of this new development is not to replace the familiar individual instruments but to carry out independent measurements, for example of water absorption and the pasting properties of (wheat) flours, in one device and in a single operation (Sinaeve *et al.*, 2001).

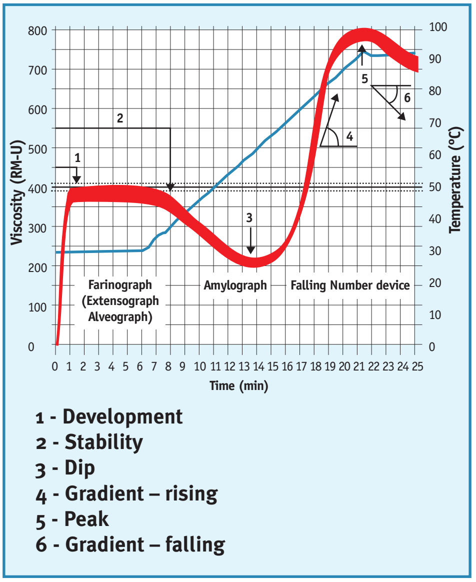

Fig. 70: Chopin Multigraph curve and evaluation points or areas

This combination was deliberately developed without a correlation with the familiar standard devices such as the Brabender Farinograph or Extensograph, the Chopin Alveograph or Brabender Amylograph and the Perten Falling Number system. The equipment is intended for use in the acceptance of raw materials (e.g. with whole meal from the Falling Number mill); the data it supplies yields internal information that is useful for processing. In particular it is intended to identify wheat lots that have impaired baking properties according to French standards. That explains why the differences in the curves for good quality baking wheat of the E and A type[19] and also good B wheat are less apparent. The suitability of the device for use with rye flours is still being examined.

Fig. 70 shows a basic example of a Multigraph curve and the usual evaluation criteria. Further curves (Fig. 71) then show the differences found between two different wheat flours, a weak one (flour 1) and a stronger one (flour 2). The left part of the figure shows the Multigraph curves; the centre part contains the Farinograph and Amylograph curves, and the right hand side shows the Falling Numbers. The different flour properties are shown similarly in all three cases.

The beginning of the Multigraph curve can be compared with the results of the Brabender Farinograph, in this case especially for water absorption, then with the dough properties as shown by the Brabender Extensograph or the

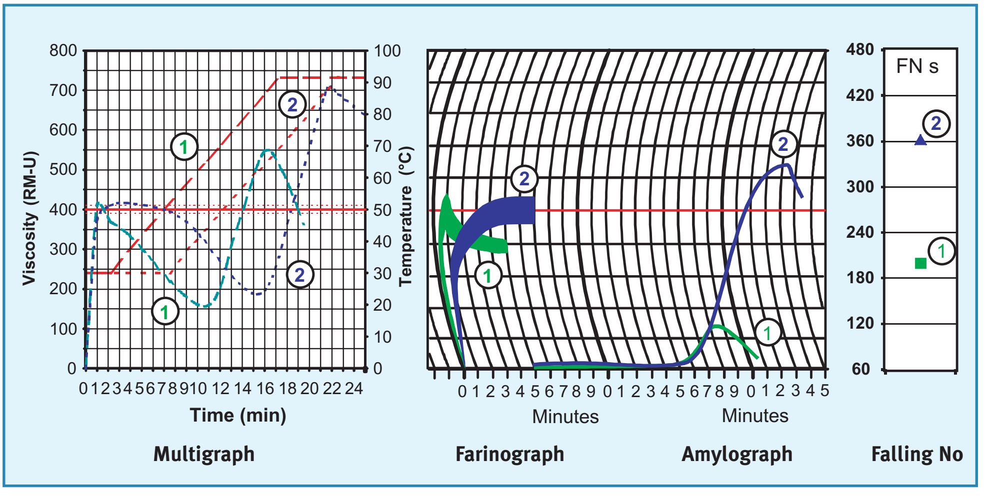

Fig. 71: Comparison of Chopin Multigraph curves with Farinograph and Amylograph curves and Falling Numbers (Multigraph: dotted red curves = temperatures in the doughs)

[19] *German wheat classes in descending order for bread baking quality: E-A-B-C-K. For details see also chapter 12.6.3, page 108.*

Chopin Alveograph. The values for the water absorption of wheat flours calculated by us with the Multigraph tended to be higher than with the Farinograph. But in the tests carried out to date, which are not yet sufficient, we have already calculated a correlation of r = 0.82. It may be possible to improve this by taking different dough consistencies into account.

The addition of water necessary for preparing the dough is controlled by the mouse button of the PC and is unaccustomed at first. Moreover, the quantities added should be larger than the constant small steps of 0.2 mL.

In the subsequent heating phase the temperature rises at 4 °C per minute, so the range from 30 to 90 °C is covered fairly quickly. The results achieved at the beginning of this heating phase may correspond to the swelling curve of the Brabender Amylograph. The measurements that follow should relate to the Perten Falling Number and the information on temperature and viscosity from the Brabender Amylogram. Similarity with the Amylogram values, for example, might be greater if the heating phase were not automatic but could be adjusted individually, in particular if it were slower. Evaluation of the curves does not yield figures similar to those of the Amylogram or the Falling Number; it characterizes certain ranges, for instance those with good pasting properties that are required of certain raw materials.

Cleaning after the test can be carried out quickly and easily, but one has to get used to the fact that the Multigraph is very hot compared with other mixers. Cooling of the equipment seems to present a problem. So it should be possible to connect an external cooling device to supplement the water cooling system.

The exact significance and information value of the figures calculated by the equipment's software need to be substantiated on the basis of further specimens. The manufacturer already has a large volume of results that can be made available to potential buyers. In our opinion the equipment's potential has not yet been fully exploited. Once this is done, the device will automatically rise out of the field of receiving inspections and be used chiefly for research and development purposes.

Perten Shakematic 1090 (Automatic Shaking Device for Falling Number Analysis)

Perten Instruments has carried out intensive development work on new instruments on the basis of ICC Standard Method No. 107/1, "Falling Number", and the equipment required for the test.

A labour-saving device that has attracted too little attention so far is the automatic sample mixer for rapid and uniform preparation of the suspensions for the standard falling-number method of testing wheat and rye meal and flour. Although it is a worthwhile aid to making up suspensions for determining the Falling Number, it should be designed in such a way that larger samples can be produced, for example for use in the Gluten Aggregation Test or the viscosity test on rye. Unfortunately it is very slow to find its way onto the market. But a similar instrument is already sold by NIR-Weinard, Bad Viebel (Germany).

Perten Fungal (α-Amylase) Falling Number (FFN)

In the past, systematic documentation of the addition of enzymes, for example for flour improvement, by the standard falling-number method presented certain problems. The problems were greater when fungal α-amylase was used than with α-amylase concentrates obtained from cereals (malt flour). In tests on treated and untreated milled products it was possible to trace these changes better with the Brabender Amylograph, particularly with the maximum viscosity (Brümmer, 1984a).

The new development by Perten Instruments is a modified Falling Number method that uses the ability of amylases to liquefy gelatinized starch and therefore to reduce measurable viscosities. The material used is a suspension of potato starch in a buffer solution (pH 5.3, as in the swelling curve after Drews (1971), to which the milled product to be tested, enzyme preparations or other relevant raw materials are added. Preparation of the sample to be tested and measurement of the changes in viscosity are then carried out much as in the familiar standard Falling Number method.

Both cereal and fungal amylases can be detected by this modified method. Since the fungal amylases are inactivated at lower temperatures than the cereal amylases, it is possible to differentiate between them. The influence of "side activities" such as xylanase or protease is usually slight, although these may alter the Falling Number at least if the dose is too high. But the FFN did seem to react sensitively to different flours, i.e. if the same enzyme preparations were used on flours from different wheat varieties and these were subsequently tested. This may be due to differences in the susceptibility of the ingredients to enzymatic attack.

114 All in all it may be said that the enzymatic changes in raw materials could still be detected better and with greater differentiation by the maximum viscosity of the Brabender Amylogram curves than by various Falling Number methods. However, the Brabender Amylogram only records total activity and cannot help to distinguish between cereal and fungal amylase as the modified Perten Falling Number method does.

Further series of tests need to be performed to establish how far microbial contamination of cereal, e.g. with fusaria, can be determined directly or by comparison with the standard Falling Number. Washings from deliberately contaminated cereal have so far shown only slight effects on the measurements. It was concluded from this that the enzymatic activity of fusaria, for example, is only slight. It was not possible to decide whether or not a sample was contaminated with fusaria or whether technological effects can be expected to result from the micro-organisms.

Perten Falling Number Plus

With this new device, Perten has created an instrument with a wide variety of applications. It will permit a great diversity of tests and analyses. After studying this new development closely we can say that the device will probably go beyond many of the questions answered by routine tests and therefore has capabilities that will make it excellently suitable for research and development work.

The new measuring technique records three curves of different colours for each of the two cylinders (Fig. 72).

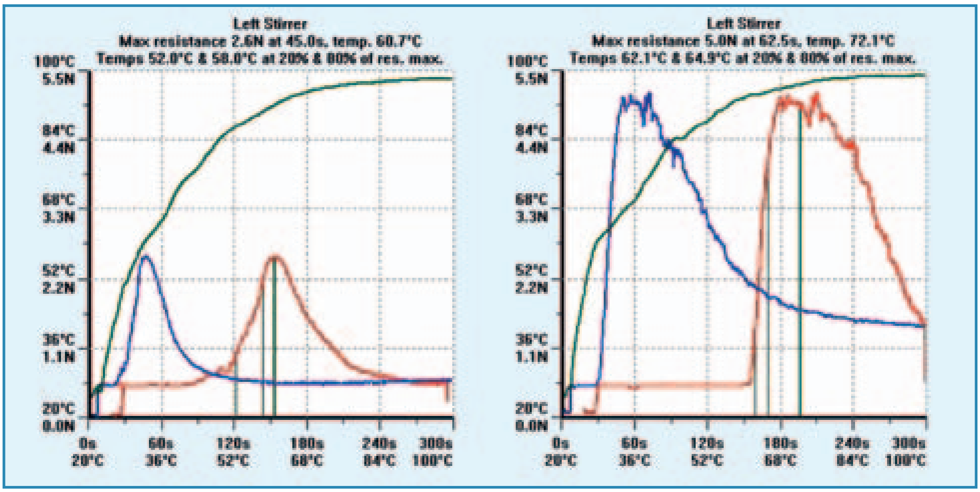

Fig. 72: Measurement curves of the Falling Number Plus instrument (FN Plus)

A red curve shows the relationship between the resistance of the suspension and the rise in temperature, i.e. the viscosity behaviour of the suspensions during stirring and heating.

An interesting point is the start of the viscosity increase, i.e. the possible beginning of gelatinization. Here, a wider measuring range would probably enable an even better correlation with the Brabender Amylograph values, for example.

A blue curve indicates the viscosity behaviour of a suspension over the measuring period, i.e. it reflects the course taken by viscosity during the test as a function of time.

A green temperature/time curve yields specific information, for example on how, when and at what temperature of the suspension the recorded changes occur. These can subsequently be related to other curves or values from other standard methods.

In some cases, comparisons with established standard methods revealed very close similarities (Lotte *et al.*, 1999). For example, a correlation of r = 0.70 was found between the Perten gelatinization temperature and the maximum temperature of the Brabender Amylogram, and the correlation between the Perten FN Plus temperature and the maximum viscosity of the Brabender Amylogram was r = 0.79. At r = 0.92 the result of the comparison between the Perten FN Plus resistance and the Brabender maximum temperature was even better, although it was not linear; this was also true of the correlation between the Perten FN Plus resistance and the Brabender maximum viscosity (r = 0.86). Such results permit the conclusion that the Perten FN Plus instrument might make it possible to combine the information from determination of the Falling Number with that of the gelatinization curves in one operation.

Here too, the control software offers many more options that were not yet available in the prototypes.

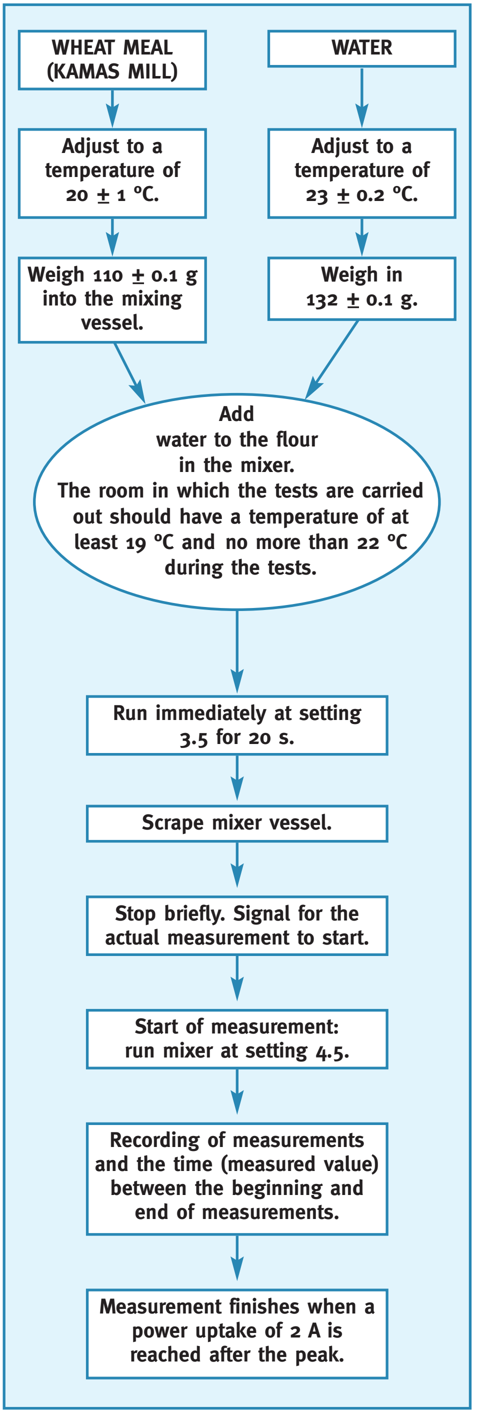

Fig. 73: Flow chart for the Gluten Aggregation Test

But besides these extended possibilities of evaluation there are many variations on the individual steps that can be performed in order to find answers to different questions.

These include variable temperatures for the water bath, so that measurements do not necessarily have to be made at the boiling point of water as in the standard Falling Number method.

The advantage of this was pointed out years ago (Both, 1978 and Brümmer, 1984b). Moreover, the intensity (i.e. the number of up and down movements of the Falling Number body) for making the suspensions can be altered. For further research tests we recommend changing the current pH, for example by adding buffers, acids or alkaline solutions.

The possibilities can probably be extended beyond the usual processing of wheat and rye to other raw materials, ingredients etc., and analyses of end products other than bread, small baked products and pastry goods are also conceivable.

Gluten Aggregation Test with Whole Wheat Meal

Much work has recently been done on wheat flours with the "KO" (knock-out) test (Gluszczynski *et al.*, 2001).

For wholemeal analyses we see further possibilities of characterizing the raw material after grinding wheat in the Falling Number mill. The author feels certain that the use of this method alongside NIR and Falling Number determinations, for example, will enable wheat to be allocated more precisely to quality groups. The method cannot replace the standard tests, nor is it meant to do so; its usefulness lies chiefly in providing quick information on delivered lots of quality wheat. The test itself, on a milled sample, takes only about 15 min.

The procedure is shown in the flow chart in Fig. 73. The most important evaluation criteria are aggregation time and aggregation area, and also power uptake (Tab. 62).
Moreover, the temperatures should be recorded continuously throughout the test. They are closely related to viscosity behaviour.

Tab. 62: Gluten Aggregation Test

KO time KO area	Power uptake	Mean	Suitability of the flour Maximum	
s	cm²	A	A	
≥ 1000	None	≤ 1.15	None	Very good
700 - 999	0 - 10	1.16 - 1.30	≤ 3.5	Good
200 - 699	10 - 25	1.31 - 1.50	3.6 - 3.7	
≥ 120	10 - 20	1.51 - 1.70	> 3.7	Adequate
< 120				Unsuitable
Example (deviating values are underlined)				
	Measurements			Assessment
KO time (Rating)	KO area	Power uptake		
		Mean	Maximum	
s	cm²	A	A	
863 (Good)	11.5	1.15	3.61	Adequate
343 (Good)	55.3	1.58	3.76	Adequate

Tab. 63: Average results of the Gluten Aggregation Test (wholemeal and extracted flours) [a]

Quality group		E	A	B	K
Wheat characterization		Elite wheat	Quality wheat	Bread wheat	Biscuit wheat
Aggregation time	s	60-120	40-180	20-150	> 700
Aggregation area	cm^2	< 45.0	30-60	20-50	< 20
Mean power uptake	A	1.4-1.6	1.4-1.6	1.3-1.9	< 1.3
Maximum power uptake	A	> 3.9	> 3.7	> 3.6	< 3.8
Final temp. of the test suspension	°C	> 45	40-45	< 43	> 50

[a] *Characterization of German wheat classes, see also chapter 12.6.3, page 108*

The main purpose of this test is to confirm the stated quality classes of delivered lots of wheat. However, at the points where wheat qualities overlap, this quick test of the raw material also produces ambiguous results, as the diagram of typical GAT (Gluten Aggregation Test) curves shows (Fig. 74).

This method is especially suitable for determining the gluten properties of special types of wheat, e.g. for biscuits, at an early stage. Unlike protein analysis, the GA Test indicates characteristics that would not otherwise be discovered until the baking test, in spite of possible overlapping. Tab. 63 shows the possibilities for evaluation. At present these values are only national, i.e. geared to German requirements, for example for acceptance at mills.

The first part of the curve with aggregation times up to about 60 s – i.e. those of wheat

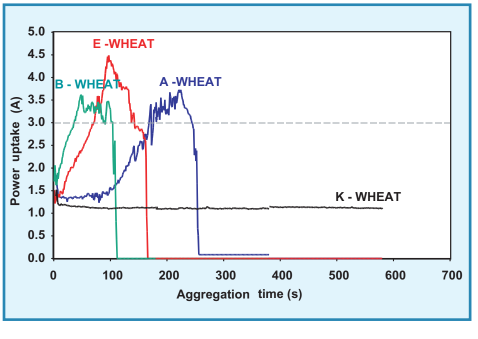

Fig. 74: Typical curves from the Gluten Aggregation Test on wholemeal wheat

with medium baking potential such as the German B varieties – is dominated by soft gluten structures with high water absorption. These are revealed analytically by relatively low gluten index values.

This is followed in the range of aggregation times from about 100 to 250 s by patterns showing higher protein, moisture and gluten levels if the corresponding gluten structures (meaning better baking functionalities) can be derived from them.

Wheat with poorer baking properties, i.e. weaker B varieties and also C and feed wheat and the biscuit wheats so important for the durable baked goods industry, that usually have low protein and gluten values and low water absorption, are then characterized by aggregation times of > 300 s or even > 700 s for soft biscuit wheat. Unfortunately the wheats produced by organic farming also fall into this category of inferior baking wheat. Although the protein they contain bakes fairly well, they have very poor aggregation properties because of their lower wheat protein levels and especially their low gluten content.

The information derived from the GAT is made more reliable by the fact that the maximum and mean power uptake and above all the aggregation area circumscribed by the curve are measured in addition to the aggregation time.

But before we go into these general trends in greater detail we should explain the typical differences between the GAT values for extracted wheat flours with mineral contents of about 0.5 to 0.7% in the dry matter and wholemeal flours from a Falling Number mill (Kamas mill).

The GAT curves for whole wheat meal (Falling Number mill) show more rapid aggregation than those of the extracted flours of the same patterns (0.5 to 0.7% mineral content) because of greater natural viscosity, but the peak value of the curves is lower. This tends to apply to biscuit wheat too. But here a certain amount of aggregation is observed with wholemeal flours which no longer occurs with the extracted flours. This shows that the extraction rate of the cereal and the ingredients of the outer layers of the grains influence the viscosity of the suspension in the GAT. Fig. 75 shows typical curves from the Gluten Aggregation Test carried out on wholemeal wheat flours and extracted flours produced from the same wheat, with a mineral content of about 0.55 to 0.65% of the dry matter, from the various German quality groups. Quality group K characterizes "biscuit wheats" for the durable baked goods industry, and group C "other wheats", including feed wheat. The distinctions between the various quality groups result from comparison and combination of the most important GAT data – aggregation time and area, the course taken by power uptake, and in future perhaps a measurement of the temperature of the suspension as the difference between the initial and final temperature or a temperature at certain points in time.

If we compare all the tests carried out to date on wholemeal flours and the corresponding extracted wheat flours, we find that the wholemeal product yields rather less information on the properties of the gluten because the outer layers of the cereal always reduce gluten formation. When testing wholemeal flour to identify biscuit wheats it is important not to be misled by the fact that certain aggregations may occur after about 400 to 500 s. When extracted flours from the same wheats are tested, these do not occur.

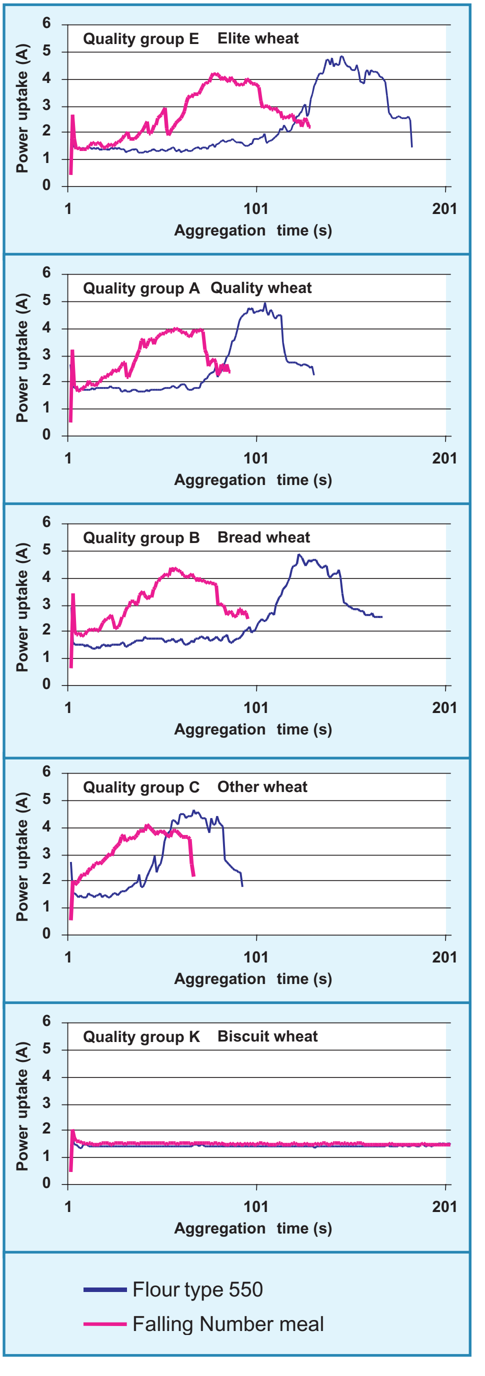

Fig. 75: Gluten Aggregation Test: results of tests with wheat, Falling Number meal and classified flours of various qualities

The following GAT trends have been ascertained to date:

- Short aggregation times (up to about 80 s) generally mean high water absorption.
- Soft gluten indicates only moderately good baking properties even if the peak values of the curves are fairly high, i.e. if the protein and gluten content is possibly elevated.
- Late aggregation (periods over 300 s) means lower water absorption, normal to firm gluten but also short gluten, with a generally low protein and gluten content.
- No aggregation or very late aggregation (over 400 s with wholemeal flour or 700 s with extracted flours) indicates very low water absorption, firm, short or even crumbly gluten, and varying but generally low protein and wet gluten content (also organically grown wheat).

Moreover, increasing aggregation areas mean stronger gluten complexes with gluten properties that are generally more suitable for bread baking. These trends are the same whether wholemeal wheat flours or extracted flours are tested. The better possibility of prediction offered by extracted flours is already explained by the fact that their good baking properties have been deliberately concentrated in their design and production. So it is not surprising that wheat with very good baking properties is characterized best; and it is this that makes the GAT valuable for the acceptance of cereals at a mill.

But besides the general trends there are also variety-specific observations, especially concerning the results obtained with wholemeal wheat flours; these are then also reflected in the GAT with extracted flours. Tab. 64 shows that a knowledge of varieties is an advantage in this analysis as it is in the assessment of cereals in general. So far these special features have only been followed up with German wheat varieties.

There are promising correlations between GAT values and baked volume when an extracted flour (in Germany Type 550, for example) is used in the Rapid Mix Test, a baking test for bread rolls (Fig. 76 - Fig. 78). Fig. 76 shows the average GAT value ranges obtained to date with German E, A and B wheat with the analytical means of all the samples tested. For example, the E wheats had an average aggregation time of 87 s, an aggregation area of 45 cm² and a baked volume of 732 mL/100 g flour in the RMT. Fig. 77 shows the scatter, especially of the baked volume in the RMT, in comparison with the GAT measurements. The most important correlations between the aggregation area in the GAT and baked volume in the RMT can be seen from Fig. 78. In the E-wheat range this includes some quality wheat varieties from abroad, for example the USA and Canada, with extreme GAT aggregation areas.

Tests have also been carried out with wheat from four non-European and five European growths, in which the quality rating given by

Tab. 64: Variety-specific trends in the GAT on wheat (wholemeal and extracted flours)

Aggregation tendency	**Quality group**		
	E	**A**	**B**
Time:			
- Earlier	Altos	Tarso	Drifter, Greif
- Later	Bussard, Dream, Avon	Balis, Toronto, Transit, Astron	Atlantis, Fleur, Dekan, Skater, Tommi
Area:			
- Smaller	Avon, organically grown wheat	Petrus, Tarso	Fleur, Skater, Ritmo
- Larger	Altos, Zentos	Aspirant, Ludwig, Tiger	Drifter

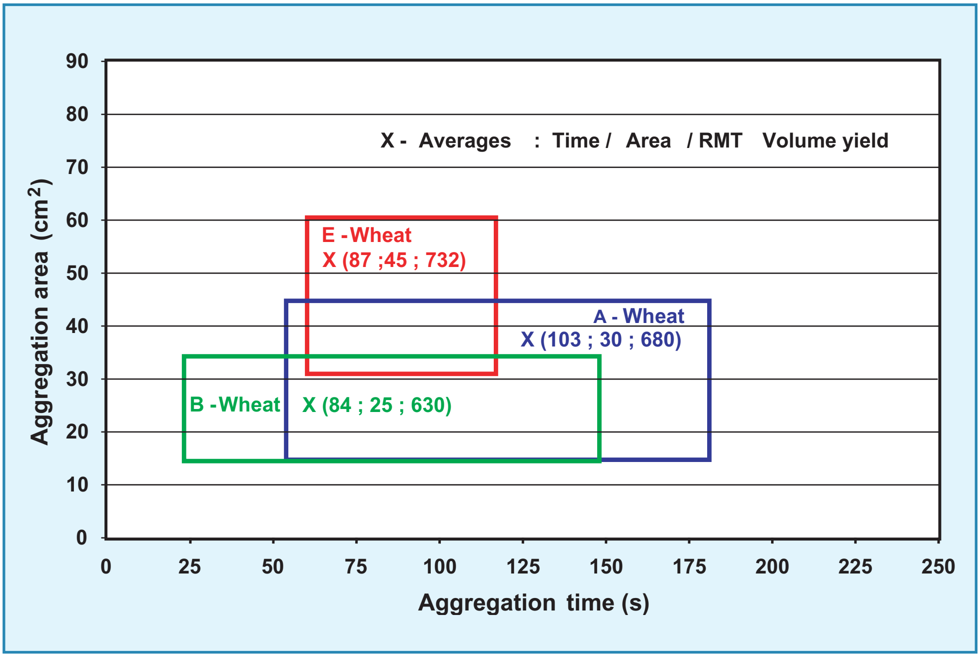

Fig. 76: Wheat characterization by GAT values and baked roll (RMT) volumes

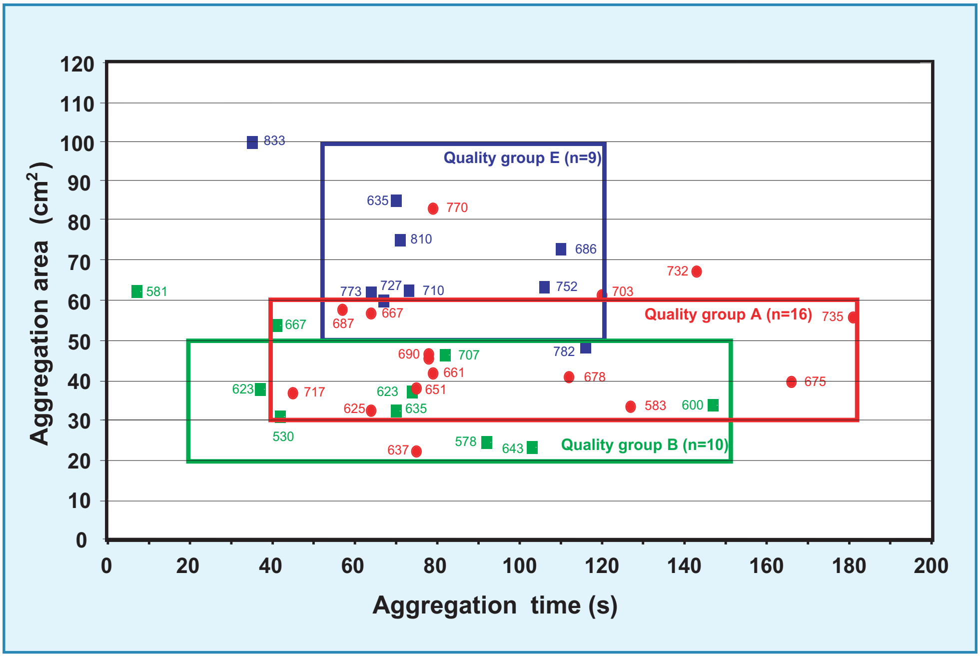

Fig. 77: Wholemeal wheat flours compared with the volume yields (mL/100 g) of various quality groups in the RMT

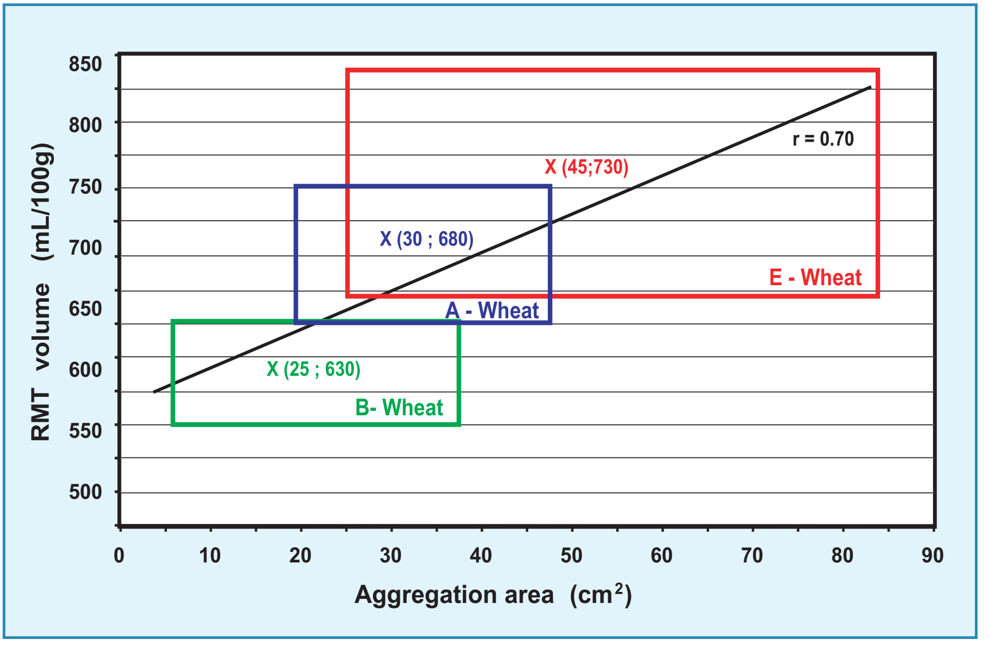

Fig. 78: Correlation between the aggregation area and volume yield in the RMT for the 2002 harvest

the sender was compared with our GAT readings. Requests for samples were made largely according to the following criteria: high and medium baking quality and – especially important – so-called biscuit wheat. The comparability of baking quality was good to very good, with a few deviations that plainly resulted from differences in the definition of good or medium baking quality in Germany and other countries. All the wheats intended for durable baked goods (hard biscuits and wafers) were identified very reliably. A further noticeable feature was that very strong baking wheats from the USA and Canada sometimes produced double peaks, which resulted in extremely large aggregation areas. But in general it was possible to maintain a value greater than 50 cm^2 for the aggregation area to differentiate between high and medium baking quality.

Rye Viscosity Test (RVT)

This newly developed method of determining viscosity behaviour is discussed in detail in the chapter 15.9 (page 186).

Zymoexpansiometer (ZEM)

A treatise by De Leyn and Vanneste (2003) appeared just in time to be considered in this chapter. It deals with an instrument designed for testing fermenting doughs. The authors have given the instrument a name that goes back to the old term for the complex of fermenting enzymes, namely zymase. It is also reminiscent of the mode of action of a similar device, the Zymatograph.

Cereal chemists have long been seeking a way to monitor rheological processes in fermenting doughs, which presents a considerable challenge. An overview of the instruments used for this in the past, such as the Chopin Rheofermentometer, the Brabender Maturograph and the Brabender Oven Rise Recorder, appeared a number of years ago (Brümmer, 1990). But these instruments mainly measure the development of volume, i.e. gas formation properties, and are less able to take changes in dough viscosity or gas retention into account. Nevertheless, the Rheofermentometer and the Maturograph have provided researchers with very important information in this field too. So it is not surprising that the basic principles of these earlier devices were included in the development of this new instrument.

The ZEM instrument measures changes in a dough over a certain period; the fermentation temperature, composition of the dough and pressure in the measuring chamber can be modified. In order to come closer to the dough processes usual in practice, these pressure alterations simulate the degassing that takes place in the punching of a dough. Ultimately, the aim of the measurements is to bring the measured volume of the dough as close as possible to the baked volume of products made from the same doughs.

As with the Brabender Oven Rise Recorder (ORR), the measurements are made with doughs enclosed in a basket and brought to the desired temperature by submerging in an oil bath. The ZEM curves are very similar to those of the ORR. The most important factor influencing measurements with the ORR is the time at which oil penetrates the dough specimen, thus greatly altering the properties of the dough. However, this point is not discussed in the treatise on the ZEM.

The ZEM can operate at normal pressure or at slight negative pressure and record the changes in dough volume that occur. The measurements are made in several stages, for example they may start by determining fermentation times at atmospheric pressure, followed by degassing of the dough at slight negative pressure in the measuring chamber and finally monitoring of one or several fermentation cycles.

Besides the volume of the dough, the resulting curves show its expansion and resistance. The fully automatic instrument has so far been used to test different wheat flour qualities, different dough yields, different types and doses of baker's yeast, different mixing and kneading processes and also different flour improvers. The fermentation time and a specific dough volume are selected as target values and compared with the fermentation times and/or baked volumes determined in baking trials. According to the authors, the correlations between the ZEM and baked volume are good ($r = \pm 0.9$); the correlations between the ZEM volume and the protein content of wheat flour and the sedimentation value after Zeleny are also within the usual ranges of $r = 0.5$ to 0.7.

The ZEM instrument and the suggested testing method are intended to simulate fermentation of the dough, including degassing processes. From the results, De Leyn and Vanneste draw the conclusion that rheological tests on non-fermenting doughs are practically worthless for assessing the rheological properties of doughs leavened with baker's yeast. They therefore regard the results of the ZEM as particularly valuable, for example since they make it possible to monitor various flour qualities and the way they are treated, the quantity of yeast of a particular quality and various methods of mixing. Besides the rising power itself, the effect of these parameters on the properties of a dough is shown. But all these factors also influence doughs tested with the methods used in the past. The future will show whether the Zymoexpansiometer has real advantages. There can be no doubt that the current state of the art has advantages over the older measuring techniques.

This is surprising, since some of the studies by the author and also more recent findings (Hruskova and Kucerova, 2003) lead to different conclusions. In the past, the lack of correlation between the dough volume measured by instruments and actual baked volume has been explained by the fact that gas formation by micro-organisms, chiefly yeast, is only partly responsible for the leavening of baked products. A further important factor is leavening by water vapour, and this has not yet been measured adequately even by heating in an oil bath.

13.2.3 New Rheological Methods and Flour Treatment

Apart from the Perten Falling Number determination FFN (see chapter 12.4), none of these new methods has so far yielded information on the effects of flour improvers – less still on possibilities of checking them. It is however conceivable that the functional effect of active substances in flour improvers can be monitored with these new methods. Of course it is still not known how far all or some of the effects of modern flour treatment, in particular correction of the oxidative or reductive or enzymatic potential, changes to the pH or the addition of minerals with a buffering effect can be detected and monitored. But the possibility that these methods will in future provide useful assistance and information in this field cannot be excluded. Indications that this is so are to be found in the principles on which they work, for example:

- their relevance to baking, which is already obvious;
- the amounts of extracted flours or meal used in relation to the water added (dough yield), which are certainly in line with normal bakery practice;
- their practical pH ranges, and
- their temperature gradients, which are similar to those either of dough or of the baking process.

At present this seems most likely in the case of the new analytical methods such as the Gluten Aggregation Test and the Rye Viscosity Test, since these directly investigate those complexes that have to do with modern flour improvement. In the GAT these are gluten formation capacity and the behaviour of wheat gluten, for example in the presence of additives with an oxidative/reductive or enzymatic effect. In the RVT, too, it should be possible to detect all influences with a direct effect on the viscosity of the suspension. All in all, these new methods and developments open up additional possibilities, especially in the control of flour treatment.

13.2.4 References

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