New Quality Control Instruments for Flour and Baked Products

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Introduction

Over recent years, Flour milling and Baking has developed into a very sophisticated process with a high level of process technology, high volume, and efficient production.

The Quality Control, whether on-line or measured in the laboratory, is therefore becoming ever more important to achieve consistent ingredients, process conditions and products.

There are a number of companies and organisations working to improve the instrumental techniques. Some are manufacturers dedicated to the Cereals Processing Industry like Perten Instruments, Chopin, Brabender and Newport.

Others may be research organisations like CCFRA or Universities who are looking at cereal research at different levels and may develop new methods or techniques which can be applied or further developed for commercial uses.

When looking at the range of Instruments used for Quality Control, it is apparent that although some techniques are very well established ' they may not meet the full needs of today's processes. Other newer techniques are being evaluated but may not be adopted because of the difficulty in applying or relating to the process. What is important is the interpretation of the results and correlation with process conditions. Sometimes a new instrument or technique is not adopted because there is no ood correlation with existing test methods. This can be frustrating if tne existing method is flawed or may not have good precision and reproducibility.

Advanced computer power has brought about the ability to process large amounts of data very quickly, enabling the analysis of complex parameters for quality control. This can provide a great deal of valuable data - but can the user interpret this data? Is there too much information? It is the role of the Instrument developer to work with industry , to determine what data is needed or useful and how it should be presented.

The UK has many different quality parameters to deal with and in recent years new instrumental techniques have continued to be applied to most of these. Some of the important parameters are:

Protein:

NIR instruments are now common for rapid Protein and the industry has standardised on Dumas as the reference method. This is very reliable for protein quantity although attention is now focussed upon protein quality, to improve on existing gluten testing methods like Glutomatic or Gluten Index. New techniques like Gel electrophoresis are being examined.

Water Absorption and Dough Rheology:

The Farinograph has been established for a long time with the addition of the Extensograph for additional information. New methods are being introduced although they may not easily be accepted in the UK if there is no advantage or direct correlation. This has happened in recent years with the Chopin Consistograph and the Rheomixer/Mlixograph systems.

Colour or Bran content

The FCG Kent Jones system has been criticised for many years but alternatives have been difficult to introduce. Tri-stimulus colour measurements, ash or other methods have not been fully accepted because they are different and it still leaves FCG. This is where imaging should be of value because the important measurement relates to bran content - but it is a direct measurement and will not necessarily correlate with Flour Colour Grade.

Loaf Volume

Seed Displacement has been the traditional method. Recently, ultrasonic measurement has been introduced but it is relatively expensive.

Crumb Structure

There has been little instrumentation in this area apart from texture analysis. The measurement of cells and structure has been sensory and here we need to compare new developments with expert analysis, which can be difficult. This will be explored further later.

Main Areas of Interest

There is not time to cover the whole range of Instruments or even just the new developments, but we can look at some specific areas where there is a lot of interest at the moment.

One area relates to the process the mixing of dough. The rheological properties of the dough and relating the Quality Control measurements to the process conditions and performance.

The other relates to a technique using Digital Imaging. The use of modem camera technology and the ability of the computer to analyse images for quality control purposes.

Dough Rheology

For many years, Millers and Bakers all over the world have worked with the Brabender Farinograph to evaluate flour and dough properties. Even though processes have changed the basic instrument and measurements have remained the same. This instrument remains

a key factor in Quality Control in the UK, even if the mixing is perhaps no longer so relevant to the process conditions. The mixer is slow and low energy compared to modern process conditions.

However, it is not so easy for the miller or baker to obtain this type of information in any other way, so the Farinograph has remained a key part of the QC procedure.

Recently moves have been made to try to develop the Farinograph to provide more relevant information. Brabender have updated the system to provide electronic evaluation (computerisation). Data is transferred to the PC and presented in Windows format. Automatic zero point and range setting is incorporated.

The new system has the facility to vary the speed - providing more energy during mixing. It is more compact and can be used with a range of standard Brabender mixers for 10g, 50g and 300g samples.

Newport Scientific are introducing their Dough Lab - a new system to measure rheological properties of dough.

This system can provide similar data to the Farinograph but has a micro controller and software system, there is no need for a separate PC although data can be downloaded. The electronic drive system has variable speed control. There is an advanced temperature control system, with heating and cooling and automatic water injection, avoiding the need for an external temperature circulator burette. It can be used with different mixers but at present does not have a mixer as standard.

Chopin, famous for their Alveograph have developed a new system called the Multigraph. This again is looking at the Farinograph type properties and has a mixer of different geometry. It can run similar profiles to the Farinograph but also vary the speed and temperature. The temperature can be ramped up to 95'C to provide starch-pasting curves similar to the Amylograph or RVA.

The curve and data produced have four fields of interest. The first region relates to the protein/gluten structure similar to the Farinograph data. The second region again covers Farinograph rheological information including stability and tolerance to mixing. In the third region gelatinisation characteristics of the starch can be seen and finally the fourth area can provide information about enzyme activity.

This instrument is not yet on the market but initial trials are interesting because it provides data from ground wheat, which relates to the final flour quality - so is possibly a new wheat intake tool.

Sam Miller at CCFRA has been working for some time on measurement of dough during the mixing process. He has applied a standard instrument, a Perten Diode Array NIR system to look at the changing NIR spectra during the mixing process. This requires very rapid measurement, data processing and advanced statistical techniques.

He has found that there is a clearly identifiable relationship between the NIR spectra and the dough properties - it is possible to determine the optimum mixing times for loaf volume or

crumb structure. Although this is still part of a research program it is possible that the information can be used by the Baker to improve Processing and eventually toprovide instrumentation within the plant.

This is a good example of where valuable research is taking place, but it may be a long time from proving the technique to presenting the processor with a practical tool, with relevant data he can respond to.

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Digital Imaging

The other main area of development concerns Digital Imaging.

The use of a camera and software to analyse images is used widely throughout industry and is now becoming accepted for Flour and Baked products.

Despite the fact that this technique has been available for many years now it seems that for the Baking industry it has been difficult to move the technology from the research lab. The need for simple, fast, repeatable instruments that can provide useful data to the processor has meant that there has been little success in applying the technique to Quality Control applications.

Systems were developed for bran in flour a number of years ago at CCFRA and DIPIX in Canada but these have not been fully accepted because it was not so easy to correlate to other methods. An offshoot from people at DIPIX, called Maztech, developed a simpler system based on a line camera or scanner.

This was more applicable to a QC lab but not suitable for on-line applications.

However, a number of bakers and millers in Europe have worked with the system and found very useful information. It is in the detection of bran components in high quality white flours that it is most effective, both for Quality Control and Process control.

Tests have shown that the system has the ability to detect different bran fractions and this combined with small particle size measurement gives a very repeatable measurement of bran even at very low levels.

It was thought that imaging systems could only detect the darker, pericarp layers of bran, but experiments by Maztech showed that the Aluerone layer was identified just as easily.

Applied to a UK bakery, the system, called the SPX was able to segregate flours that did not perform well in the bakery, despite meeting all other specifications.

A long term project showed the effect on flour quality at intake by introducing the SPX specification. In the chart it can be seen that initial variation in quality was controlled, specific events and problems were identified and the issues between the miller and baker dramatically reduced When the instrument was finally introduced to the mill as well as the bakery, very consistent flour quality was achieved. The SPX has been adopted in this application and is providing benefits for both the miller and the baker.

The latest application of Digital Imaging again comes from development work at CCFRA. This time, it is a unique system for analysing cellular structures, which has not previously been possible to such a degree with instrumental techniques. The system is designed to replace the "expert", not another instrument. It provides an objective assessment and the data can be stored and compared to other samples.

We all recognise the Bread Slice, but what means do we have to analyse the structure and provide objective data. Many of you will have the expertise, although scores may vary, but can you communicate the analysis, can you compare it with future samples, can you put numbers into a database?

The C-Cell has many features including the ability to analyse a captured image. Data presented shows dimensions, features, cell sizes, cell numbers, elongation and faults. A great deal of information is provided and this could be used to develop an objective scoring system, tailored to the needs of the individual company.

Some examples where the CCell can provide valuable data are:

The shape and appearance of bread is analysed by the C-Cell, objectively, so it can be used to evaluate problems associated with sidewall concavity.

Different cell structures can be produced using different pressure regimes during mixing. The samples have different average cell diameters that would correlate with differences in eating qualities derived from sensory panels. Such correlations could be used in quality control and product development.

In a four-piece bread sample the C-Cell can identify the periodic nature of the structure. Parameters including cell contrast, cell vertical elongation and cell orientation can be recorded. At the joins of the four pieces the structure is essentially vertical, whilst in the centre of the four pieces, the structure is essentially horizontal.

Values indicating the degree of circulation can be provided by the C-Cell. Structures with a high degree of circulation would be typical of a single piece moulding, whether for pan breads, baguette or free standing breads.

Further examples shown compare the structure of two small bloomers. One has more cells with larger diameter and thicker cell walls. An interesting example identifying a ring core is clearly displayed by the image of cell size distribution.

C-Cell can also be used for other cellular structures apart from bread and some work has already been done with cakes and other baked products.

Conclusions

There are some very interesting developments and with the mcreased use, and speed of Data processing, the opportunity for greater control of product quality can be achieved. Powerful new tools will help us to link together and quantify the many different aspects of milling and baking quality control.

There is, however, a need for industry to work closely with researchers and instrument developers. It is a constant problem in today's industry that everyone is too busy!

Sometimes people find it difficult to communicate the real needs and issues and lack the resources to evaluate new techniques.

Question: Laurie Pearson, Northants On the C-Cell how flat has your object got to be with each sample?

Answer: Yes it is important, it's not just the light shining down on the sample it's very precisely directed parallel light so if your c\sample isn't level or its sliced badly then you are going to get shadows and effects and the computer is going to interpret it slightly differently so its important to have a good quality cut and obviously as reasonably horizontal sample as possible. It is important, people have asked in the past about looking at commercially sliced bread and yes you can get a lot of information out of it but you have to be careful that some of the data might be influenced by shadow from rough edges on the individual cells if it's not sliced carefully.

Question: Richard Ball

I've actually seen the C-cell and from the lay person's point of view how useable is this machine. Is it possible to have a text summary of what you actually see in terms of the photographs or have you got to be technically aufait <u>to really understand</u> the data?

Answer - No, 1 think you've got to be technically au fait in terms of deciding what data is important. From an operator point of view it is very simple, you pull out the draw, put the sample in and click the button. It does all the analysis automatically but it gives you a lot of numbers. Now, people with experience can decide which of those numbers are important and if you're going to use the non-expert at some point then he needs to be told what numbers are important. It's really like any specification you need a range which may be numbers of cells, it may be average cell size, that sort of thing, that it's got to meet those maybe three or four parameters. Some people just have a bread score which is one number but it would be quite easy to extract four or five numbers and give the unskilled person the ability to make that quality control decision. But you have to know what you're looking for in the first place. Each company is looking for something different.

Question: The new Farinograph models and possible alternatives, will they be lower cost or less expensive?

Answer - Yes, that's a good question. The feedback back I've got is because the Farinograph is such good value because it seems to last forever, the new models don't look as though they are going to be cheaper than the Farinograph as such but they will have the sort of added features: built in things, basic thinks like automatic water addition, so there will be a lot more features. The manufactures I've talked to don't imagine them being significantlydifferent from Farinograph prices because the Farinograph and all those other things are precision instruments, the Farinograph isn't just a mixer it's a measuring instrument and that's where the cost comes.