Perten Science World
Issue No 5

Welcome

This year Perten Instruments celebrates its 50th anniversary. It's a perfect opportunity to reflect on this proud achievement, to thank those who have contributed to the company's success and especially to acknowledge my father Harald, who founded the company.


Harald Perten

It all started in 1962 with the invention of the Falling Number method, which has been developed and standardized and today is recognized as the official world standard for sprout damage detection in grain.

Our vision and mission has been to produce methods and instrumentation which deliver accurate results, are easy to use and can be official industry standards. Over the 50 years we have built a broad product portfolio covering a wide range of analyses in the agricultural industries.

Our instrumentation, combined with the important work carried out by researchers all over the world, gives our customers valuable and reliable tools to improve efficiency and help make their businesses successful.

Jan Perten

IN THIS ISSUE

RVA used in ground-breaking starch research

Mark Bason, Perten Instruments, Australia.

Mark Bason

An RVA was specially modified to allow a beam of neutrons to shine through the starch during a standard pasting profile. Mark Bason, R&D Manager, Perten Instruments Australia and Elliot Gilbert, program leader in food science at the Australian Nuclear Science and Technology Organisation (ANSTO), have, for the first time, used neutron scattering to help unravel the changes that occur in starch structure at the molecular level during cooking.

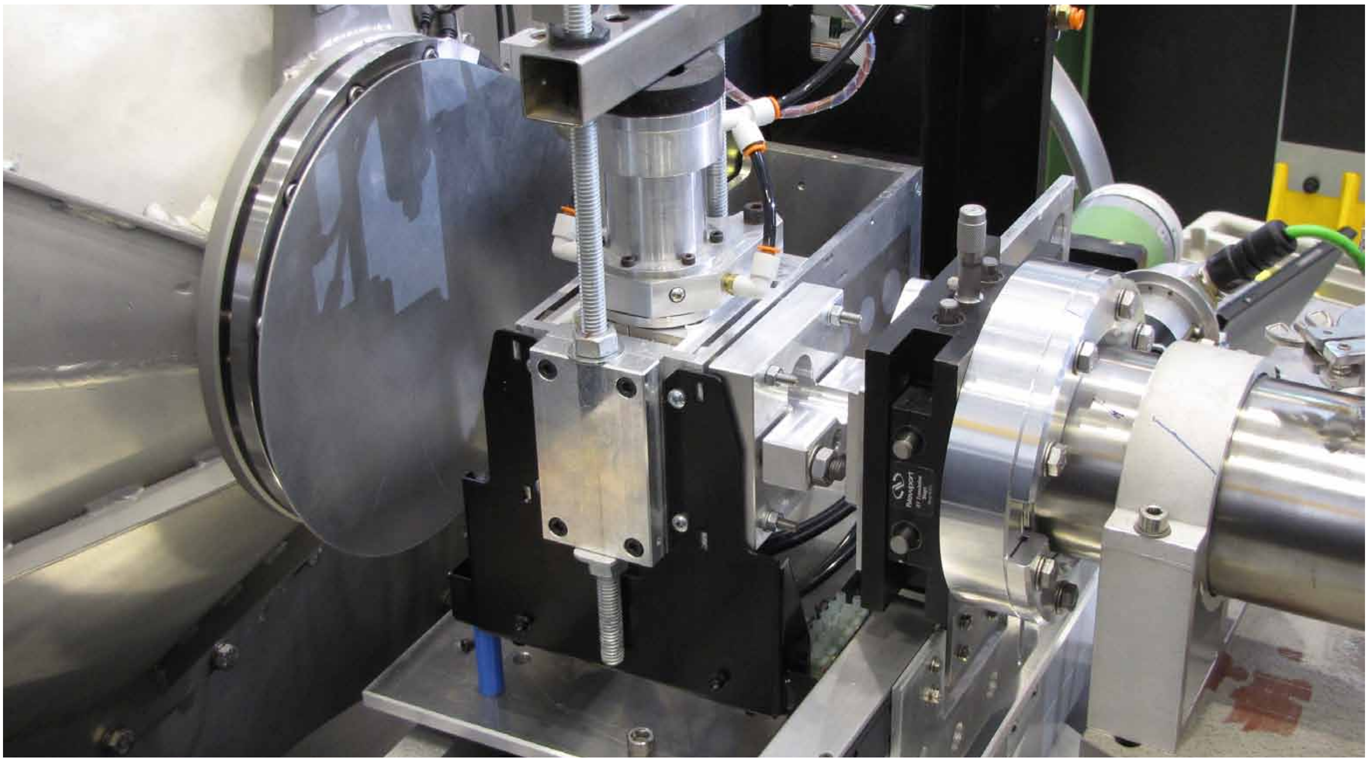
Introduction

Starch is the key carbohydrate in the human diet and the major storage polysaccharide in plants. It also finds increasing use in the polymer, pharmaceutical and biofuels industries. The native starch granule has hierarchical structure from the micron- down to the nano-scale which affects properties such as pasting. The nano-scale structural changes that accompany pasting and other starch transitions are poorly understood.

Background

Starch is deposited in granules that show considerable botanical variation in shape and size distribution (2 – 100 μm). They are composed essentially of linear amylose and highly branched amylopectin, the exact ratio of which varies depending on genomic origin. Within the granules are alternating amorphous and semi-crystalline growth ring structures. The origin of these is not well understood, but may be related to diurnal deposition patterns. The semi-crystalline growth ring structures have alternating crystalline and amorphous structures repeating every 90 – 100 Å. At the molecular level are various crystal lattice types. Cereal starches have so-called A-type, tuber starches have B-type with monoclinic unit cells and high amylose starches have B-type with hexagonal unit cells crystal structures. It is now accepted that there is an intermediate level of organisation between the lamellae and the growth rings.

A variety of granular, growth ring and molecular level mechanisms are thought to interplay when starch is heated in excess water.



nRVA fitted in the Quokka instrument's beam line.

The research team from left: Kevin James (PIAU), James Doutch (ANSTO), Elliot Gilbert (ANSTO), Douglas Clowes (ANSTO) and Mark Bason (PIAU).

Method

An RVA was modified to enable the simultaneous measurement of viscosity and small-angle neutron scattering (SANS). Starches (waxy maize, regular maize, wheat, regular potato, tapioca and acid modified maize) (3.0g) were hydrated with D2O (47.8g) instead of H2O to reduce incoherent scattering background. A modified 13 minute RVA profile starting at 25°C and reaching a maximum of 95°C before cooling to 25°C was used to paste the starch. Scattering runs were taken simultaneously with the RVA profile.

Results and Discussion

The nanometer-scale structural changes accompanying starch pasting have been measured for the first time using simultaneous SANS/RVA. SANS data were found to be divided into two regimes for the starches tested.

The first corresponded to an initial principal lamellar structure up to approximately when the peak viscosity occurs. This is consistent with starch swelling affecting the amorphous growth rings, with little change in the semi-crystalline rings.

After the viscosity reaches a peak, the lamellar scattering is replaced by a scattering pattern indicating the abrupt formation of a networked, branched polymer structure with no apparent semi-crystalline properties. It can be analysed in terms of a fractal-like gel with basic building blocks about 1nm across. There appear to be interesting variations in the relative size and complexities of the structures formed. Aggregates are formed that are several times larger, and their sizes vary across the time course of the RVA test. In waxy maize, tapioca and potato pastes, the network structures detected by SANS are relatively large. These results are consistent with a less branched or less complex structure. RVA measurements indicate that these starches have the highest viscosity. Acid modified maize, conventional maize and wheat pastes have smaller aggregate sizes. This result may correlate to a more complex structure.

Changes throughout the RVA test hint at varying levels of disruption and re-association during the pasting curve, with interesting variations around the time the holding strength is reached.

It is likely that the networks can aggregate into the larger worm-like structures that are seen with electron microscopy during retrogradation.

Conclusion

The starch granule has a hierarchical structure from the micron- down to the nano-scale which influences a number of properties of relevance from both the physiological and industrial perspective. This work offers new insights into how starch-based products are formed. Better understanding of the structure–function relationship of starch during cooking offers opportunities to improve both the products and the processes used to make them.

Adapted from: Doutch, J. et al. Structural changes during starch pasting using simultaneous Rapid Visco Analysis and small-angle neutron scattering. Carbohydrate Polymers (2-12), doi: 10.1016/j.carbpol.2012.01.066

New technology for grain moisture measurement

Bob Funk, Perten Instruments Inc., Springfield, IL, USA.

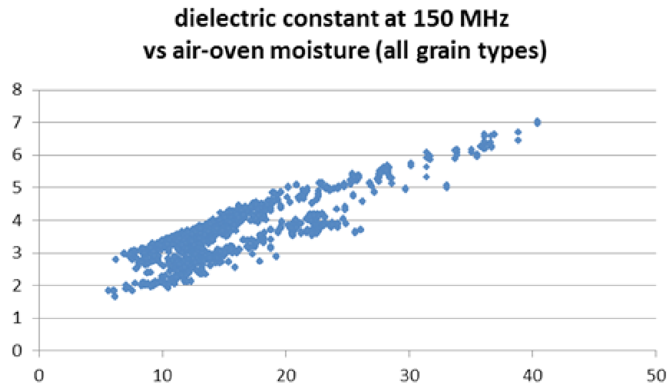
Bob Funk

Fresh insights into the nature of the electrical properties of grain, an unprecedented data bank, and access to thousands of grain samples submitted for laboratory analysis each year to the US Federal Grain Inspection Service's annual crop survey have yielded a new technology – the Unified Grain Moisture Algorithm (UGMA).

The UGMA was first presented to the grain trade by a United States Department of Agriculture (USDA) research team (led by David Funk) in 2001. This algorithm was far more than a suggestion for improving existing grain moisture meters – it was an extensively researched and exhaustively tested concept that would represent a major leap in attainable performance for rapid, objective measurement of grain moisture leading to three significant breakthroughs.

Year-to-year calibration stability

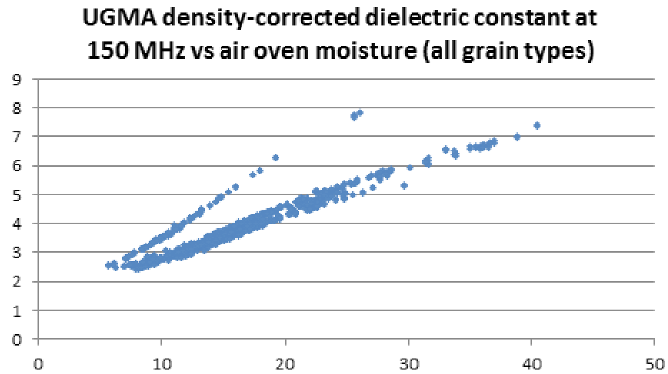
While it is well known that the dielectric properties of water are distinctive from those of the dry matter in grain, the measurement frequency for determining dielectric properties of grain are crucial. The UGMA research recommended a frequency of about 150 MHz for this determination, to minimize the surface conductivity effects that make lower frequency methods unstable. The result of this change is that year-to-year calibration stability is greatly enhanced, practically eliminating the need for annual calibration adjustments for new crops when varieties and conditions change.



At 150 MHz different grain types have very similar characteristics, although there are some differences in dielectric constants.

Improved repeatability

The packing density of free-flowing grain is not consistent, which previously frustrated attempts to accurately measure moisture content in bulk. The UGMA introduces a new density correction technique that accurately adjusts for packing density over a wide range of conditions. This technique, along with the advantages of the higher frequency method, results in dramatically improved repeatability (precision) for most grain types.

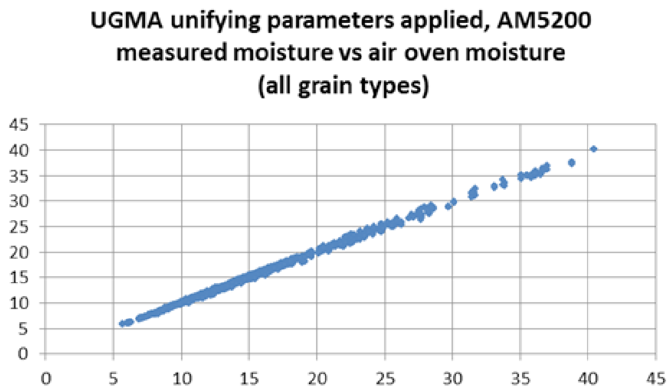


After correcting for density most of the scatter disappears, and the different grains fall into two groups.

Single calibration

A single calibration line accurately models the dielectric response of moisture in every grain type tested, with the application of simple linear adjustments. This unified calibration means that UGMA-based moisture meters are essentially one-calibration systems. The unifying parameters assigned to each grain type are easily derived with a relatively small number of reference points.

The UGMA was presented to industry as an opportunity for all stakeholders in the grain trade to benefit from breakthrough technology in a competitive environment. The first commercial grain moisture meter using the UGMA was introduced in 2006 (Perten Instruments model AM 5100), followed by Perten's second-generation UGMA meter AM 5200 in 2011. The USDA is converting the US official grain grading system to UGMA as the official moisture method, beginning in the fall 2012.



When unifying parameters have been applied, all grains line up and there is a perfect correlation between air oven moisture and moisture reported by the AM 5200.

Mark Bason, Chair of Rice Milling and Quality Technical Committee

Mark Bason, R & D Manager at Perten Instruments Australia, has been elected as the new chair of AACC's Rice Milling and Quality Technical Committee. Bason's program for the committee includes publishing on RVA rice pasting in Cereal Foods World, considering harmonizing with the new ISO method to measure amylose, surveying committee members about rice methods they would like to see assessed and published, and a satellite workshop to develop a visual method to assess chalkiness in rice kernels.

In-line NIR analyzer for meat and poultry

The United States Department of Agriculture (USDA), Dairy Grading Branch, Equipment Design Review Section has certified that the DA 7300 In-line NIR analysis system complies with NSF/ANSI/3-A 14159-1-2010 Hygiene Requirements for the Design of Meat and Poultry Processing Equipment. This approval brings value to the meat and poultry industries and means that the DA 7300 can be installed and used in meat and poultry facilities requiring sanitary designed instruments and equipment.

NTEP approves grain moisture meter

NTEP has approved the AM 5200 for moisture measurement and test weight of grains and oil seeds including wheat, corn, and soybeans from -20°C to 45°C (-4°F to 113°F). This removes the need to thaw frozen samples before analysis.

Real-time graphs with NIRView

NIRView process monitoring software presents measurements from the NIR sensor to operators in real time. NIRView shows trend charts as well as current measured values. Each constituent measured is presented in a separate graph, with up to 8 graphs displayed simultaneously. Chart timelines are user selectable, and it is easy to add upper/lower control limits and specification limits. Additional features include reports, alarms and recipe handling. Reports provide statistics such as min., max. and process capability indexes, calculated per constituent, and presented in a table.

RVA contributes to efficient bioethanol production

Biofuels from non-food plant material are an ecologically and ethically acceptable solution to our desire for environmentally friendly alternatives to petroleum derived vehicle fuels. The RVA can be used to understand the liquefaction process in an effort to reduce total enzyme use and decrease the costs of producing bioethanol from high-solid lignocelluloses. Read the paper at:

www.biotechnologyforbiofuels.com/content/4/1/2

On-line and In-line NIR customer support in North America

A dedicated Process Instrumentation Group now offers On-line and In-line NIR customer support in North America. The group is headed by Ralph Hewitt who brings years of experience in plant operations and QC management at large grain and food processing facilities such as Cargill, ADM and Pinnacle Foods. It also includes systems integration, applications development and product hardware specialists who work with a network of vendors capable of assisting Perten Instruments North America to respond to the needs of their customers. The Process Instrumentation Group will manage everything from site evaluation, installations, systems integration and applications development through to training, and support.

RVA instruction video

Now RVA users can study at their own pace with a simple Quickstart video instruction manual. It includes RVA installation, software setup, sample preparation, selecting and running a starch test, analyzing the sample and reporting results as well as safety advice and 'tips and tricks'. The instruction video will be shipped with all new RVAs and will also be available on YouTube.

Come and see Perten Instruments products and meet Perten Instruments representatives.

AOCS: USA, Long Beach, CA, Apr 29–May 2
Cibus: Parma 2012: Italy, Parma, May 7–10
IAOM: USA, Spokane, WA, May 8–11
INGESA: Austria, Salzburg, May 10–12
Feed Trading: Germany, Burg Warberg, May 15–16
Nordic Cereal Congress: Sweden, Gothenburg, May 23–25
Foodtech: The Netherlands, Rosmalen, May 23–24
Grain Trading: Germany, Burg Warburg, Jun 11–12
ACHEMA: Germany, Frankfurt, Jun 18–22
IFT: USA, Las Vegas, NV, Jun 24–29
http://www.am-fe.ift.org/cms/?pid=1000477
Fuel Ethanol Workshop: USA, Indianapolis, IN, Jun 27–30
Milling Technology Meeting: Germany, Detmold, Sep 11–13
Space: France, Rennes, Sep 11–14
IBA: Germany, Munich, Sep 16–21
HET Instrument: The Netherlands, Amsterdam, Sep 25–28
AACC: USA, Hollywood, FL, Sep 30–Oct 3
IPA: France, Paris Nord, Oct 21–25
Müllereitagung/milling technology meeting: Germany, Volkach, Oct 25–27
FoodPharmaTech: Denmark, Herning, Nov 13–15
Bakery technology meeting: Germany, Detmold, Nov 13–15