Advances in Texture Analysis for dough and baked products

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Abstract

Texture Analysis provides an objective and repeatable approach for quantifying the textural attributes of: bakery ingredients, processed materials and finished products. This information can be used in the following ways: to complement sensory evaluation, to provide a fundamental/empirical measure of mechanical properties, or as a process performance measure. From the early investigations into 'Texture Profile Analysis' in the 1960s using standard materials testing equipment Texture Analysis has developed considerably. The testing of finished baked products inevitably leads to sensory/instrumental correlations. In the case of measuring the crispiness/crunchiness of products a steady development of advances has occurred over the past 15 years. The latest and most exciting of these gives us the ability to measure the acoustic emission of brittle products under controlled deformation. The Acoustic Envelope Detector has been proven by Professor Malcolm Povey at the University of Leeds, UK, to detect individual fracture events. The number of acoustic events and their magnitude can therefore be used differentiate between products that can often have a similar force/distance behaviour. The biaxial extension of dough has been possible for some time providing us with a measure of dough tenacity and extensibility, and successful correlation has been achieved between data from the Dough Inflation System (DIS) and loaf volume. It is now possible to perform DIS tests up to 60°C thus more closely simulating the environment during proving trials will be presented obtained from the University of Reading, UK.

Media summary

Texture Analysis now provides essential understanding into acoustic and rheological properties of foods.

Key Words

Texture Analysis, acoustics, dough inflation, bakery products.

Introduction

Since antiquity agricultural crops have been converted into food products for purchase by the consumer. One of the benefits of industrialisation has been the enabling of large-scale food processing of ever-increasing size and sophistication. This advancement now makes it possible to closely control product quality for texture and taste characteristics, on the basis of a reliable quality measurement system. Traditionally, quality assessment has been conducted by trained personnel performing sensory checks. Human sensory responses are by their very nature subjective and they are also more difficult to quantify. In recent times instrumental systems have been developed that can objectively quantify textural parameters. This paper deals with the development of instrumental textural analysis and shows examples of the very latest advancement through acoustics and dough inflation measurement.

The earliest example of force measuring equipment used for foods was the Lipowitz Jelly Tester in 1861. This and the later Bloom Gelometer of 1925 were mechanical systems that allowed the user to measure the quantity of lead shot required to either rupture the gel or move a certain distance into the gel via a cylindrical probe. Texture Profile Analysis was conceived by Sczezniak in 1963 who established that instrumental texture profiles could be used to calculate sensory parameters. These instrumental parameters were shown to correlate well with human sensory data. Since then, advances in electronics and computer technology have generated more highly-developed systems that can display profiles revealing the full force/displacement relationship of foods.

Acoustic measurement

Acoustic measurement involves the recording of sounds produced during the displacing of a probe into a crisp food product. This enables quantitative information regarding the crisp, crunchy or crackly sounds to be obtained using acoustic detection devices (Duizer 2001). Historically, little research has been done on combining acoustics with force/displacement measurement. This combination enables much greater control of the deformation of foods and provides more repeatable results. Stable Micro Systems has provided the means to couple precision acoustic measurement within a standard food texture test. Sound energy is captured using a field-free microphone (Brüel and Kjaer, Naerum, Denmark) from a corner frequency starting at 1kHz up to 12.5kHz. The frequency 'envelope' covers the human audible frequency range experienced by most people of unimpaired hearing (Vickers, 1979). Within this 'envelope' sound energy is measured in decibels sound pressure level up to a maximum of 114dB. Sound energy emitted during the fracture of foods is therefore captured as pulses of energy on the dB scale. Moreover, the sound energy curve can be viewed synchronised with the force data versus displacement. As a way of proving the validity of the approach taken comparison of the dB output with the logarithm of the second differential of the force data has shown good correlation. This demonstrates clearly that the amount of sound energy captured equates to the amount of mechanical energy released on deformation (Chen et al. 2005, Varela et al. 2006). The success of the approach has been demonstrated through good correlation between numbers of acoustic events and sensory measurements across a range of bakery products (Chen et al. 2005, Piazza et al. 2006).

Dough Inflation

The Dough Inflation System (DIS) uses pressurised air to inflate dough bubbles under controlled conditions. This kind of technique, often termed biaxial extension, has been possible for some time providing us with a measure of dough tenacity and extensibility (Dobraszczyk 1997). The process of inflating dough can be displayed graphically as pressure (mm) versus distance (mm), which gives an empirical measure of dough performance. However, the data can be displayed as stress against Hencky strain. By transforming the data in this way successful correlation has been achieved between data from the DIS and actual finished loaf volume (Dobraszczyk 1998). It is now possible to perform DIS tests at elevated temperatures that more closely relates extensional rheological characteristics to breadmaking performance (Dobraszczyk et al. 2003).

Conclusion

The application of Texture Analysis to bakery products has shown clear development from a tool that provides sensory/instrumental correlations on finished products using conventional force/displacement profiles. It is now possible to probe deeper into the structure of crispy/crunchy products using acoustics. This makes more detailed sensory correlations possible. In addition to this by examining dough rheological behaviour through biaxial extension breadmaking performance can be both measured and improved.

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