A DEEP LOOK INSIDE OUR CORNFLAKES

The INSIDEFOOD project develops high-tech solutions for monitoring food microstructures

The project: Measuring food microstructures for the development of new food properties and products

Cereals are, after milk and fruit, the product most consumed by Europeans – flakes are eaten in the morning, bread accompanies any meal and crackers act as snacks. The delivery of constant and stable starch qualities to these products depends on good processes in food manufacturing. Looking into the food's microstructures, many transport characteristics can be better understood, such as colours, crispness or crunchiness.

Food processing operations affect food microstructures: existing structures are destroyed and new ones are created. For instance: the sugar and gluten contents of manufactured pastry can be better controlled through technological measurements; the sponginess of bakery and pastry products can be better steered through knowledge of the microstructures. Not only should processed food be better monitored for optimised qualities, the microstructures of fresh and dried fruit should also be the subject of closer inspection in order to identify foreign content, to detect bitter pit, core browning or water cores. To make significant steps towards improved food monitoring, the project INSIDEFOOD focused on using different technologies to measure the microstructures of the products: 3D imaging, measurement of water and soluble status, texture properties and optical properties. The project was completed in May 2013 and is now looking to apply the spin-offs in several ways.

The product: 3D-imaging, sensor, and x-ray instruments for texture measurement, optimised processes, applications

The aim of INSIDEFOOD is the design of dedicated applications for fruit and cereals: sugar, and gluten-free products were given particular attention, as these two restrictions have a crucial influence on the texture of cereal products. Crispy dried fruits as healthy snacks containing vitamins, minerals and fibre were tested as well as new extracted cereals which were tested for enhanced crunchiness.

Foams, gels, cereals and fruit were the research models in the INSIDEFOOD project. The researchers inspected them with scanners and optical techniques which were already available in bio-medicine. Along with this, INSIDEFOOD developed new and accurate technologies that signal changes in the internal food composition and microstructures, especially of micro-porous foods containing large amounts of air. The quantum leap was the 3D visualisation of internal food structures without destroying them.

Various 3D imaging methods were optimised. Almost all investigated methods operated in a contactless mode, which is a prerequisite for future at-line or in-line measurements. Special emphasis was put on speed, sample size, field of view, penetration depth, contrast and sensitivity to micro-structural differences. Spectroscopic techniques (NMR relaxometry), and slow Magic Angle Spinning (MAS) were optimised to extract information about the water and solute status of microstructured foods. Other notable successes have been the acquisition of the first on-line NMR relaxation spectra of apples using a prototype on-line NMR sensor and the discovery of useful correlations between the MAS spectra and the effects of storage.

Appropriate methods and parameters were selected to determine mechanical and acoustic properties of the model foods. Microstructure was shown to have a larger effect on the texture of candy model gels than the chemical composition. In addition, quantitative data was collected on the texture properties of the food products using force-deformation measurements in parallel to acoustic measurements. The obtained results can be applied to monitor and control the texture of food products in industrial conditions.

Optical systems based on time, and space-resolved reflectance spectroscopy (TRS and SRS) were optimised for the project's model systems, and upgraded systems were successfully made operational in the lab. Physical models have been delivered to describe water transport and light propagation in complex microstructured fruits. For the first time, water transport in

fruits was quantified at the micro-scale level explaining the relative importance of the different microstructural features for water transport.

Non-contact sensor technologies have been optimised for real life on-line and at-line food applications.

New technologies: Industrial products, prototype sensors, modeling software

Industrial products:

- Desktop Nano- and Micro-CT for micro-structure assessment of fruit and bakery products
- 3D-visualisation and analysis software
- New technological applications of HR-MAS and micro-MRI spectrometers

Prototype sensors:

- Fast and compact OCT sensor for contactless fruit-surface-quality assessment, dynamic assessment of rehydration processes, measurement of coating effectiveness
- Low-cost on-line MRI sensor for internal quality inspection of fruit
- TRS and SRS spectroscopy sensors for at-line screening of fruit quality
- Acoustic emissions sensor for at-line measurement of cracker texture

R&D modelling software:

- Moisture transport in microstructured foods
- Light penetration in foods
- Multivariate statistics

The end-users: Food manufacturers, SMEs and labs, the scanner and sensor industry, food consumers

Food manufacturing and crafts will benefit from research and development results in order to optimise the quality of processed food, to control health properties and to optimise processes in waste and energy reduction and to increase labour productivity.

SMEs and labs will benefit from new analysis, and control-technologies ICT industries and device-producers will adapt existing scanning and sensing technologies towards 3D visualisation and 3D printing of food.

Consumers will benefit from the enhanced food quality.

The inventors: Academics, research institutions, technology producers, ICT industry, food industry

12 partners across Europe collaborated in the project.

Research institutes: University of Leuven, BE; RECENDT, AU; Institute of Food Research, UK; Politecnico di Milano, IT; Universidad Politecnica de Madrid, ES; Warsaw University of Life Sciences, PL.

ICT and sensor companies: VSG, FR; Bruker micro-CT, BE; Bruker BioSpin, DE.

Food sector: Flanders Centre of Postharvest technology, BE; Chaber, PL, Nestlé, CH.

INSIDEFOOD addressed several sensor technologies and 3D-visualisation techniques for the optimisation of food processing focusing on the production of new bakery products, the process-control of downstream processing of breakfast cereals, and the optimisation and process-control of osmo-air dehydration of fruit.

A list of the concrete achievements and inventions of each consortium member can be received from the technology transfer manager of INSIDEFOOD, Pieter Verboven at KU Leuven (Pieter.Verboven@biw.kuleuven.be).

Development stage: Proof of concepts, demonstrators, market readiness

Several technologies are already on the market now through one of the partners in the consortium (Bruker BioSpin, Bruker micro-CT, VSG), while others are in a more advanced level of technological readiness. In a follow-up phase for these techniques we seek to set up collaborations with interested end-users or technology developers to bring the technology closer to the food industry. A detailed status of the different technologies can be found in the Assessment Report of the technologies that can be downloaded from www.insidefood.eu.

Policy impact: Competitiveness of the European bio-economy, ICT and sensor industries

As INSIDEFOOD's focus is predominantly on business, the contribution is to enhance European competitiveness and innovations in the food industry and to create new jobs and growth in high-added-value productions and in high-tech industries. The RTD efforts of the project are in line with the Europe 2020 strategy for smart, sustainable and inclusive growth.

Next steps: More practical applications

Current initiatives include continued R&D efforts through large scale projects such as PICKNPACK and TOMFOOD (e.g., www.picknpack.eu, www.tomfood.be) and multiple bilateral collaborations between R&D partners and interested end-users. Food-industry or sensor-technology developers are invited to contact us to discuss more dedicated tests and potential collaborations towards practical applications.

The prime target sector for the INSIDEFOOD project is the entire food industry. New technologies, products and processes made possible by the sensors developed by INSIDEFOOD will contribute to the increased innovation performance of food companies and enhanced labour productivity.

INSIDE FOOD
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