



Fresh on demand

Quality and sustainability in Fruit and Vegetable chains

Factsheets



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Quality and sustainability in fruit and vegetable chains

How to maintain high product quality of fruit and vegetables while reducing the use of chemical pesticides and environmentally harmful packaging? How do cooperating parties in the chain ensure they can continue supplying fresh, high-quality products? And to what extent can this increase consumption of fruit and vegetables? These and other research questions were examined in the Fresh on Demand project.

Results

The Fresh on Demand project consisted of seven sub-projects:

- 1 Biomarkers for quality
- 2 Taste and non-destructive measurements
- 3 Intermodal transport of perishables by rail
- 4 Optimising the tropical fruits chain quality
- 5 Firm, tasty blueberries
- 6 Food safety of cut fruit and vegetables
- 7 Development of a dynamic packaging concept

For each of the sub-projects, the research outcomes, scientific innovations and relevance for the sector have been summarised in the factsheets.



Volatile Organic Compounds (VOCs) as BIOMARKER for fruit quality

During the storage of fruit small amounts of gases (Volatile Organic Compounds, VOCs) are released. The composition of these VOCs is a BIOMARKER for the quality of the fruit. Fruit flies have known this for a long time: they know how to find rotting fruit flawlessly. The aim of this research is to identify measurable VOCs that can serve as a biomarker for fruit quality, with a primary focus on red currant and pear during long-term Controlled Atmosphere (CA) storage.

About the research

During three storage seasons lab experiments have been conducted with red currants. VOCs and fruit quality were regularly analyzed. In another lab experiment, pears were infected with various fungal species, including *Cadophora* (fish eye rot, a.k.a. side rot). Produced VOCs and mold growth have been monitored. Many ad hoc practical measurements have been carried out to get an impression of the VOCs that occur in commercial storage rooms in specific situations.

Scientific innovations

A correlation has been shown between VOCs and the quality of red currants during long-term CA storage. In lab experiments VOCs were identified that are specific to common fungi in pear storage.

Relevance for sector

Monitoring VOCs gives an indication of the quality of fruit during storage, and can therefore help in optimizing the sales moment.

"Some VOCs are an indicator of fruit quality, and those VOCs are measurable in CA storage rooms"



For more information about the project and the partners, please visit:

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Ministry of Agriculture,
Nature and Food Quality



Taste and non-destructive flavour prediction

The flavour of a tomato is a critical factor that can influence consumer preference and satisfaction. Therefore, assessing the flavour of tomatoes accurately and efficiently is crucial for maintaining quality.

About the research

The aim of the project is to apply non-destructive optical and radio frequency based sensors for measuring quality parameters of tomato, including Brix, acidity, firmness and human flavour perception. To this end, 10 measurement sessions with twenty varieties each were carried out. In these sessions, several tomato cultivars grown under different conditions were measured both destructively, assessed by sensory panels and measured with a broad range of non-destructive sensors. Several tomato sensorial parameters were predicted based on non-destructive measurements. We also successfully developed a model to predict liking with near-infrared (NIR) spectroscopy using a commercially available sensor.

Scientific innovations

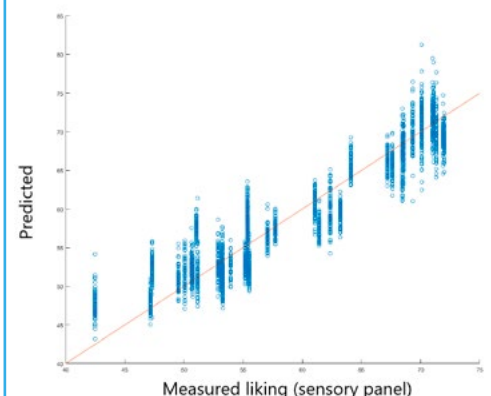
We compared a wide range of sensors and their ability to predict various sensorial attributes on a large range of tomato varieties grown under different conditions. This resulted in a broadly applicable taste model for the sector. The model will be made available for a commercial sensor. Further development and improvement -beyond the data acquired during the project- will help to increase the model robustness. Another interesting finding was that data from novel sensors using radio frequencies in the GHz range also showed good correlations with tomato quality parameters.

Relevance for sector

The model offers a quick, objective, and less labour-intensive alternative to traditional sensory analysis and has the potential to transform the industry by improving flavour prediction, breeding selection, reducing waste, and increasing productivity.

"The model offers a quick, objective, and less labour-intensive alternative to traditional sensory analysis"

Example of predicted liking based on non-destructive measurements vs. liking as scored by a sensory panel.



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Perishables by rail – improving temperature homogeneity in 45ft reefers

Europe experiences a growing interest in long distance rail transport of perishables. In this project we worked on the development of an improved version of a 45ft reefer for transport of perishables by rail to China. The gained insights are relevant to any transport modality.

About the research

A large number of climate chamber tests has been conducted: measurement of energy consumption, airflow and temperature in dozens of locations within stuffed reefer containers in many operating conditions imposed in a climate chamber. The collected data gave valuable insights and were used for Computational fluid dynamics (CFD) model calibration and validation. In-depth studies have been performed to unravel the insulation value of insulated 45ft reefers.

Scientific innovations

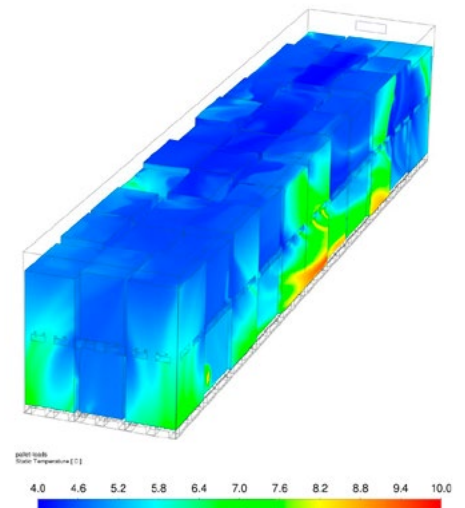
An advanced CFD model was set up to accurately predict airflow and temperature distribution in refrigerated transport equipment. Based on the CFD simulations a new air chute design is proposed for better temperature homogeneity.

A measurement methodology was developed and tested to measure the insulation value of individual container wall sections.

Relevance for sector

A 45ft reefer container has been developed which is better suited for (very) long distance rail transport than any earlier equipment: more uniform temperatures and access to further destinations without refuelling. Understanding of the key success factors helps adequate repetition in other applications.

"Temperature homogeneity: the underrated aspect of refrigerated transport"



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Optimising the postharvest chain for papaya

Research work in the subproject 'Optimisation of the tropical fruit supply chain' aimed at achieving a good papaya quality for the consumer, while taking into account sustainability requirements. This topic is highly relevant for the shipment of 'Tainung' papaya from Brazil to the European market. Sea freight instead of air freight brings economic and environmental advantages. But at the same time the challenge and goal is to maintain papaya quality as high as possible.

About the research

The main points of attention for papaya quality are better control of the ripening, less water loss and mould reduction. In trials on site in Brazil, but also in shipments from Brazil to the Netherlands, tests were done with new technologies which are or will soon become commercially available. Both MA (Modified Atmosphere) packaging (PerfoTec) and the use of hypobaric storage chambers (RipeLocker) have given good results, especially on the control of ripening and reduction of water loss. Both technologies will be further optimised for papaya export.

Scientific innovations

Colour analysis and Near Infrared Spectroscopy have been explored as objective and non-destructive techniques for evaluation of papaya maturity and quality. The colour analysis by the 'Smart Colour Inspector' proved to be useful for external and internal colour analyses.

Relevance for sector

It is essential that the long transport time from production site to the shelf in European supermarkets occurs at optimal conditions. First of all, maintaining the cold chain is of high importance. The further success of MA or hypobaric storage depends on the quality at harvest (low mould development risk). Under these conditions, both technologies are very promising to fulfil consumer demands and avoid product waste.

"The project partnership brought various chain partners and experts together which provided an unique chance to improve external and internal papaya quality"



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Blueberry quality in the chain

There is a year-round market demand for high quality blueberries. **Textural parameters as firmness and mealiness are key.** The project goal is to develop a **reliable, fast and objective assessment method** that can support quality management in the industry.

About the research

The research has delivered:

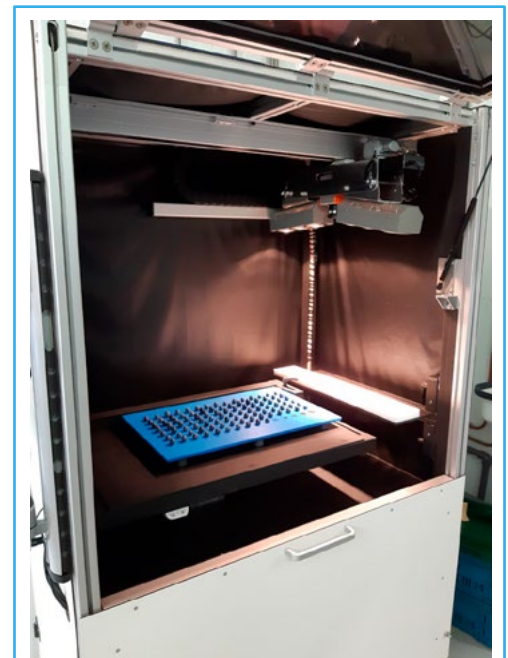
- an assessment method to measure the firmness of blueberries based on Hyperspectral Imaging (HSI), non-destructive and very fast.
- accuracy and robustness of the assessment method validated with blueberries from different cultivars, growers and distribution chains.
- sample size defined: how many blueberries in a batch should be measured to achieve the necessary accuracy.

Scientific innovations

Texture is the most complex (sensorial) quality aspect to be reliably measured. The application of HSI to predict firmness, mealiness and internal breakdown in blueberries is a new development. In addition, a number of other techniques, from Terahertz radiation to an impact deceleration based instrument, have been studied and insight in their potential is now available.

Relevance for industry

Year-round blueberries supply is currently achieved through the geographical segregation of production and relies on global logistics to ensure (long) distance distribution. At the same time blueberries should be picked at a near to full ripe stage, which makes quality management very challenging. The developed assessment method is fast and objective and can support the industry to **manage blueberry quality successfully and avoid unnecessary losses in the supply chain.**



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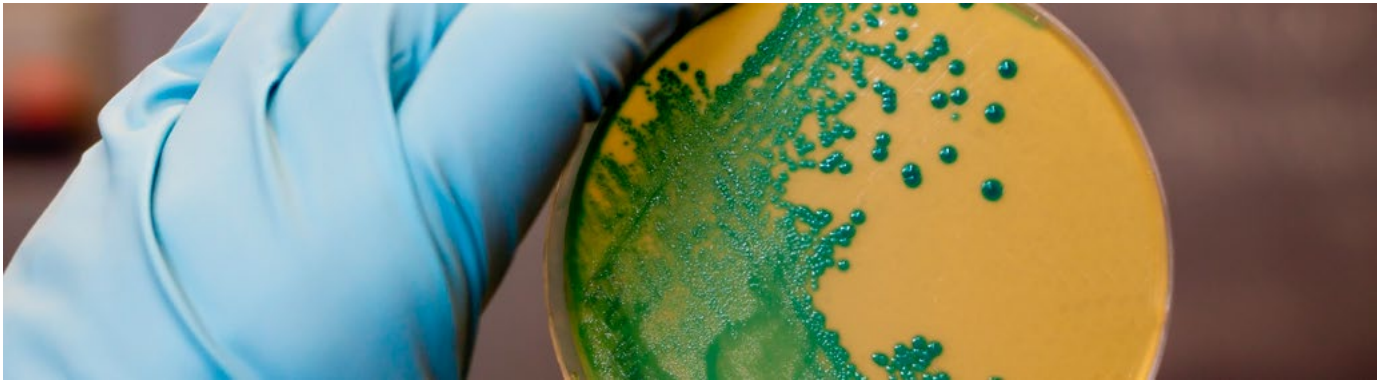


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Listeria monocytogenes growth relevant to minimally processed vegetables

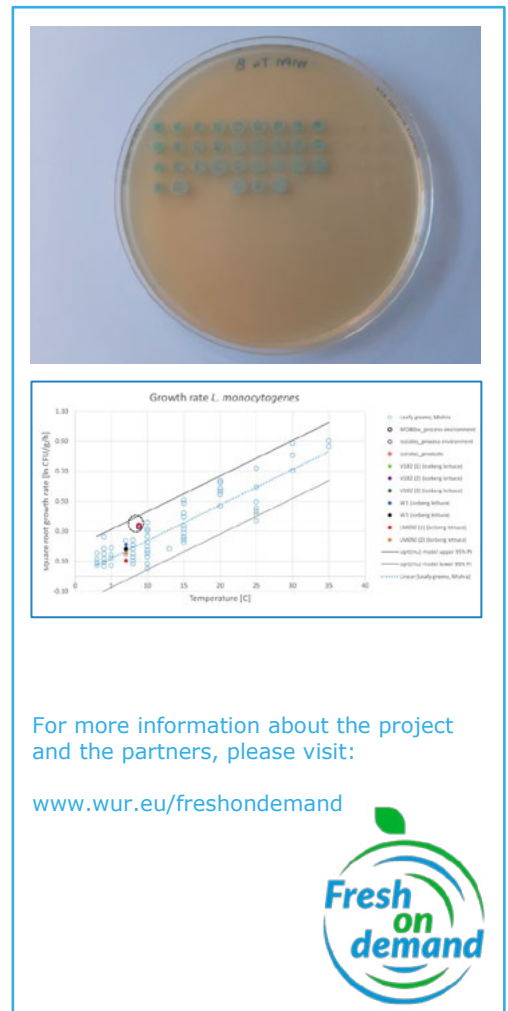
For minimally processed vegetables, manufacturers should demonstrate that *Listeria monocytogenes* (*Lm*) levels will not exceed 100 cfu/g during shelf life. Challenge tests provide information on the growth behavior of *Lm* on a product. Technical guidance at EU level describes the use of *Lm* reference strain(s) from a characterized strain set. This strain set does not include isolates from vegetable products. Information on maximum growth rates of *Lm* strains isolated from vegetable products can be used for selection of relevant strains in challenge test and allows for more accurate prediction of expected cell numbers in growth models.

About the research

A set of 37 *Lm* strains previously isolated from vegetable products or its process environment were characterized for maximum growth rate at 8°C in a culture broth and for a selection of strains on iceberg lettuce. Experimentally determined growth rates were compared to data from literature and are in line with those reported for leafy greens.

Relevance for sector

Growth rates of *Listeria monocytogenes* isolates from vegetables have been determined in broth and on iceberg lettuce and can be used for more accurate prediction of growth on minimally processed vegetables.



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Sustainable packaging based on side stream starches

Rodenburg Biopolymers and Wageningen Food & Biobased Research developed a pilot scale production process of a 100% certified renewable packaging film based on side stream starches. The film is claimed to be economic viable due to specific dynamic barrier properties. This film can be an alternative for fossil-based fresh food packaging and a possible high value application of side stream starches. In this project, the usage of the film for the packaging of (fresh-cut) vegetables and fruits was studied.

About the research

The research was performed in three iterations:

1. Optimisation of the film by varying the composition of the base resin and the structure of the film. Physical properties and gas barrier permeability were analysed on lab level.
2. Classification of products to be packed based on respiration rate and modified atmosphere requirements, followed by shelf life tests.
3. Investigation of behaviour of the sustainable packaging film on industrial packaging line of project partner Koninklijke Vezet B.V.

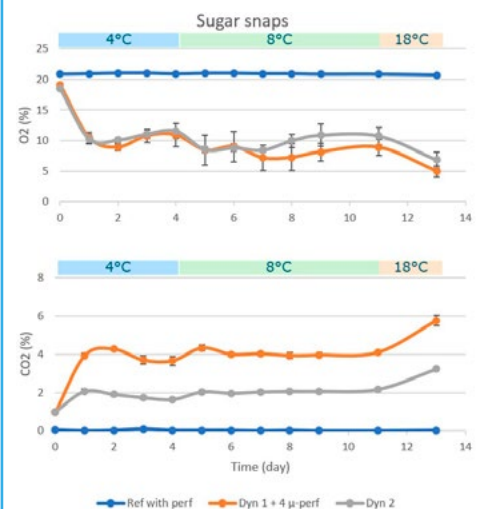
Scientific innovations

By a specific combination of hydrophilic and hydrophobic polymers, a packaging film with dynamic barrier properties can be created. Thanks to adjustment of the various Gas Transmission Rates, an optimal Modified Atmosphere condition can be reached much faster than by conventional packaging. Due to the dynamic behaviour of the gas barrier, fluctuations in temperature and relative humidity during shelf life are compensated.

Relevance for sector

A packaging film based on side stream starches that assures a longer shelf life of fruit (e.g. grapes) and vegetables (e.g. sugar snaps) is a real breakthrough. This will reduce food waste and diminish the use of fossil-based packaging materials.

"Usage of agricultural side-streams in packaging applications can bring more than only an increase of biobased content"



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More information

Fresh on Demand is co-financed by the Ministry of Agriculture, Nature and Food Quality (TKI, Top Consortia for Knowledge and Innovation), Fresh Produce Center and an extensive group of private companies from growers to suppliers of sensors and technologies.

Curious to learn more about the results of the project or what experts of Wageningen University & Research can do for your company? Please visit www.wur.eu/freshondemand.



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