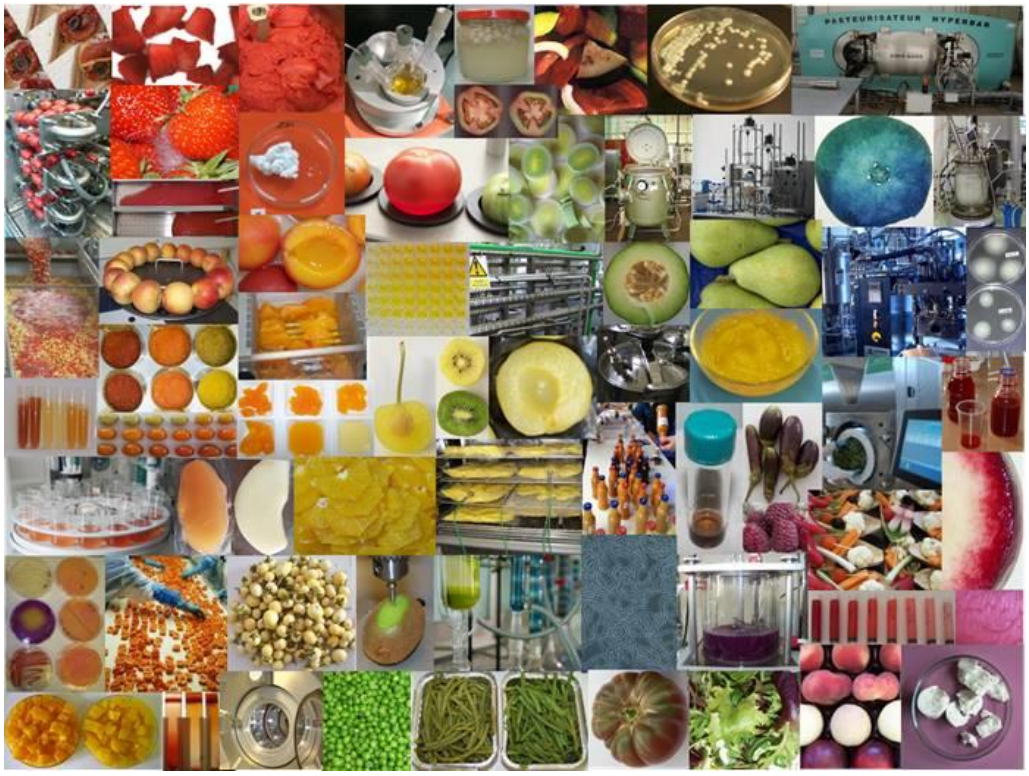
Fruit & Veg Processing

Catherine M.G.C. Renard

Fruit & Veg Processing

2nd Euro-Mediterranean Symposium



Avignon, 4-6 April 2016

2nd Euro-Mediterranean Symposium on Fruit and Vegetable Processing

An integrated view on sustainability and how it can interact with quality, safety and the consumers

Sustainable processing for high quality Fruit & Vegetables

Fruit and vegetables are an essential part of a balanced diet, both for nutrition, taste and diversity, and they are mostly consumed as processed products. How will we be able to meet the challenge of inventing more sustainable ways to process fruit and vegetables and deliver them to the consumers? How will we ensure that they allow at least the same levels of quality, of safety, of convenience and consumer acceptability? That they decrease losses and waste? That fruit and vegetable part in food patterns is maintained or increased?

This demands a new look at Fruit and Vegetables Processing to enhance its sustainability, i.e. decreasing losses and waste , inventing or identifying more sober processes, having a renewed look at fermentation and biopreservation, developing plant extracts to replace chemical additives, finding means to deal with different and more variably raw materials, …

For this interdisciplinary research is needed, bridging the gaps between safety, quality, nutrition, production, consumer science and process engineering. Therefore this symposium will bring together these different aspects of research in the food science community, including academics, transfer organisation and R&D researcher of the fruit&veg processing industries.

The Symposium will consider the sustainability issues in the specific case of Fruit and Vegetables Processing, with particular focus on their specific research questions, linked to

1) New, sober processes that may be applied to stabilize fruit and vegetables while meeting consumer demands for “natural” foods;

2) their interest as sources of micronutriments, to questions on bioaccessibility of these same micronutrients;

3) The challenges due to intrinsic variability and fast evolution of the raw material;

4) The consumer interest, with disaffection in younger generations, with a fear of pesticide contamination.

Following the successful Fruit and Vegetables Processing symposium in 2011, it is now time to bring together the recent advances and identify the new challenges facing Fruit and Veg Processing, notably in terms of sustainability and adoption by the new generations.

A word of welcome

Dear Attendees,

On behalf of the members of the scientific and organisation board, it is my great pleasure to welcome you to the Second Euro-Mediterranean Symposium for Fruit and Vegetable Processing.

I hope you will all find interesting results and challenging discussions as well as identify people with whom to work in the future.

I wish you all a fruitfull Symposium and a very pleasant stay in Avignon.

Catherine Renard

Head of the Unit for Safety and
Quality of Plant Products
Convener of the Symposium

Contents

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The Symposium is organised by INRA and the University of Avignon, co-organisers : CTCPA and Optifel with support from Effost, Terralia and Agropolis.

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Grants

The organisers wished to promote the participation of young scientists from Mediterranean countries and new members of the EU, in order to support the building of an academic network on Fruit & Vegetable processing. Selection criteria will be scientific excellence and potential practical applications.

The eligibility criteria were:

- **Young scientists**, less than 35-years-old at the beginning of the symposium
- and residents in one of these countries:
  a Mediterranean countries, including Portugal but not France
  new members of the European Union: Bulgaria, Estonia, Hungary, Latvia, Lithuania, Poland, Czech Republic, Romania, Slovakia, Slovenia

The Scientific Committee would like to congratulate our grantees from Nigeria, Romania, Portugal and Italy that will present their work (oral communications):

Jaari Adekunle from the University of Ibadan (Nigeria):
"Evaluation of heavy metals and health risk index in *Amaranthus hybridus* L. vegetable grown in selected frams in Ibadan, nigeria"

Mihaela Geicu-Cristea from the University of Agronomic Sciences and Veterinary Medecine of Bucharest (Roumania):
"Consumption and attitudes regarding berries-based products – comparative analysis of Romania and France"

Ricardo Malheiro from the Polytechnic Institute of Bragança (Portugal):
"Addition of olive leaves improve the sensorial and volatile fractions of olive oil from cv. Cobrançosa"

Ana Meireles from the University of Porto (Portugal) :
"Persistence of pathogenic and spoilage bacteria in a minimally processed vegetables plant"

Stella Plazzota from the University of Udine (Italy):
"Effect of high pressure carbon dioxide on the storage quality of unpasteurized apple juice"

Mauro D. Santos from the University of Aveiro, Portugal:
"Watermelon juice and melon juice preserved by hyperbaric storage at variable (uncontrolled) room temperature as an alternative to refrigeration"

Marielena Di Biase from the Institute of Sciences of Food Production, Bari (Italy):
"Biopreservation of nutritional and microbiological features of ready-to-eat vegetables processed by the probiotic strain *Lactobacillus paracasei* LMGP22043"

Catherine Bowe from Northumbria University, Newcastle (UK)
"Improving sensory perception by compensatory pathways on populations with sensory impairments"

Programme

Monday 4 April 2016

10h00 – 13h30 Registration – Setting up poster session 1
12h00 – 13h30 Welcome brunch
13h30 – 14h00 Welcome speeches

Georges Linares – Vice-Président for Research, Université d'Avignon et des Pays de Vaucluse;
Michel Bariteau – President of the INRA Center PACA;
Catherine Renard – Head of the Unit for Safety and Quality of Plant Products, INRA.

14h00 – 15h25: Topic 1 – Innovative processes for improved sustainability

Chair: Catherine Bonazzi — AgroParisTech, Inra, Université Paris-Saclay Massy

14h00 *IC* **Henry Jäger** – Innovative technology options for resource efficient and high quality fruit and vegetable processing
14h40 *IO1* **Graziele Gustinelli** – Supercritical CO2 extraction of bilberry (*Vaccinium myrtillus* L.) seeds: composition and antioxidant activity
14h55 *IO2* **Vlad Nicolae Arsenoaia** – CFD simulation of heat and mass transfer during apricots drying
15h10 *IO3* **Ariette Matser** – High pressure high temperature treatment: potential applications for preservation of food products, with special focus on tomato products

15h25 – 16h55 Coffee break — Posters session 1

16h55 – 18h30: Topic 2 – Quality at the heart of sustainable markets for F&V products

Chair: Olivier Dangles — University of Avignon, France

16h55 *QJ1* **Ricardo Malheiro** – Addition of olive leaves improve the sensorial and volatile fractions of olive oil from cv. Cobrançosa
17h15 *QO1* **Sam Multari** – Potential of Fava Bean as Future Supply of Protein and Phenolic Compounds
17h30 *QO2* **Marc Lahaye** – Apple cell wall contribution to fruit viscoelastic properties
17h45 *QO3* **Justyna Kadzińska** – Effects of pumpkin purée incorporated into the polymer matrix on the physicochemical properties of edible pumpkin films
18h00 *QO4* **Lenka Staroňová** – Mapping the colour changes in frozen-thawed blueberry using computer vision system
18h15 *QO5* **Montserrat Pujolà** – Effects of the drying technique on the retention of phytochemicals in conventional and organic plums (*Prunus domestica* L.)

18h30 – 19h30 Get together party

Tuesday 5 April 2016

8h30 – 9h55: Topic 3 – Constraints on F&V processing: microbial, safety and waste management issues

Chair: Pierre Picouet — IRTA, Monells (Girona), Spain

8h30 *NC* **Ana Allende** – Ready-to-eat vegetables: current problems and potential solutions to reduce microbial risks in the production chain

9h10 *NO1* **Oluwafemi J. Caleb** – Impact of minimal processing on the dynamics of volatile organic compounds emitted from fresh strawberry

9h25 *NO2* **Madalena Sobral** – Thermally processed fruit salads with long shelf-life at different storage temperatures

9h40 *NO3* **Cyrelis Collazo Cordero** – Studies on the biocontrol mechanisms of *Pseudomonas graminis* strain CPA-7 against food-borne pathogens on fresh-cut fruit

9h55 *NO4* **Gary Pickering** – Quality and sustainability of juice and wine: technologies for removing alkyl-methoxypyrazines

10h10 – 11h00 Coffee break

11h00 – 12h20: Topic 1 – Innovative processes for improved sustainability

Chair: Henry Jäger — University of Natural Resources and Life Sciences, Vienna, Austria

11h00 *IJ1* **Stella Plazzotta** – Effect of high pressure carbon dioxide on the storage quality of unpasteurized apple juice

11h20 *IO4* **Lorenzo Siroli** – Use of lactic acid bacteria and natural antimicrobials to improve the safety and shelf-life of minimally processed sliced apples and lamb's lettuce

11h35 *IO5* **Chaitanya Sarangapani** – Impact of atmospheric plasma on quality-related attributes of cherry tomatoes

11h50 *IO6* **Lovisa Eliasson** – Effect of drying technique, particle size and fractionation on the extraction efficiency of anthocyanins from bilberry press cake

12h05 *IO7* **Boudewijn Meesschaert** – Biomimetic processes for phosphate recovery from waste water of vegetable and potato processing companies

12h20 – 14h Lunch — Setting up posters session 2

14h – 15h40: Topic 2 – Quality at the heart of sustainable markets for F&V products

Chair: Jarosław Markowski — Research Institute of Horticulture, Skierniewice, Poland

14h00 *QC* **Cristina Garcia-Viguera** – Changes in phytochemicals during Fruit and Vegetable processing

14h40 *QO6* **Julie Le Grandois** – Online determination of antioxidant capacity of lipophilic compounds from *Capsicum annuum* using HPLC-ABTS and determination of interactions between lipophilic compounds in synthetic mixtures

14h55 *QO7* **Stéphane Guyot** – Recent advances on the phenolic molecules and oxidative mechanisms involved in the color of classical and "rosé" cider apple juices

15h10 *QO8* **Lagle Heinmaa** – Health-beneficial and health- threatening compounds in organic apple juice depending on processing technology

15h25 *QO9* **Eivind Vangdal** – Effects of the drying technique on the retention of phytochemicals in conventional and organic plums (*Prunus domestica* L.)

15h40 – 16h55 Coffee break — Posters session 2

16h55 – 18h20: Topic 3 – Constraints on F&V processing: microbial, safety and waste management issues

Chair: Ana Allende — CEBAS-CSIC, Murcia, Spain

16h55 *NJ1* **Ana Meireles** – Persistence of pathogenic and spoilage bacteria in a minimally processed vegetables plant

17h15 *NJ2* **Jaabir Adekunle-Jimoh** – Evaluation of heavy metals and health risk index in *Amaranthus hybridus* L. vegetable grown in selected farms in Ibadan, Nigeria

17h35 *NO5* **Cécile Bigot** – Studies on the biocontrol mechanisms of *Pseudomonas graminis* strain CPA-7 against food-borne pathogens on fresh-cut fruit

17h50 *NO6* **Hugues Guichard** – *Brettanomyces* anomala, a double drawback for cider aroma

18h05 *NO7* **Marija Zunabovic** – Strategies of shelf life prolongation of fresh-cut vegetables

18h30 – 19h30 Visit of Avignon old town
OR Workshop: European projects
20h30 Gala dinner

Wednesday 6 April

8h30 – 10h35: Topic 4 – Consumer preferences and needs - OPTIFEL sponsored session

Chair: Catherine Renard — SQPOV, INRA, Avignon, France

8h30 *MC* **Isabelle Maitre** – Are fruits and vegetables good candidates for an appealing diet for the elderly?

9h10 *MJ1* **Mihaela Geicu-Cristea** – Consumption and attitudes regarding berries-based products – comparative analysis of Romania and France

9h30 *MO1* **Carmen Barba** – Odorants increase sweetness perception in fruit juices

9h45 *MO2* **Matthieu Mingioni** – Do elderly people differ in their preferences? Sweet and acid preferred levels in apple purees

10h00 *MO3* **Davide Menozzi** – Understanding and modelling vegetables consumption among young adults

10h15 *MJ2* **Catherine Bowe** – Improving sensory perception by compensatory pathways on populations with sensory impairments

10h35-11h00 Coffee break

11h00 – 11h50: Topic 2 – Quality at the heart of sustainable markets for F&V products

Chair: Cristina Garcia-Viguera — CEBAS-CSIC, Murcia, Spain

11h00 *QJ2* **Mariaelena Di Biase** – Biopreservation of nutritional and microbiological features of ready-to-eat vegetables processed by the probiotic strain *Lactobacillus paracasei* LMG.

11H20 *QO10* **Catherine Caris** – Tomato carotenoids processing during simulated digestion: stability and transfer between tomato particles from Hot Break and Cold Break tomato purée, emulsion and mixed micelles

11h35 *QO11* **Aleksandra Polubok** – Triterpenes and phenolic content in the peel of seven apple cultivars in relation to fruit maturity and treatment before peeling

11h50 Poster prizes
12h20 – 14h Lunch

14h00 – 15h20: Topic 1 – Innovative processes for improved sustainability

Chair: Dominique Pallet — CIRAD, Montpellier, France

14h00 *IJ2* **Mauro D. Santos** – Watermelon juice and melon juice preserved by hyperbaric storage at variable (uncontrolled) room temperature as an alternative to refrigeration

14h20 *IO8* **Zehra Kaya** – UV-C Irradiation Assisted with Mild Heat Treatment for Inactivation of *S. cerevisiae* in Verjuice

14h35 *IO9* **Jean-Roch Mouret** – Modelling of the production kinetics of the main fermentative aromas in winemaking fermentation

14h50 *IO10* **Ester Betoret** – Effect of high pressure processing and trehalose addition on structural dependent functional properties of mandarin juice enriched with probiotic microorganisms

15h05 *IO11* **Luciana Gomes** – Identification of key factors affecting biofilm formation in food industries.

15h30 – 16h30 Round Table: sustainability, what can it mean in F&V processsing?

16h30 – 17h Conclusions — Identification of next venue

– OR –

15h30 – 17h30 Ecoberries session

15:30 – 17:30: Ecoberries workshop

Chair: Catherine Renard

15:30 *BE1* **Marie Alminger** (Chalmers) – Eco Berries – General introduction and overview

16:00 *BE2* **Valerie Guillard**, (UMR-IATE) – Modified Atmosphere Packaging for extending the shelf life

16:20 *BE3* **Marco Dalla Rosa**, (UNIBO) – Overview on mild technologies applied to organic berries to increase stability and functionality

16:40 *BE4* **Evelina Tibäck**, (SP Food and Bioscience) – Functional powders – processing for added value products

17:00 *BE5* **Mona Popa**, (USAMVB) – Quality indicators and post-harvest shelf life assessment of fresh berry fruits

17:15 Questions and discussions

Abstracts — Oral Communications

1 / Innovative processes for improved sustainability

Innovative technology options for resource efficient and high quality fruit and vegetable processing

Henry Jäger*
University of Natural Resources and Life Sciences (BOKU) Vienna, Institute of Food Technology, Muthgasse 18, 1190 Vienna, Austria
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The need for high-quality fresh fruits and vegetables and processed products thereof with good sensory quality, long shelf life and a high nutritional value is increasing. In addition, energy and water consumption as well as the occurrence of waste and by-products are major concerns along the production chain. To fulfil these requirements, new processing technologies are under investigation and development. Fruits and vegetables as living organisms are highly perishable and post-harvest handling including the selection of appropriate storage concepts as well as the application of gentle decontamination techniques are crucial in order to maintain desired quality characteristics of the fresh products. On the other hand, further processing may involve the recovery of ingredients as well as the manufacturing of fruit and vegetable products which require a high process intensity. Emerging technologies such cold plasma or pulsed light treatment are under investigation as non-thermal surface decontamination techniques used as an alternative to the application of conventional chemical methods applied to whole or fresh cut fruits and vegetables. Other emerging technologies such as high pressure or pulsed electric field treatment are already introduced to the market since years and gain increasing interest for the gentle, non-thermal preservation of fruit and vegetable products. The recovery of ingredients as another processing goal requires a disintegration of the cellular structure in order to increase the process efficiency. Here, pulsed electric field treatment or ultrasound application are successfully used to increase extraction yields or enhance other processes like drying of fruits and vegetables. Products with extended shelf life at ambient temperature require a sterilization step which negatively affects the quality attributes of the plant raw material in most of the cases. Moving towards high temperature short time processing, the optimization of conventional sterilization processes such retort processing e.g. by acoustic mixing or the application of volumetric heating methods such as ohmic heating or microwave processing gain increasing interest. The presentation will highlight recent developments in the field of fruit and vegetable processing focusing on technological aspects as well as their implications on product quality and safety.

Keywords: thermal and non-thermal processing, food quality and safety, water and energy consumption, bioactive compounds, by-products

Effect of high pressure carbon dioxide on the storage quality of unpasteurized apple juice

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Introduction. Consumption of unpasteurized fruit juices has risen over the last years, due to the increasing demand for healthy and fresh-like food. These products present high safety and quality issues, due to microbial growth, chemical reactions and enzymatic activity. Different non-thermal technologies have been proposed to extend the shelf-life of these fruit derivatives, such as the use of high pressure carbon dioxide (HP-CO_2). CO_2 is inert, inexpensive, nontoxic, nonflammable, recyclable and leaves no residues [1]. During the HP-CO_2 treatment, food is in contact with pressurised CO_2 at temperature/pressure conditions above or below the critical point (31.1°C, 7.38 MPa). Significant inactivation effects of HP-CO_2 on different microorganisms and enzymes have been demonstrated [2]. The effect of HP-CO_2 on the storage quality of unpasteurized apple juice was studied in this research.
Materials and Methods. Filtered apple juice was HP-CO_2 treated at different pressures (0–18 MPa), temperatures (20–45°C) and treatment time (0–30 min). The treatment at 12 MPa and 35°C for 10 min achieved the higher polyphenoloxidase inactivation (20% of residual activity), while maintaining temperature, pressure and treatment time as low as possible. This treatment was applied to apple juice. Samples were stored for 15 days at 4°C. During storage, browning degree (assessed spectrophotometrically), sensory attributes and microbial loads (total, lactic acid bacteria, yeast and mould counts) were monitored. Data were compared with those relevant to a pasteurized (15 s at 72.1°C) and to an untreated apple juice (control).
Results and Discusson. In HP-CO_2 treated samples, browning resulted lower than in control, due to the partial inactivation of polyphenoloxidase. After 15 days of storage, the microbial load of HP-CO_2 treated samples (2 Logs) was about 4 Logs lower than that of control. Pasteurized samples showed the higher microbial and colour stability. HP-CO_2 treatment did not modify sweetness and acidity of apple juice. Fresh-apple flavour of HP-CO_2 treated samples resulted significantly higher than that of pasteurized juices and not different from that observed in the control.
Conclusions. HP-CO_2 treatment allowed to partially inactivate polyphenoloxidase and native microflora of apple juice, while maintaining product fresh-likelihood. HP-CO_2 could thus be considered a valuable green technology for the shelf-life extension of fresh-squeezed apple juice.

Keywords: HP-CO_2, polyphenoloxidase, shelf-life, apple juice, pasteurization

References:

1. Clifford, A.A. and Williams, J.R. (2000). "Introduction to supercritical fluids and their applications". In J.R. Williams, A.A. Clifford. and N.J. Totowa (Eds.). "Supercritical fluid methods and Protocols", **1**: 1–16.
2. Xu, Z., Zhang, L., Wang, Y., Bi, X., Buckow, R. and Liao, X. (2011). "Effects of high pressure CO_2 treatments on microflora, enzymes and some quality attributes of apple juice". *Journal of Food Engineering*, **104**: 577–584.

Watermelon juice and melon juice preserved by hyperbaric storage at variable (uncontrolled) room temperature as an alternative to refrigeration

Mauro D. Santos*, Álvaro T. Lemos, Liliana G. Fidalgo, Rui P. Queirós, Rita S. Inácio, Maria J. Mota, Rita P. Lopes, Ivonne Delgadillo, Jorge A. Saraiva
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In the 60's, the research submarine Alvin sinking showed the possibility to use pressure as a preservation methodology, since some foods were found in consumable conditions after 10 months at 1540 m (3–4°C). This new food preservation methodology, in which food is preserved under pressure, is becoming known by Hyperbaric Storage (HS) and can be applied at naturally uncontrolled room temperature, thus with no energetic cost to control temperature. Watermelon juice (WJ) and melon juice (MJ) samples were stored by HS under different pressure levels (25–150 MPa) at different temperatures (15–37°C) up to 21 days. The HS results (microbiological and physicochemical analyses) were always compared with samples stored at the same temperature and atmospheric pressure (AP), and refrigeration (RF). The results obtained for WJ stored 8 h at 100 MPa/≈20 °C, presented a microbial load decrease of ≈1/≈2/≈1 log CFU/mL for total aerobic mesophiles (TAM), Enterobacteriaceae (ENT), yeasts and moulds (YM), respectively, comparatively to the initial values, remaining unchanged up to 60 h of storage. In contrast, in 0.1 MPa/≈20°C and RF storages, the microbial counts were >6 log CFU/mL for TAM/ENT/YM and ≈4/≈3/≈3 log CFU/mL, respectively. When HS was set to 15°C at 75 MPa, a reduction of ≈2/≈2.5/≈2 log CFU/mL (TAM/ENT/YM) was verified over 21 days of storage, compared to initial values. Thus, in 8 h of HS and regardless of temperature (20/25/30/37°C) a pressure of 75 MPa was capable to inhibit the microbial growth similarly to RF, and an additional inactivation effect was verified for 100/150 MPa (initial microbial load decrease). A similar trend was detected in MJ preserved 8 h under HS, regardless of temperature (25/30/37°C), since a pressure level of 50/75 MPa resulted in microbial growth inhibition and 100/150 MPa had an additional inactivation effect. Concerning physicochemical analyses (pH, titratable acidity, total soluble solids, cloudiness and browning degree), generally there were not detected considerable differences in both juices under HS compared to the initial parameters. Therefore, this work proved the HS feasibility for WJ and MJ at variable room temperature with basically no energetic costs (only necessary for compression/decompression phases), since it is not required energy to control temperature and pressure.

Keywords: Watermelon juice, Melon juice, Hyperbaric Storage, Food preservation, Refrigeration

Acknowledgements: FCT/MEC for financial support to the QOPNA research Unit (FCT/ID/QUI/00062/2013), through national funds and where applicable co-financed by the FEDER, within the PT2020 Partnership Agreement.

Supercritical CO_2 extraction of bilberry (Vaccinium myrtillus L.) seeds: composition and antioxidant activity

Graziele Gustinelli*[1,2], Cecilia Svelander[2], Lovisa Eliasson[1], Marie Alminger[2], Lilia Ahrné[1,2]
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Bilberries (*Vaccinium myrtillus* L.) are commonly used as raw material for food and drinks in Europe, generating seeds as by-products. Most of these seeds are treated as waste impacting the environment, even though they contain valuable biological compounds, such as vitamin E. Different extraction methods can be used to recover bioactive compounds from the seeds and the extraction step has an essential role on the yield and properties of the obtained extract. Several factors such as type of technology used, solvent, temperature, time, pressure and plant matrix can have an impact on the outcome of the extraction process [1]. The conventional methods for extraction are based on heating and solvation power of organic solvents which may affect the bioactivity of the extracted compounds. Green technologies for extraction are alternative technologies to replace conventional extraction methods, such as supercritical fluid extraction (SFE). For food applications carbon dioxide is the most commonly used solvent in SFE and the method allows extractions at mild temperatures and solubilisation of non-polar substances. It also provides high purity extracts since carbon dioxide is easily removed by simple expansion to ambient pressures [2]. The objective of this work was to evaluate the effect of varying temperature and pressure conditions during SFE on the yield, antioxidant capacity, fatty acid composition, and vitamin E content of bilberry seed extracts.

The SFE extractions of bioactive compounds from bilberry seeds were carried out at different temperature (40 – 60°C) and pressure (200 – 500 bars) conditions.

The applied temperature and pressure conditions affected the yield and the effect of temperature was more pronounced at lower pressures. The fatty acid composition was similar in extracted oils but the content of vitamin E and the antioxidant activity varied between different extracts. Bilberry seed oils with the highest antioxidant activity index (AAI) (3.57 ± 0.00) also had the highest concentration of vitamin E, 129.23 ± 4.89 mg/100 g of oil. The results suggest a correlation between high antioxidant and high content of vitamin E in the extracts. The study also showed that it was possible to obtain a bilberry seed oil with enhanced vitamin E content of by optimizing the extraction conditions.

Keywords: Supercritical CO_2 extraction, bilberry seeds, Vaccinium, chemical composition, antioxidant

Acknowledgements: This work was financially supported by SUSFOOD ERA-Net – Healthy and Sustainable and Capes.

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1. Azmir, J. *et al.* "Techniques for extraction of bioactive compounds from plant materials: A review." *Journal of Food Engineering*, v. **117**, n. 4, p. 426-436, Aug 2013.
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CFD simulation of heat and mass transfer during apricots drying

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Introduction. The operation of drying has been widely used to preserve food products, since the reduction of their water content to certain levels inhibits microbial growth and enzymatic modifications [1]. Since fruits have structures which are highly affected by water removal, simulation models of the drying process is far from simple [2]. Furthermore, drying models that describe more accurately the process are difficult to obtain, mostly because transport properties (like for instance, the moisture diffusivity) are not constant, and their variation throughout the process is not available [3].
Materials and Methods. The experimental researches were carried out with dehydrating equipment with the possibility of variation of the important parameters in the drying process. The CFD simulation was performed with the Ansys-Fluent software. Dried apricots (the Romanian variety 'Dacia') were divided into two parts. The experiments and simulation of CFD have been made to unblanched apricot and blanched (by immersion in water at 90°C for 120 s). The temperature of the drying agent was varied between 50°C and 80°C and its velocity from 1 m s^{-1} to 2 m s^{-1}.
Results and Discusson. The CFD simulation using models of the mass and heat transfer applied to dried apricots, lead to a better understanding of the convective drying process by viewing of color graphics of the time evolution of the fields of temperature and humidity at any point inside and outside the product. Pretreatments and temperature of the drying agent have a high influence on the variation of absolute humidity of apricots, and on drying time. The drying CFD simulation after 150 minutes shows that the maximum absolute humidity for the unblanched apricots is of 0.529 kg water/kg of dry matter and a maximum temperature of 56°C, while for the blanched apricots is of 0.411 kg water/kg of dry matter and a maximum temperature of 53°C. The humidity and temperature distribution inside apricots also show differences compared with the blanched and unblanched products.
Conclusions. The CFD unsteady simulation was performed on unblanched and blanched apricots with three-dimensional geometry by introducing a mass transfer model to observe the variation of humidity inside and outside the product. The parameters (humidity of the drying agent and product, density, specific heat conductivity) in the model of mass and heat transfer, which varies over time, were obtained experimentally. The observations made by simulation on the distribution of moisture and temperature inside the apricot during drying can lead indirectly to estimate distribution or loss of water-soluble vitamins.

Keywords: apricots, drying simulation, mass transfer, Computational Fluid Dynamics (CFD)

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High pressure high temperature treatment: potential applications for preservation of food products, with special focus on tomato products

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High pressure processing is currently widely used in food industry for pasteurization of fruit and vegetable products. A typical HP pasteurization treatment is done at 500–600 MPa for 1–5 minutes holding time at room temperature or lower. Examples are fruit and vegetable juices, smoothies, guacamole and ready-to-use vegetable mixtures. The products have a shelf life in the range of 3–8 weeks, when stored at 4°C. Shelf life is limited due to remaining enzyme activity, potential outgrowth of spores and chemical changes. In addition to chilled pasteurized products, there is a need for fruit and vegetable products of high quality that can be stored at ambient temperatures for longer times. High pressure combined with high temperature can be one of these innovations to produce high quality fruit and vegetables with long shelf life at ambient temperatures.

In recent years, much research is published focusing on the effects of high pressure high temperature processing on fruit and vegetables. In the presentation, a short summary will be given of the main developments in high pressure high temperature processing which are relevant for fruit and vegetables, including treatments like, pressure assisted thermal sterilisation (PATS), and pressure enhanced sterilisation (PES).

The possible applications of high pressure high temperature processing will be illustrated with the potential application on tomato and tomato products. The effects of pressure-assisted thermal sterilisation (PATS) on sensorial (texture, colour and flavour) and nutritional quality (beta carotene, vitamin C) of diced, cherry and whole peeled tomatoes were compared with conventional sterilisation treatment (CS). The quality was analysed after one day and one and two months storage under ambient, dark conditions. $CaCl_2$ was used to improve the texture, with optimal amounts 0.5% for diced and 0.75% for whole peeled tomatoes. Cherry tomatoes lost all internal structure under PATS. CS samples were found to be more brown compared to PATS samples after one day. Colour remained stable under CS processing, while discolouration occurred during storage for PATS samples. PATS resulted in reduced pectin methylesterase (PME) activity. However, residual PME was found during storage which can contribute to enhanced firmness of stored diced tomato. This was supported with higher calcium content in PATS treated products. The flavour profile of whole peeled tomato showed that small amounts of off-flavours were found in PATS samples compared with CS. However, PATS only had instantaneous positive effects on some fresh associated compounds which decreased further during storage. The profile of diced tomato after one day showed similar results. High pressure sterilisation showed a large advantage on vitamin C retention. For beta carotene a benefit was not observed.

Keywords: high pressure, high temperature, sterilization, tomato.

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Use of lactic acid bacteria and natural antimicrobials to improve the safety and shelf-life of minimally processed sliced apples and lamb's lettuce

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Minimally processed fruit and vegetables are susceptible to microbial proliferation due to the loss of natural resistance and their high water and nutrient content [1]. Traditional chemical sanitizers are unable to completely eradicate or kill the microorganisms on fresh produce [2]. These conditions have stimulated research into alternative methods for increasing their safety and shelf-life. The use of protective cultures, particularly lactic acid bacteria, microorganisms from indigenous microflora and their antimicrobial products, has been proposed for minimally processed products [2]. Moreover, in recent years also the use of essential oils and their components as natural antimicrobials has been proposed for minimally processed products [1]. However, the application of these solutions has been limited at the industrial level. From this perspective, the main aims of this study were to select LAB from minimally processed fruits and vegetables to be used as biocontrol agents and then to evaluate the effects of the selected strains, alone or in combination with natural antimicrobials (2-(E)-hexenal/hexanal, 2-(E)-hexenal/citral for apples and thyme essential oil for lamb's lettuce), on the shelf-life and safety characteristics of minimally processed apples and lamb's lettuce. The results indicated that applying the *Lactobacillus plantarum* strains CIT3 and V7B3 and the nisin producing *Lactococcus lactis* strain CBM21 to apples and lettuce, respectively, increased both the safety and shelf-life. Moreover, the combination of the selected strains with natural antimicrobials produced a further increase in the shelf-life of these products without detrimental effects on the organoleptic qualities. Therefore, the proposed biocontrol agents, particularly in combination with other preservative methods, may represent a good strategy to increase the safety and shelf-life of minimally processed fruits and vegetables.

Keywords: Minimally processed products, Biocontrol agents, Natural antimicrobials, Lactic acid bacteria, Safety and shelf-life

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Impact of atmospheric plasma on quality-related attributes of cherry tomatoes

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Introduction. Raw fresh produce has frequently associated with food-borne pathogens despite of good hygienic practice and good manufacturing practices during the post-harvest. However, application of thermal process is limited by its detrimental effects on quality of fresh produce. This, in turn, led to development of cold plasma technology a potential antimicrobial treatment and has been tested on various food products. Unlike research for food-borne pathogen inactivation, and general scarcity of information on impact of cold plasma on product quality, nutritional profile forms the motive of present work. This study is focussed on the effects of atmospheric cold plasma on quality attributes of cherry tomato.
Materials and Methods. The physical quality testing (colour, texture, TSS, weight loss) and sensory evaluation as per procedure of Misra et al., [1], analysis of chemical changes Total phenols, antioxidant profile, Total carotenoids by UV-Vis spectrophotometer and Organic acids, Vitamin C, Lycopene, β-carotene contents by HPLC-UV [2].
Results and Discusson. The results revealed that atmospheric plasma treatment maintained the physical quality parameters of fruit. The plasma treatment conditions 60 kV and 80 kV did not affect soluble sugars, antioxidant content, β-Carotene and total carotenoids. However, a significant decrease ($p < 0.05$) in lycopene, flavonoids and ascorbic acid contents was observed at higher voltages. This is attributed to oxidation by reactive species such as ozone, hydroxyl radical. The FTIR spectra results showed the plasma induced chemical changes. Sensory results showed an overwhelming preference for fruit subjected to plasma treatment.
Conclusions. The results indicate that atmospheric cold plasma treatment induce changes in the chemical constituents of cherry fruit while maintaining critical quality parameters. This study improved understanding of the effects of plasma on nutritional profile of fresh produce is important to facilitate industrial adoption of this technology.

Keywords: Atmospheric cold plasma, quality, FTIR

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Effect of drying technique, particle size and fractionation on the extraction efficiency of anthocyanins from bilberry press cake

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Bilberry (*Vaccinium myrtillus*) press cake from the beverage industry is an important source of anthocyanins and other bioactive compounds. Instead of being discarded as waste, a sustainable approach would be to extract these compounds for further use as natural ingredients in the formulation of healthy foods. Besides the use of green extraction solvents, the sustainability of the extraction process is highly related to the extraction efficiency of the compound of interest. New combination of pretreatments, influencing the properties of the press cake, could be an important way to improve the extraction efficiency. Therefore, the objective of this work was to study the combined effect of different drying techniques, particle size and fractionation on the extraction efficiency of anthocyanins.

Bilberry press cake was dried by microwave, hot air or freeze drying and fractionated into one large size fraction (>710 µm) and one small size fraction (<710 µm) prior to extraction. Extraction of anthocyanins by pressurized carbon dioxide, with ethanol co-solvent, was applied and compared to conventional methanol extraction.

For microwave and hot air dried press cake, the large size fraction showed higher anthocyanin content (83.6–87.3 mg/g dry basis) compared to the small size fraction (59.9–65.1 mg/g dry basis). Although a higher anthocyanin content in the large size fraction, the small size fraction was more beneficial for a high anthocyanin recovery when using high pressure carbon dioxide, independently of the drying technique applied. The highest anthocyanin recovery was obtained from the small size fraction that previously was freeze dried. This could be due to a different structure of the freeze dried press cake leading to more efficient milling of the anthocyanin rich bilberry peel.

It was concluded that the anthocyanin extraction efficiency from bilberry press cake considerable can be improved by using an appropriate combination of pretreatments (drying technique, particle size, and fractionation).

Keywords: anthocyanins, *Vaccinium myrtillus*, pretreatment, carbon dioxide extraction

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Biomimetic processes for phosphate recovery from waste water of vegetable and potato processing companies

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Introduction. Due to the fact that phosphorous reserves are limited and concentrated in only some countries, in waste water treatment the elimination of phosphorous, mostly phosphate, gradually shifts to its recovery. In current practice the use of $FeCl_3$ to coprecipitate phosphate together with the sludge in the clarifier is gradually replaced by the use of $MgCl_2$ to recover phosphate as struvite ($MgNH_4PO_4$.6H2O) between the anaerobic and the aerobic step of the waste water purification. We propose the combination of urea and ureolytic sludge as a sustainable alternative to sodium hydroxide to increase the pH in struvite precipitation. This is a biomimetic process similar to the development of kidney stones. Furthermore we suggest the precipitation of phosphate as hydroxyapatite [$Ca_5(PO_4)_3OH$] as a cheaper and even more sustainable alternative for the recovery of phosphate, since hydroxyapatite can be used in phosphorous industry. This latter process is analogue to the development of dental calculus.
Materials and Methods. Sludge from a waste water facility of a vegetable or a potato processing plant was adapted to urea and as a consequence developed ureolytic activity. When subsequently this sludge was fed with waste water the ureolysis increased pH and in the presence of a source of Mg^{2+}-ions this resulted in struvite formation. In an alternative approach it was investigated if it was possible to precipitate phosphate from the waste waters as calcium phosphate salts. To this end we increased the pH and investigated the effect of (bi)carbonate and nitrification.
Results and Discusson. Phosphate removal as struvite driven by the ureolytic activity of the sludge appeared to be as effective as the normal procedure which is driven by alkalization with sodium hydroxide: it was possible to recover up to 90% of the phosphate. A nitrification as pretreatment bypassed all the problems that we encountered when we tried to precipitate phosphate as calcium phosphate salts: the simultaneous precipitation of struvite was made impossible and it removed most of the buffering capacity as well as the competition of phosphate and carbonate for the Ca^{2+}-ions. The recovered precipitate was identified as hydroxyapatite by XRD.
Conclusions. Our results show that it is possible to recover phosphate from the waste waters of vegetable and potato processing companies by an urease driven struvite precipitation and as calcium phosphate salts. Since calcium phosphate salts are the major components of the ores used in phosphorous industry, recovered calcium phosphate salts have a broader application potential than struvite. The latter can only be used in agriculture as a slow release fertilizer and furthermore – within the frame of recent legislation in many Western-European regions – its use is limited.

Keywords: waste water, phosphate, struvite, calcium phosphate, hydroxyapatite

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UV-C Irradiation Assisted with Mild Heat Treatment for Inactivation of *S. cerevisiae* in Verjuice

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UV-C irradiation is one of the non-thermal technologies used for preservation of juice due to its germicidal effectiveness [1]. Yeasts and moulds are the heat resistant microorganisms responsible for spoilage of fresh verjuice. They have the ability to grow at low pH, and resistance against preservatives and UV-C irradiation [2]. The aim of this research is to study the inactivation efficacy of combined processes of UV-C irradiation and mild heat treatment for the inactivation of acid adapted *S. cerevisiae* in freshly squeezed verjuice. The UV-C treatments were carried out by using lab-scale continuous flow UV system with a gap size of 5 mm. Four hundred milliliters of verjuice was passed through the system at the flow rate of 3.80 mL/s. The circulated juice was collected in a double wall sample glass tank. Water was circulated around the tank at two different temperatures, i.e. 50°C (MH1) and 60°C (MH2). Temperature of the juice within the system was checked by a K-type thermocouple during the process. The lethal effect of mild heat (MH) and UV-C irradiation (UV) on the inactivation of *S. cerevisiae* was determined in the same system. During mild heating, all the UV-C lamps were turned off. UV-C irradiation was carried out by passing the verjuice through the system at room temperature. The population of *S. cerevisiae* in verjuice was reduced by 3.59 ± 0.03 $\log_{10}$ CFU/ml when the circulating water temperature was kept at 55°C (UV+MH1) (juice temperature was recorded as 48.22 ± 2.17°C). On the other hand, 5.16 ± 0.24 $\log_{10}$ CFU/mL was achieved at 60°C (UV+MH2) (juice temperature was 51.24 ± 2.74°C). UV dose applied in UV+MH1 and UV+MH2 processes were 1.463 ± 0.000 J/ml and 1.006 ± 0.003 J/ml, respectively. However, UV treatment at room temperature hardly achieved 0.40 ± 0.04 $\log_{10}$ CFU/mL reduction at 2.301 ± 0.002 J/ml. Heat treatments alone reduced the number of S.cerevisiae by 0.96 ± 0.25 $\log_{10}$ CFU/mL (MH1) and 3.13 ± 0.05 $\log_{10}$ CFU/mL (MH2), respectively. The resistance parameters were calculated by fitting survival curves with the Weibull model. Synergistic effect was observed by applying UV-C irradiation and mild heat treatment simultaneously and predicted as 31.90% and 50.79%. The results showed that the lethal effect of UV-C irradiation on *S. cerevisiae* suspended in verjuice was increased synergistically by applying mild heat treatment. The UV-C irradiation at moderate temperatures can be suggested as an alternative to thermal pasteurization of verjuice by allowing inactivation of spoilage microorganisms and promising longer shelf life.

Keywords: UV-C irradiation, mild heating, verjuice, kinetic modelling, *S.cerevisiae*.

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Modelling of the production kinetics of the main fermentative aromas in winemaking fermentation

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Fermentative aromas (especially esters and higher alcohols) highly impact the organoleptic profile of young and white wines. The production of these volatile compounds depends mainly on temperature and Yeast Available Nitrogen (YAN) content in the must. Available dynamic models predict the main reaction (bioconversion of sugar into ethanol and CO_2 production) but none of them considers the production kinetics of fermentative aroma compounds during the process of fermentation.

We determined the production kinetics of the main esters and higher alcohols for different values of initial YAN content and temperature, using an innovative online monitoring Gas Chromatography device. We then elaborated a dynamic model predicting the synthesis of five fermentative aromas representative of three different chemical families: two higher alcohols (isobutanol, isoamyl alcohol), one acetate ester (isoamyl acetate) and two ethyl esters (ethyl hexanoate, ethyl octanoate).

The online monitoring highlighted two successive linear phases of aroma compound production from sugar. We therefore began by modeling changes in the production yields of these compounds (aroma compound vs. sugar) depending on initial nitrogen concentration and temperature. We then integrated these yields into a previously developed model of the kinetics of sugar consumption during the fermentation process. We thus obtained a dynamic model predicting the production kinetics of volatile compounds throughout the alcoholic fermentation from initial nitrogen concentration and temperature values. The parameters of the model were identified from nine fermentations performed at temperatures between 18 and 30°C and with initial YAN contents ranging from 70 to 410 mg N /L. The model was validated in six independent experiments with conditions in the same range. Predictions were accurate: the mean difference between experimental and estimated values for fermentative aroma synthesis throughout the process was below 10%, for both the fermentations used to build the model and those used for validation.

This model is the first to simulate the production kinetics of fermentative aromas and provides new insight into the synthesis of these volatile compounds. It will facilitate the development of innovative strategies for controlling the production of those aromas in winemaking, through management of the principal control factors: YAN content and temperature during the alcoholic fermentation.

Keywords: Bioprocess monitoring, dynamic modeling, fermentation, aroma compounds, wine.

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Effect of high pressure processing and trehalose addition on structural dependent functional properties of mandarin juice enriched with probiotic microorganisms

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Introduction. There is increasing interest in developing alternatives to prevent or fight infections caused by resistant pathogens avoiding the antibiotic treatments that suppose a high cost to the European Healthy System and to the environment. The application of technologies such as high pressure homogenization (HPH) can improve the functional properties of probiotic microorganisms [1]. Moreover, trehalose can sustain and preserve a wide array of biological molecules [2]. The aim of this work is to determine the effect of homogenization pressures and addition of trehalose on the functional properties of mandarin juice enriched with *Lactobacillus salivarius* spp. *salivarius*, a probiotic microorganism with proved effect against *Helicobacter pylori* infection.

Materials and Methods. Strain *Lactobacillus salivarius* spp. *salivarius* has been used as a probiotic microorganism in low pulp mandarin juices enriched with 0, 10 and 30% (w/w) of trehalose and homogenized at 0, 20 and 100 MPa. The juice composition has been modified in order to maximize the levels of the probiotic microorganisms. The microorganisms have been determined during 0, 1, 2, 3, 7, 9 days at 4°C. The hydrophobicity has been calculated following the methodology proposed by Vinderola & Reinheimer [3].

Results and Discusson. Homogenization treatments and addition of trehalose had a significant effect on the growth levels of probiotic microorganism. Homogenization pressures at 20 MPa resulted in the highest growth levels. The hydrophobicity of the microbial cells, related with their ability to adhere to intestinal cells and associated immune response, increased notably with homogenization pressures and with the addition of trehalose.

Conclusions. HPH treatment has been able to modify some features linked to the cell wall of *L. salivarius* spp. *salivarius* and, consequently, could alter the interaction with the small intestine. Management of food processes can contribute to maintain and even increase the functionality of the products in which they are applied. The knowledge of the relations structure-properties-process is a key element necessary to achieve this objective.

Keywords: probiotics, *Helicobacter pylori*, homogenization pressures, hydrophobicity.

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Identification of key factors affecting biofilm formation in food industries

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Biofilm formation on food-contact surfaces is a major factor in pathogen persistence in food processing environments, leading to economic losses and health concerns. It has been referred that besides the bacterial composition, the surface properties, the nutrient load and the hydrodynamic conditions can have a profound effect in biofilm formation [1].

Microtiter plates are one of the most commonly used platforms to study biofilm formation. In order to verify if agitated 96-well microtiter plates were able to mimic the shear stresses found in critical areas in the food industry, computational fluid dynamics (CFD) was used to determine the hydrodynamic shear forces inside the wells for different orbital shaking diameters and frequencies. Biofilms were then produced in either static or agitated conditions mimicking industrial scenarios and it was found that *Escherichia coli* biofilm formation was reduced with shear stress. The relative importance of the shear stress (0 or 0.27 Pa), the culture medium (high nutrient or low nutrient) and the surface properties (using glass, copper and stainless steel) was then analysed. It was verified that the most important factor under the conditions tested was the surface properties and it was confirmed that higher biofilm development occurred in static conditions.

Taking into account this previous result and also taking into consideration the existence of zones of stagnant flow in fresh-cut food processing facilities, the impact of modified stainless steel surfaces on the biovolume and spatial structure of single- and multi-species biofilms was evaluated in static conditions. For the single-species biofilms formed by a model *E. coli* pathogen (*E. coli* SS2 GFP) and isolates from a fresh-cut salad process (*Pseudomonas grimonti* 13A10 and *Pantoea agglomerans* 19V1), confocal laser scanning microscopy (CLSM) showed that biofilm formation was reduced for the isolates on SICAN and SICON® [2] when compared to stainless steel surfaces. On the other hand, for mixed biofilms formed by *E. coli* in the presence of a competing isolate, *E. coli* growth was reduced on the modified materials.

Keywords: biofilm, microtiter plate, shear stress, modified surfaces, confocal laser scanning microscopy

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2 / Quality at the heart of sustainable markets for F&V products

Changes in phytochemicals during fruit and vegetable processing

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In addition to vitamins, minerals and dietary fibre, fruit and vegetables are an excellent source of non-essential nutrients called phytochemicals, that have been shown to improve human's health and /or protect against numerous chronic diseases.

Within phytochemicals, polyphenols and carotenoids are the major found in fruit and vegetables. Nevertheless, others such as glucosinolates or betalaines are characteristic of some specific botanical families.

Nevertheless, these phytochemicals in freshly harvested plant foods may be degraded by processing techniques, including cooking, being the main cause of this loss the thermal decomposition. Even if pasteurization is the most popular and traditional system used by the industry, other techniques, such as dehydratation or microwave heating, or other non-thermal systems such as high pressures, pulsed electric fields, ultrasound or cold plasma are actually promising alternatives for fruit and vegetables processing.

Other factors that have to be taken into account in order to preserve plant food phytochemical composition are the pre-processing steps, such as soaking, blanching, tissues removal, freezing, etc, as well as post-processing steps as packaging and storage conditions.

Specifically, among others, anthocyanins (coloured flavonoids from the polyphenols family) are of a special interest, because their thermal degradation renders less healthy and organoleptic attractive products.

Addition of olive leaves improve the sensorial and volatile fractions of olive oil from cv. Cobrançosa

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Olive leaves, an abundant waste of olive oil extraction, when added in small quantities during the extraction process could improve the quality and composition of olive oils obtained from overmature olives. However, the impact of leaves in the sensorial and volatile fraction of olive oils has never been investigated. In this work, the effect of olive leaves addition during extraction process (0%, 5% and 10% w/w) and malaxation time (20, 30 and 40 minutes) on cv. Cobrançosa olive oil sensorial and volatile fractions were studied. Thirteen independent combinations, from olives (maturation index), leaves and malaxation times, were prepared and extracted in an Abencor pilot extraction system. The experiment was made in triplicate originating 39 samples overall. In each sample sensorial analysis was performed according to olfactory, gustative-retronasal and olfactory-gustative sensations (14 descriptors overall). And, volatile composition was assessed by headspace solid phase-microextraction (HS-SPME) and gas-chromatography with mass spectrometry detector (GC/MS). The Pctage of olive leaves added and the malaxation time influenced the sensorial profile and the volatile composition of cv. Cobrançosa olive oils. In the sensorial assessment the lowest score was obtained in the olive oils with 0% 30 min (69.8 points), and the olive oil with higher score was the one with 0% 40 min (75.4 points). Clearly the malaxation time influence the sensorial profile of olive oils. With leaves addition is verified a slight increase in the scores of fruity and green (olfactory sensations), mainly in olive oils with 10% and 5% of leaves respectively. For volatiles, a total of 22 compounds were identified, being GLV's (green leaf volatiles) the most abundant [(Z)-3-hexenal; (E)-2-hexenal; and (Z)-3-hexenyl acetate]. (Z)-3-hexenal varied between 1.90 and 5.59 mg/kg of oil (5% 40 min and 10% 20 min respectively). (E)-2-hexenal varied from 7.68 to 14.1 mg/kg (0% 40 min and 10% 40 min respectively). (Z)-3-hexenyl acetate varied from 1.23 to 3.73 mg/kg (10% 40 min and 5% 30 min respectively). These volatiles are responsible for odors of leaf, green, and fruits like banana. It has been verified that the addition of olive leaves improves the volatile fraction of olive oils, with the increment of specific compounds. Malaxation time is also important for the sensorial and volatile profiles of olive oil. On other hand this work highlight that olive leaves can be valorized as natural source of powerful odorants for olive oil industry.

Keywords: waste, malaxation time, sensory characteristics, volatile composition.

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Biopreservation of nutritional and microbiological features of ready-to-eat vegetables processed by the probiotic strain *Lactobacillus paracasei* LMGP22043

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Probiotic strains used as starter cultures may combine the positive image of fermented foods with a functional appeal. Moreover, these bacteria can be used as bioprotective cultures to extend the shelf-life of ready-to-eat (RTE) foods and to control harmful microorganisms Indeed, new probiotic vegetable products – table olives, artichokes and cabbage – have been obtained after a mild fermentation process supported by the probiotic strain *Lactobacillus paracasei* LMGP22043 [1,2].In this study the probiotic strain *L. paracasei* LMGP22043, was applied as bioprotective culture (7 log CFU/g) to preserve RTE artichokes and as a starter to ferment blanched white cabbage thus preserving its nutritional quality. The probiotic strain was used to pilot the fermentation of cabbage leading, after 71 h fermentation, to a final product containing about log 8 CFU/g live cells and the 35% of the total glucosinolates (GSs) detected before fermentation otherwise completely lost during conventional fermentation of sauerkraut [3].After 30 days of refrigerated vacuum packed storage, GSs and the probiotic concentration still persisted. Moreover, the bioprotective features of the probiotic strain were ascertained in RTE artichokes challenged (3 log CFU/g) with pathogens *Listeria monocytogenes* ATCC19115, *Salmonella enterica* subsp. *enterica* ATCC13311, or *Escherichia coli* ATCC8739 and stored at 4°C for 45 days. All pathogens decreased in the probiotic RTE product, whereas a longer survival was observed in the standard product (control). At the same time, the probiotic RTE product still contained an adequate amount (more than 7 log CFU/g) of live probiotic cells [1].Therefore, studies demonstrated that vegetables can be processed to obtain functional products, using a probiotic strain which plays the double role of starter and bioprotective culture.

Keywords: functional food, fermentation, bioprotective culture, glucosinolates.

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Potential of Fava Bean as Future Supply of Protein and Phenolic Compounds

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Due to the growth of the world's population, food production became a major issue for agri-food industry and policy makers, as it is intertwined with climate change. In this respect, protein play a crucial role as they always occupied a distinct position in human diet. However, over the last century, an accelerated nutritional transition has resulted in animal rather than plant products becoming the main source of protein in higher economy countries [1], and consequently associated food-related environmental pressures [2], especially when protein are obtained from meat.

To date, our research has demonstrated that fava bean protein isolates offer an alternative to partially replace our dependency on unsustainable protein-rich foodstuffs, as they were found to provide a diverse range of phenolic compounds, including phenolic acids and their derivatives and several classes of flavonoids (210 ± 57 mg kg^{-1}). As the phytochemical fraction influences the oxidative stability of the product in which it is contained, we developed the prototype of a functional processed meat product, in the form of beef patty, with improved oxidative stability and potential health benefits, as fava bean protein isolates and its related bioactive fraction are major ingredients. Increasing the replacement of beef protein with fava bean protein, significantly decreased lipid peroxidation as shown by a prolonged induction time, which is the phase before the onset of oxidation,and a decrease in the concentration of malondialdehyde (MDA) which is an end product of lipid peroxidation. Besides, protein oxidation was reduced as shown by a reduction in the concentration of carbonyl groups, which are markers of protein oxidation.

The present study provides a doable method for replacing meat protein with fava bean protein in processed meat, without affecting organoleptic and physiochemical characteristics of the final product. The results of the research could encourage a higher consumption of vegetable protein, which would be favourable from both health and environmental perspectives.

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Apple cell wall contribution to fruit viscoelastic properties

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Fleshy fruit quality relies on various characters among which texture impact, production, processing and consumer acceptance. To date, texture is still poorly controlled as structural, physicochemical and mechanical factors are yet to be fully identified and their mechanisms of variation elucidated. Fruit texture implies viscoelastic mechanical properties of parenchyma tissue that result from tissue microstructure, water content and compartmentation, and cell wall mechanical properties. The latter depends on the structure and organization of pectin, hemicellulose and cellulose which individual contribution to the elastic (E') and to the viscous ($\tan\delta$) mechanical characteristics remains to be established.

With Golden Delicious and Granny Smith apple parenchyma tissue as models, the contribution of the different cell wall polysaccharides to viscoelastic properties was assessed after infusion of specific pectinases, hemicellulases and cellulases in an osmoticum to control turgor pressure. The results showed that both the viscous and elastic properties are linked ($\Delta\tan\delta/\tan\delta \approx -\Delta E'/(2E')$) and that all cell wall polysaccharides contribute to both the viscous and elastic characteristics. Enzyme hydrolysis sensitivity test showed that homogalacturonan pectic domain plays a major role on the parenchyma tissue viscoelastic properties. Fucosylation of xyloglucan and crystalline cellulose were also identified as cornerstone structures for parenchyma viscoelastic properties. These key cell wall structures may prove to be interesting targets to develop new textured fruit products.

Keywords: apple, cell wall, mechanical properties, enzymes.

Effects of pumpkin purée incorporated into the polymer matrix on the physicochemical properties of edible pumpkin films

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Pumpkin is a very important vegetable not only because of its nutritious value, but also a relatively low cost of cultivation. However, still more than 50% overall supplies of this crop is utilized in culinary processing and as a decoration. Therefore, searching an alternative way of pumpkin processing to add value to this vegetable is significantly needed. Novel cultivars of pumpkin developed in Poland are characterized by higher contents of polysaccharides and protein which may provide sufficient properties to form biodegradable, renewable and inexpensive edible packaging. Edible pumpkin films would not require to isolate the film-forming compounds such as starch or pectin, making material preparation easier. Pumpkin films may be used as food and food packaging. Therefore, they have a potential to be commercial.

Purée, as a primary ingredient in all films, was obtained from pumpkin fruit of the variety of Ambar developed at the Department of Plants Genetics, Breeding and Biotechnology, Faculty of Horticulture and Landscape Architecture, Warsaw University of Life Sciences – SGGW. The formulation of edible film was prepared as the mixture of pumpkin purée, hydroxypropyl methylcellulose, beeswax and glycerol with water. Physicochemical (thickness, water content, solubility and swelling), optical (opacity and colour), mechanical (elongation, tensile strength) and barrier (water vapor permeability) properties were determined, and the structure was analysed by means of scanning electron microscopy.

The research showed that the amount and physicochemical properties of pumpkin purée added to the HPMC-beeswax films have significant influence on their physical properties. Pumpkin films can be formed with flexible, opaque and orange appearances. Pumpkin film strength increased with increasing purée contents. Pumpkin purée contains certain amount of protein and various polysaccharides which may improve the film strength. The WVP of the films moderately increased with increasing pumpkin purée content. That may be attributed to the relatively high content of polysaccharides in pumpkin purée, which are featured as hydrophilic.

These results suggest that pumpkin films might be suitable as edible packaging as well as coating on food products to provide nutrition and convenient use for consumers reducing food packaging waste. However, relatively poor mechanical properties compared to synthetic packaging materials may hinder application of purée films on an industrial scale. Further studies are needed to find such compounds and their contents which may produce synergistic effect to form edible packaging with desirable mechanical and barrier properties.

Keywords: pumpkin, purée, edible film, physicochemical properties.

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Mapping the colour changes in frozen-thawed blueberry using computer vision system

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In this study CVS (computer vision system) was applied to determine colour changes of frozen-thawed blueberry in real time measurement. Computer vision is generally used for grading, defect detection, classification and finding out the ripeness of fruits based on its appearance. Measurements were done with 500 wild frozen blueberries (*Vaccinium angustifolium*), harvested in Truro in 2012, in calyx end orientation. First we set up, according to relevant papers that the anthocyanins absorbance is read from 460 to 560 nm. For this spectrum was recalculated CCT and the light sources were chose according obtained data (D_{55} with CRI 90 and LED with CRI 70–90+). This work evaluates CVS of frozen-thawed colour and compares it with colorimeter used as reference in the analysis of colour on food. The results obtained prove that the CVS predicts the colour changes of blueberry with a good reliability ($R_2 = 0.975$). The results indicated that CVS combined with image processing has the potential to visualize colour changes in frozen–thawed blueberries. This technique could be useful in real-time quality monitoring in food processing industry.

Keywords: Computer vision system, colour, blueberry, colorimeter, light sources

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Quality attributes and shelf-life of vacuum packaged potato strips (*Solanum tuberosum*) as affected by edible coatings, thermal and non-thermal treatments

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Blanching is a method commonly used in processed potatoes (French fries) to prevent enzymatic browning by inactivating polyphenol oxidase, reduced microbial load, promoted more uniform colour after frying and limit oil absorption. However, the losses of texture due to gelatinization of starch reduced the quality and appearance of blanched potato strips. Two possible clean alternatives to the thermal treatment are the use of ultrasound and edible coatings. Ultrasound has been studied for replace sanitizing with and for enzyme inactivation [1]. Alginate has been used to reduce weight loss, microbial grown and browning in fresh-cut vegetables. The objective of this work was to investigate the effectiveness of ultrasound or edible coating as possible alternative to blanching on the quality of vacuum packaged potato strips. Before vacuum-packaged in PA/PEHD bags, potato strips 10 × 10 mm (cross-section) were: blanched (85°C, 3.5 min), coated with 2% alginate, sonicated (42 Hz, 5 min) in a ultrasonic bath containing 2% citric acid solution or rinsed in distilled water (control). Packaged samples were stored up to 12 days at 3 ± 1°C. During the shelf-life of the packaged potato strips the pH, polyphenol oxidase (PPO) activity and microbial load was assessed. As well, the colour, firmness and dry matter of the treated and fried potato strips and the oil adsorption after frying was evaluated. PPO activity of the treated samples was no significantly different along time ($p > 0.05$).The application of the treatments did not affect the attributes of the fried potato strips along time without significant changes in oil adsorption and colour ($p > 0.05$). However, the visual quality of sonicated packaged potato strips was significantly better than the other treatments after 12 days of storage at 3 ± 1°C. As expected the losses of texture of blanched potatoes were remarkable ($p < 0.05$) before and after frying. Regarding the reduction of the microbial grown along time the combination of ultrasound and citric acid was the treatment that reach this goal. After 12 days, samples treated with ultrasound and citric maintained the mesophilic bacteria counts under 2 $\log_{10}$ CFU·g^{-1} whereas blanched and alginate coated samples reach values higher than 5 $\log_{10}$ CFU·g^{-1}. In conclusion, the combination of ultrasound and citric acid promotes the quality of shelf-life of vacuum packaged potato strips and can be used as alternative to blanching. However, further experiments in pilot plant are needed to confirm the effectiveness of ultrasound in the potato industry.

Keywords: ultrasound, blanching, PPO, alginate, French fries

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Online determination of antioxidant capacity of lipophilic compounds from Capsicum annuum using HPLC-ABTS and determination of interactions between lipophilic compounds in synthetic mixtures

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Background Since several years, antioxidant compounds are of great interest due to their implication in protection against radicals. A particular interest in natural antioxidants has risen especially during the last two decades. Beneficial health effect of natural compounds was found in food and beverages, such as fruit, vegetables and their derived products. Thus nutrition could be a preventive strategy in order to reduce oxidative damage and its associated pathologies. The study of the protective effect of these natural compounds is mainly based on the use of bioassay-guided fractionation of natural extracts from plants, fruit and vegetables or on the use of antioxidant assays measuring total radical scavenging activity in food samples. Some of these assays could be adapted to an on-line hyphenation of a separation technique and specific detection of chemical radical scavenging reactions (HPLC-DPPH, HPLC-ABTS).
Aim of the study The aim of this study was to compare the TEAC-ABTS values of pure natural compounds obtained using the common TEAC-ABTS assay with those obtained with the HPLC-ABTS method to validate the method for the online determination of antioxidant capacity on lipophilic compounds. Both methods were also applied to the determination of the antioxidant capacity of natural lipophilic extracts from *Capsicum annuum*.
Experimental and Results In this study, individual TEAC (Trolox Equivalent Antioxidant Capacity) values of pure lipophilic compounds were determined using a microplate assay and an optimized online LC-AOx (HPLC-ABTS) method [1], with post-column reaction. No significant differences were observed between both methods. Hence, TEAC values of lipophilic extracts from *Capsicum annuum* (red and green peppers) were determined using both methods. Differences were then observed and significant interactions were suspected. To evaluate these interactions, mixtures of lipophilic compounds identified in *Capsicum annuum* were prepared in variable proportions. TEAC value ($n = 3$) of each mixture was determined using the microplate TEAC assay. Interaction effects were calculated and additive, antagonist or synergic effects were observed. Results showed HPLC-ABTS provides individual TEAC values without interactions, but helps in the identification of compounds involved in antioxidant capacity, whereas microplate assay only provides TEAC values of mixtures, including interactions.

Keywords: Trolox Equivalent Antioxidant Capacity, synergisms, antagonisms, HPLC, post-column reaction.

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Recent advances on the phenolic molecules and oxidative mechanisms involved in the color of classical and "rosé" cider apple juices

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The color of beverages accounts for a crucial criterion which influences the choice of the consumers [1]. Moreover, color differences are the source of innovative products as it is now attested by the development of pink ciders in the French market. In juices and ciders commonly produced, the color is mainly formed during the first steps of apple processing when fruits are crushed and pressed leading to the enzymatic oxidation of the polyphenols in the presence of polyphenoloxidase (PPO) and dioxygen. Still today, the structures of the molecules, the environmental factors and the mechanisms associated to color formation in juices and ciders are unclear. In addition, those mechanisms are rendered more complex in rosé products with the involvement of apple anthocyanins.

Our recent works aim to better know the molecules and the mechanisms that control the color in both conventional and rosé apple musts during the first steps of fruit processing. The varietal effect was studied using both classical French cider apple varieties and also red fleshed cultivars. Juices were prepared according to two contrasted modalities regarding the oxidation level. The color of the clarified juices was measured (CIE Lab) and the detailed polyphenol profiles were monitored by C18 HPLC coupled to UV-visible spectroscopy and mass spectrometry. PPO activities in the crude juices were measured by polarography.

For conventional juices, UV 420 nm chromatographic profiles allowed to distinguish between well-resolved peaks corresponding to yellow-orange phenolic oxidation products and a large unresolved absorbance hump. The latter was characterized as a complex colored fraction having tanning properties with regard to its large removal after gelatine fining [2]. In parallel, the structures of new colored oxidation products deriving from dihydrochalcones or corresponding to coupling products between flavanols and dihydrochalcones were clearly identified and confirmed in model solution using purified substrates and apple PPO.

For the musts issued from red fleshed apples, the crucial role of the cultivar was highlighted influencing both the polyphenol profiles and the PPO activity. Cyanidin-3-*O*-galactoside (*i.e.* ideain) was confirmed as the main anthocyanin contributing to the red color of the juice although it was more or less degraded depending on the cultivars. The underlying mechanisms were studied by HPLC monitoring of model solutions containing ideain, apple PPO and mixtures of standard compounds representative of the main other polyphenolic classes (*i.e.* chlorogenic acid, (-)-epicatechin, and procyanidin trimers). Results confirmed that ideain is not a substrate for PPO but can be extensively degraded by redox reactions involving other polyphenols. LC-MS analyses of the oxidised model solutions gave access to preliminary information concerning the structures and the formation mechanisms of those anthocyanins oxidation products.

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Health-beneficial and health- threatening compounds in organic apple juice depending on processing technology

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The demand for cloudy organic apple juice is increasing among health-conscious consumers in Europe. In several countries, rack-and-frame press (RFP) is traditionally used by small-scale apple farmers for juice production. Due to the slow process and exposure of mashed apples to the air, considerable amounts of ascorbic acid (AsA) and polyphenols are lost due to the oxidation. In order to make the processing faster, juice producers are implementing water press (WP) or belt press (BP). Little data is available discussing advantages and disadvantages of WP and BP in terms of juice quality.

The aim of the study was to evaluate the quality of cloudy organic apple juice processed by RFP, WP or BP in terms of sensory properties, content of health beneficial compounds (AsA, polyphenols and antioxidant capacity) as well as health-threatening compounds (mycotoxin patulin and main apple allergens).

'Cortland', 'Krista', 'Krameri tuviõun' and 'Talvenauding' apples grown in Estonian organic orchards were separately processed into juice by RFP, WP and BP. Juice was pasteurized at 85°C and packed into airtight 1.4-litre aluminium foil bags. Total soluble solids (TSS), titratable acidity (TA) and AsA content were determined from raw apples and from juice. Antioxidant capacity was determined from lyophilized apples and from juice; other quality parameters were determined only from juice.

For identification and quantification of polyphenols (chlorogenic acid, catechin, epicatechin, procyanidin B2, quercetin-3-D-galactoside, quercetin-3-D-glucoside, quercitrin, rutin and phloridzin), Shimadzu Nexera X2 LCMS-8040 system with electrospray ionisation was used. Patulin content was determined by HPLC. Descriptive sensory analysis was carried out by the trained sensory panel at the Aarhus University. The main apple allergens (Mal d 1 homologs) were determined at the Technische Universität München by using ELISA test. The antioxidant capacity measurements were performed by electron paramagnetic resonance approach at the CREAA, IAA, Milan.

Patulin content was below detection limit (<4 µg/L) in all processed juices. Significant differences in juice quality were caused by cultivar properties and also by pressing methods. Juice processed from 'Cortland' apples had higher TSS/TA compared to other cultivars irrespectively of the pressing method, resulting the sweetest juice. AsA content was best retained in 'Krista' juice. As an average of pressing methods, highest content of chlorogenic acid, epicatechin and procyanidin B2 was retained in BP juices and the highest content of quercetin-3-D-glycoside and -galactoside and quercitrin in WP juices. The loss of most polyphenolic compounds was greatest in RFP juices.

Keywords: rack press, belt press, water press, polyphenols, quality

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Effects of the drying technique on the retention of phytochemicals in conventional and organic plums (*Prunus domestica* L.)

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Plum is a fruit consumed both fresh and processed, mainly by drying. Its phytochemicals are related to phenols, mainly hydroxycinnamates as neo-chlorogenic acid (NEO-CGA), the most present, and to anthocyanins as cyanidin glycosides (CYAN) and ascorbic acid (ASA), with minor amounts. The drying process of plums causes decrease in content of main phytochemicals, as well as the production of thermal markers, such as hydroxy-methyl-furfural (HMF). Plum cultivars are known to have a separate behaviour after drying, with different phytochemical retention, but little data exists regarding possible differences between conventional (CONV) and organic (ORG) plum, especially after drying. The aim of this study was to evaluate the phytochemical content in three different CONV and ORG plum cultivars (Jubileum, Reeves and Victoria) in freeze-dried (LIO) fruits and after two types of drying, conventional in forced-air oven (OVEN) and in innovative plant (http://mieri.entecra.it), exclusively utilizing solar irradiance (SUN). Fruits were harvested at commercial maturity. The considered phytochemicals have been NEO-CGA and CYAN as phenols, ASA as reductone and HMF as thermal marker, measured by reversed-phase HPLC. Moreover, a measurement of the Folin-Ciocalteu (F-C) reducing index has been performed. The phytochemical contents were compared and the retention was calculated by the Pct of the relative concentrations in dried products *versus* the LIO ones. Phenols, HMF and F-C were extracted in EtOH 50% with HCl 0.06 N, while ASA in 6% metaphosphoric-acid.

Similar amounts of dry matter have been obtained in LIO and OVEN samples, with a decrease in SUN, especially in Reeves, that suffered for mold infection during SUN drying both in CONV and ORG fruits. The higher content of the major phytochemical, NEO-CGA, was found in CONV LIO fruits, with peak values in Victoria. Surprisingly, these differences have been inverted after drying, with higher values in ORG for Reeves and Victoria products that stood out also for the low values of loss after drying. This trend was valid also for the F-C index, that resulted in the best correlation with NEO-CGA content (r_{xy} = 0.935). As for NEO-CGA and F-C index, the OVEN induced a better retention than SUN.

The content ASA and CYAN, present in lower amount than NEO-CGA, was highest in Jubileum LIO fruits, and were strongly depleted after drying. However, these compounds were better retained in SUN samples than OVEN ones. Finally, the HMF was found only in OVEN samples, with high amounts in Jubileum CONV and Victoria ORG samples.

Keywords: plums, conventional and solar drying, phytochemicals.

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Tomato carotenoids processing during simulated digestion: stability and transfer between tomato particles from Hot Break and Cold Break tomato purée, emulsion and mixed micelles

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Introduction. The process of digestion of plant food matrix could modulate the bioaccessibility of nutritionally relevant lipophilic micronutrients like carotenoids. Different steps are: diffusion of carotenoids into an oil phase, which also depends on food processing [1], transfer of carotenoids either into emulsion (gastric digestion) or inside micelles (intestinal digestion) [2], possible degradation through oxidation. To better understand the factors limiting the bioaccessibility of carotenoids, we investigated their stability and their kinetics of transfer in experimental models mimicking digestion, *i.e.* from tomato particles to emulsions and mixed micelles and from emulsions to mixed micelles.

Materials and Methods. Oil-in-water emulsions, mimicking those in the gastric compartment [3], were elaborated and characterized. Main carotenoids present in food (*i.e.* β-carotene, lycopene and lutein) were incorporated into these emulsions and we measured the emulsion droplet size and their stability as well as the stability of carotenoids during 4 hours at 37°C in the dark and room pressure. Transfer of carotenoids to mixed micelles was studied for carotenoid-enriched emulsions and also for tomato particles, prepared from tomato purée produced either by cold break (CB) or hot break (HB) tomato processing.

Results and Discusson. Carotenoids did not modify neither mode nor size distribution of emulsion lipid droplets. No significant change in the total carotenoid concentration was observed during the transfers but a 3–8% isomerization of the carotenoids. The transfer of carotenoids from emulsion to mixed micelles was time and carotenoid dependent: lutein was significantly more efficiently transferred (23%) than β-carotene (9%) and lycopene (7%). A larger proportion of lycopene was transferred to the oil phase for HB particles (6%), compared to CB particles (3%); the opposite was observed for the β-carotene (29% CB and 21% HB). A very small but significant transfer of carotenoids was observed directly from tomato particles to mixed micelles: 0.09–1.6% for β-carotene and 0.05–0.09% for lycopene. Carotenoids from tomato particles were better transferred to mixed micelles from HB than from CB tomato particles.

Conclusions. Carotenoids are stable during digestion but their transfer efficiency is a limiting factor for their bioaccessibility. More interestingly, we showed for the first time that processing type of tomato (HB or CB) influences the diffusion of carotenoids into emulsion and mixed micelles. Thus type of tomato processing impact carotenoid bioaccessibility and nutritional value of tomato products. Several hypotheses are under study to explain these results: modification of the structure of tomato particles and/or differences in their biochemical composition.

Keywords: carotenoid, oil-in-water emulsion, tomato processing, mixed micelles.

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Triterpenes and phenolic content in the peel of seven apple cultivars in relation to fruit maturity and treatment before peeling

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The experiments were performed in view of a possible utilisation of apple peel contained in apple press cake as additive to food products. There are several literature data dealing with the presence of triterpenes in a wax surface of apples [1]. Most of them suggested that some health benefits of apples originate from oleanolic and ursolic acid content. Available literature review indicate that the increasing the apple storage time may thicken the wax layer, due to the increased of triterpenes content in the skin. Our study was performed to investigate the influence of storage apples cultivars and their surface treatment by dipping fruits in cold, hot water and chloroform on triterpenes and phenolics content in apple peel. Water is normally used for fruit washing, however, we used chloroform because it is the most popular agent for wax layer removing. Fruits of seven apple cultivars harvested in 2013 at the experimental orchard of the Research Institute of Horticulture in Skierniewice (at optimum maturity for long term storage) were used for the research. Triterpenes and phenolic compounds were determined in the treated fruits at harvest and after three months of storage at 2°C under normal atmosphere. Analyses of triterpenes were performed using HPLC following methanol extraction according to the method described by Tian et al. [2] with minor modification, and the phenolic compounds were determined by a modified version of the HPLC method of Tsao and Yang [3]. Three months of apple storage in normal atmosphere did not influenced the triterpenes and phenolics content in apple skin. Peel from 'Topaz' and 'Golden Delicious' cultivars contained more phenolics and triterpenes than either 'Shampion', 'Cortland', 'Idared', 'Ligol' or 'Jonica'. Irrespectively of cultivar differences the analyses showed that peel of apple can be a value-added food ingredient due to the high content of bioactive compounds. The investigations showed that even if the layer of wax is removed (by e.g. chloroform) the contents of triterpenes in fruit skin remain unchanged. Our results showed also that apple peel have much more triterpenes than of the phenolics (500–1000 mg/100 g DM and 1500–3000 mg/100 g DM respectively) that's why the content of triterpenes may be more important than phenolics compounds in respect to health-promoting properties of apple peel.

Keywords: apple peel, wax surface, oleanolic acid, ursolic acid, HPLC

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3 / Constraints on F&V processing: microbial, safety and waste management issues

Ready-to-eat vegetables: Current problems and potential solutions to reduce microbial risks in the production chain

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Processing of leafy vegetables involves the application of several unit operations, which can provide opportunities for cross-contamination whereby a small lot of contaminated product may be responsible for the contamination of a large proportion of the processed product. Different studies identified the most important sources of cross-contamination during processing which includes, among others, conveyor belts, cutting units, centrifugation and filling operations. However, washing seems to be the most relevant processing step regarding cross-contamination of leafy vegetables. Washing is a key intervention step aimed to remove dirt, foreign materials, tissue fluids from cut surfaces, and microorganisms. To reduce microbial risk associated to process wash water, the use of disinfectant agents is the most recommended intervention strategy. Many different disinfection systems have been tested and proposed as good alternatives to maintain the microbial quality of process wash water. Nevertheless, only few of them have been implemented by the industry and in most of the cases chemical sanitizers are the only alternative. This review will bring an overview of the main microbial risks face by producers of ready-to-eat fresh produce and the available alternatives to reduce these risks. Data will be shown to gain insight on the microbial contamination throughout the processing operations involved in fresh-cut leafy vegetable production as well as the identification of suitable sampling points and their relation with the microbial contamination of end products. Studies carried out by our research group showed that the presence of pathogenic microorganisms is rarely detected in the processed product, but they can be found in the process wash water. In fact, process wash water coming from the centrifugation units has been identified as a suitable sampling point for testing the microbial contamination of the processed product.

Keywords: Leafy greens, cross-contamination, pathogenic microorganisms, intervention strategies, disinfection systems

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Persistence of pathogenic and spoilage bacteria in a minimally processed vegetables plant

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Introduction. Food safety is a growing concern due to the increasing demand for microbiologically safe products [1]. Additionally, disinfection techniques must evolve to cope with the development of antimicrobial resistance. An efficient disinfection strategy should have into account the type of microbial contaminants. Consequently, the knowledge on the microorganisms present in an industrial process is crucial to define the best strategy for their control. Despite the microbial pathogenic potential, the spoilage action needs to be considered.
Materials and Methods. Bacteria were isolated from a minimally processed vegetables (MPV) plant, particularly the process surfaces, the air and the vegetable surfaces. The isolates were identified by 16S rRNA sequencing. The isolates were also characterized in terms of biofilm formation ability and selected virulence aspects: proteases, gelatinases and siderophores.
Results and Discusson. Twenty different bacterial species were identified and *Pseudomonas* spp. were the predominant microflora present in the MPV. The isolates included recognized pathogenic (*Pseudomonas oryzihabitans*, *Stenotrophomonas maltophilia* and *Rahnella aquatilis*) and spoilage microorganisms (*Xanthomonas campestris*, *Pseudomonas* spp. and *Erwinia* spp). Among all the isolates, *Pseudomonas* spp. and *R. aquatilis* persisted along the process chain and were present in the final product. *Pseudomonas* were the genera that produced more biofilm. Generally, all the bacteria were capable of producing proteases, siderophores and gelatinases.
Conclusions. The bacterial isolates were capable of producing virulence molecules. This is of particular concern for the pathogenic (*P. oryzihabitans*, *S. maltophilia* and *R. aquatilis*) and spoilage (*X. campestris*, *Pseudomonas* spp. and *Erwinia* spp.) bacteria. The persistent bacteria in the MPV proposes that decontamination and sanitation processes should be targeted for those resilient microorganisms in order to increase produce quality and guarantee food safety.

Keywords: biofilm, MPV, pathogenic, persistence, spoilage

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Valuation of heavy metals and health risk index in *Amaranthus hybridus* L. vegetable grown in selected farms in Ibadan, Nigeria.

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This study was conducted to evaluate the heavy metals; Lead (Pb), Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), and health risk associated with the consumption of *Amaranthus hybridus* contaminated vegetables. Four selected vegetable farms: Mokola, Ojoo, Olorunda Aba and Agbon-Ile in Ibadan, Nigeria and Teaching and Research Farm, University of Ibadan (control site) were used during rainy and dry seasons for eight weeks respectively. The experiment was laid out in a completely randomized design replicated three times. Data collected were analysed using descriptive statistics ($p = 0.05$). The results indicated that heavy metal concentrations were higher in water, soil and vegetables (root and shoot) during the rainy season. Heavy metals in vegetables grown in Ojoo farm were significantly higher than quantity found in other farms including the control. Irrigation water from farms showed highest heavy Pb concentrations between 116.90 – 96.83 mg/L, and lower Cd concentrations 0.12 – 0.06 mg/L during rainy and dry seasons respectively. Heavy metal concentrations in the vegetable shoot contained highest concentrations of Cr (9.41 – 11.66 mg/kg) and lowest (0.04 – 0.06 mg/kg) of Cd in both rainy and dry seasons. The concentrations of heavy metals in vegetable root samples from all the farms followed the same trend Zn > Cu > Cr > Pb > Cd in both rainy and dry seasons respectively. The results from the soil revealed highest concentrations of Pb of 128.36 mg/kg and 0.40 mg/kg of lower concentration of Cd in dry seasons. The human Health Risk Index (HRI) values of the root and shoot of Amaranthus hybridus vegetable samples in dry and rainy seasons were < 1 in most farms. The vegetable samples (root and shoot) however, recorded HRI > 1 from Pb and Zn (ranged from 1.15 – 8.32) during the dry and rainy seasons especially at Ojoo farm. This study revealed that the proximity of Ojoo vegetable farm to heavy traffic road appeared to be the major contributory factor to its high heavy metal accumulation which resulted to high Health Risk Index.

Keywords: Heavy metals, *Amaranthus hybridus* L., Irrigation water, Soil, Health Risk Index, Farm sites.

Impact of minimal processing on the dynamics of volatile organic compounds emitted from fresh strawberry

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Change in composition and concentration of volatile organic compounds (VOCs) is one of the primary indicators in the sequence of postharvest degradation processes in fresh and minimally processed produce. Due to the high volatility and variable concentration of VOCs, understanding the impact of sample processing and incubating temperatures on the volatile profile is essential. This study investigated the effects of minimal processing on the change in composition and relative abundance (%) of VOCs emitted from strawberries. A total of 70 VOCs belonging to six chemical classes were identified via gas chromatography-mass spectrometry (GC-MS). The volatile profile obtained for strawberries were significantly ($p < 0.05$) influenced by minimal processing and the headspace incubating temperature. Aldehyde chemical group were most abundant in strawberry puree (34%) compared to sliced (18%) and none was detected in the headspace for the intact fruit sample. Esters were most abundant in the sliced strawberry (63%) compared to intact fruit (51%) and puree (49%) samples. Increasing the incubating temperature of sample vials from 60 °C to 80 °C resulted in three fold increase in number of VOCs. This investigation showed that postharvest analysis of VOCs of fresh produce towards the determination shelf-life/quality, requires detailed understanding of essential parameters influencing evolution of volatiles. Thus, caution should be taken in metabolic profiling and interpretation of GC-MS data for aroma compounds of fresh produce.

Keywords: Static headspace sampling, volatile profile, strawberry (*Fragaria* × *ananassa*),postharvest

Thermally processed fruit salads with long shelf-life at different storage temperatures

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The development and optimization of food preservation processes are a demand in order to fulfill the consumer's needs, security and quality of food. The creation of innovative ways of food consumption, associated to the development of healthy and tasty food products, has been mostly focused on the need of easy and rapid meals. Additionally, the production of an individual homemade fruit salad is expensive (at least 3 different types of fruit) and results in food waste (the use of whole fruit, instead of pieces of each one). Thermal processing is used to extend shelf-life, although it could result in browning of fruit salads, affecting consumer's acceptance due to the sensorial changes and possible loss of bioactive compounds. Storage can also affect the quality of food products due to the development of off-flavours and change of sensorial properties [1]. Thus, the challenge is the production of single-dose fruit salads with extended shelf-life using a low thermal treatment.

Two fruit salads (National and Tropical fruit salads) pasteurized at 80°C and stored over 56 days at 4 and 25°C were studied concerning the physicochemical (pH and titratable acidity), biochemical (soluble solid index, ascorbic acid, total phenolic and antioxidant capacity) and sensorial properties (colour, flavour, texture and aroma). The effect of the thermal treatment on enzymes and microbial inactivation (aerobic microorganisms, yeast and molds and acid lactic bacteria) were also followed. The pasteurization ensured microbial inhibition and enzymatic inactivation. The time of storage, independently of the temperature, did not influence pH and acidity, as well as the antioxidant capacity, but resulted in loss of bioactive compounds (ascorbic acid and total phenolic content) over time. The colour was the most affected in the sensorial analysis, since the fruit salads underwent non-enzymatic browning reactions during storage.

The results obtained show that pasteurized fruit salads can be stored at room temperature, reducing industrial costs along manufacturing, but refrigeration at 4°C presents better organoleptic properties. The juice added to the fruit salads seems also to confer a protecting effect, retarding oxidation.

Keywords: Thermal processing, Thermal-stability, Fruit salads, Storage effect

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Studies on the biocontrol mechanisms of Pseudomonas graminis strain CPA-7 against foodborne pathogens on fresh-cut fruit.

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Pseudomonas graminis strain CPA-7 is a Gram-negative bacterium, native from whole apples surfaces, which has shown effectiveness in reducing the populations of *Listeria innocua*, *Salmonella* spp. and *Escherichia coli* on minimally-processed fruits [1]. *Pseudomonas* mechanisms involved in biological control include rapid colonization, nutrient competition, induction of plant defense response and exudation of lytic enzymes, antimicrobial compounds and siderophores [2]. In this work, putative mechanisms of action associated with the biocontrol capacity of *P. graminis* CPA-7 against foodborne pathogens were studied in vitro and in vivo levels. The inhibitory effect of soluble secondary metabolites produced by CPA-7 in different culture media against *Listeria monocytogenes* was tested at different stages after inoculation. The antagonistic effect of cell-free supernatants against *Listeria* spp. and *Salmonella* spp. were also tested on fresh-cut *Piel de sapo* melon at 5°C and 10°C. Adherence capabilities of CPA-7 were assessed by testing its ability to form biofilm on polystyrene plates and by quantifying spectrophotometrycally the production of uronic acid containing- exopolyssacharides. Nutritional similarity between CPA-7 and *L. monocytogenes*, *Salmonella* spp. and *E. coli* was estimated from NOI (niche overlap index) [3] derived from in vitro sole carbon/nitrogen sources utilization profiles. No significant reduction of *L. monocytogenes* population was observed in cell-free supernatants compared to the non-inoculated selected culture media. In vivo analyses did not shown a significant inhibitory effect of the cell-free supernatants on the pathogens growth after five days post-inoculation. CPA-7 showed to be negative for biofilm formation on polystyrene plates and the production of acidic exopolysaccharides was close to the negative control. Up to the present studies, competition for physical space and nutrients is the most likely mechanism of CPA-7 to antagonize the investigated human pathogens. Further studies on the composition of the fruits where CPA-7 has shown to be effective or ineffective as antagonist, need to be carried out to establish a relation between the availability and the use of specific nitrogen/carbon sources by the pathogens and the antagonist in vivo.

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Quality and sustainability of juice and wine: technologies for removing alkyl-methoxypyrazines.

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Quality is a key driver underpinning consumer acceptance of and purchase behavior toward processed fruit products, including juice and wine. Therefore, contamination of juice and wine with unpleasant odor- or taste- compounds detracts from perceived quality, and may lead to product rejection, concurrently threatening the sustainability of the sector. Such a threat has been identified in the case of alkyl-methoxypyrazines (MPs), grape juice and wine. MPs are endogenous components of several grape varieties used for wine production (e.g., *Vitis vinifera* L. cv. Merlot), and have also been found in the juice of grapes used in juice production (e.g., *Vitis labrusca* L. cv. Concord). Recently, an exogenous and unexpected source of MPs has been identified in juice and wine: beetles. Members of the ladybeetle family (Coccinellidae), *Harmonia axyridis* ('Multicolored Asian ladybeetle') and *Coccinella septumpunctata* ('C7') migrate into vineyards in autumn, and are unintentionally incorporated into the harvested fruit. When processed further (juiced or fermented), these beetles release haemolymph that contains high concentrations of MPs, which contaminate the final product ('ladybug taint').

Interestingly, *Harmonia axyridis* has recently been designated as an invasive pest in some parts of Europe, and observed in vineyards in several key wine regions, including France and Germany. Climate change may be contributing to the increasing concern over high-MP juice and wine, specifically the increased frequency of extreme weather events and the warmer winters observed in northern climes. The former may prevent grapes from reaching optimum maturity, with the degradation of MPs in the fruit that would normally accompany full physiological ripeness more limited. Additionally, warmer winters, particularly in more northern climes, are allowing *Harmonia axyridis* to establish itself in regions that were once beyond its natural range.

This paper reviews the role of MPs in wine quality, and the approaches that have been used in both the vineyard and winery to address these challenges. We also present recent research from our group on remediation options for treating high-MP juice and wine. Specifically, we show results from the development of a highly specific odorant-binding protein-based system for treating juice, and a polylactic acid-based polymer that is effective in wine. Correct identification and treatment of juice and wine tainted with MPs are necessary to maintain the quality of these important Euro-Mediterranean products, and to the sustainability of these industries.

Comparative analysis of microbial communities of fruits from different farming types

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Traceability and authenticity (UE Regulation 178/2002) of foods are mandatory to ensure food safety, and so the protection of consumers. But traceability and authenticity of foods are mainly realized by administrative means: most systems trace foods by their packaging while a few do trace the product itself, which increase the susceptibility to fraud. Organic foods are no exception to the rule and are among commodities the most subjected to fraud in Europe (European Commission, 2013). It is therefore necessary to resort to advanced analytical tools to limit the cases of food frauds.

So, the purpose of our study was to develop an effective analytical tool to authenticate organic fruits. To this end, we used the comparative analysis of the natural microflora (bacteria and fungi) present on the surface of fruits. Our hypothesis was that agricultural practices have a measurable impact on the microbial environment of fruits. To test this hypothesis, we combined molecular fingerprinting approaches (PCR-DGGE and HRM) and high-throughput sequencing technologies.

Our results indicated that there was a specific molecular signature of the farming type that allowed organic fruits to be differentiated from conventional fruits. We demonstrated also that some microbial groups (fungal and bacterial) may be specific to organic fruits or to conventional fruits. Statistical analyses confirmed the importance of using these microbial groups as discriminant markers for organic fruits.

This pioneering study constitutes the basis for the development of an analytical tool that could meet the needs of consumers and actors along the production and distribution chain in terms of authenticity and food safety. There is a need to confirm and precise the persistence of the bacterial and fungal markers identified in this study for discriminating organic fruits.

Keywords: Organic, authenticity, traceability, microbes, fruits

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Brettanomyces anomala, a double drawback for cider aroma

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Brettanomyces anomala is well known for its negative impact on fermented products aroma such as cider. Besides, the sensorial cider space shows a strong polarization that opposes fruity ciders, mostly represented by pasteurized products, and ciders with both phenolic aromas and gustatory characteristics due to polyphenols as bitterness and astringency [1]. A first hypothesis was proposed to explain this bi-polarization: the masking of fruity aromas by volatile phenols.

This cider sensorial space representation was refined and completed during a new study in which similar sensorial groups were described. Nevertheless, aroma analyses showed that the presence of high levels of volatile phenols in "phenolic-like" products is specifically correlated with a lack of acetate esters while the fruity ciders are containing some. These observations led us to make the hypothesis of acetate esters degradation by *Brettanomyces*. This hypothesis was verified experimentally in studying the esters degradation in five different very fruity ciders inoculated with a *Brettanomyces* strain and in comparison with *Saccharomyces* and *Hanseniaspora* strains isolated from ciders.

The esterase activity potential of several cider *Brettanomyces* strains was studied by following para-nitrophenyl acetate degradation. This activity was also measured during yeast growth in order to determine the degradation conditions.

These results confirmed the specific acetate esters degradation by *Brettanomyces* (ethylic esters being not degraded) with or without a volatile phenols generation. Thus, even before producing the volatile phenols likely to mask the fruity characteristic of ciders, *Brettanomyces* can negatively impact the cider aroma by degrading the esters contributing to fruity notes.

Following this work, advices can be done to producers in terms of equipment hygiene and cider protection against *Brettanomyces* development. The perspectives will be to better know the population level needed and sufficient for beginning the degradation with the aim in giving a maximum level not to overtake for a cider aroma protection.

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Strategies of shelf life prolongation of fresh-cut vegetables

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Changing consumer attitudes to healthier, low caloric and high convenience levels of foods play an increasingly important role in our society. Minimally processed vegetables (MPV) seem to be a useful solution, as they combine the features of freshly harvested food and time saving convenience. Despite these advantages, MPV underly limited shelf life due to faster microbial spoilage. With these trends, fresh-cut produce increased the need for microbial decontamination methods.

The present work elaborated practical ideas and strategies of shelf life prolongation of fresh-cut vegetable cubes with storage conditions relevant to retailer requirements. Different packaging materials, gas atmosphere variations and treatments with pulsed light (PL), citric acids and various spice extracts have been examined. Results of tests at laboratory scale including the growth behaviour of relevant bacterial spoilage indicators and pathogenic types have shown individual antimicrobial effects. Nevertheless, the optimization of hygienic and basic technological operations at manufacturing level were the most relevant to establish realistic hurdle concepts.

4 / Consumer preferences and needs - OPTIFEL sponsored session

Are fruit and vegetables good candidates for an appealing diet for the elderly?

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As the European population becomes older, malnutrition risk is more and more taken seriously because of its deleterious consequences. Factors influencing food behavior are multiple, even more at this age than younger: physical and psychological health, physical activity, mood, attitudes toward food, sensory perceptions, preferences, habits, culinary skills, ability to cope with daily tasks. They all play a role and are modified with age and especially for the dependent elderly people. Fruit and vegetables are traditional foods for the elderly. They are healthy and present nutritional qualities as fibers and vitamins; on the other hand, they are not always easy to prepare. Are they still a large part of the meal when the dependency comes? After exploring the literature, we will present the results of an European survey done during Optifel project. In 5 countries, 460 interviews were conducted with dependent elderly people (M=82 yrs old). Three categories of dependency were considered: Category 1 : elderly person living at home with help for food purchasing, Category 2 : elderly person needing help for food preparation or having meal delivery, Category 3 : elderly person living in a nursing home or a retirement home with at least 50% of meals in the restaurant. The questionnaire addressed many dimensions : health, food behavior, meals structure, food consumption frequencies, food selectivity, pleasure of eating, interest for natural products, interest for health, food preferences, preferred packaging, difficulties - to purchase - to prepare - to eat, kitchen equipment, usual ways of cooking vegetables. The results showed a large variability in the sample, even if fruit and vegetables are mainly well liked among the elderly people. Different preferences profiles were highlighted and these results can be used to design and/or adapt F&V-based products according to elderly consumers' liking.

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Consumption and attitudes regarding berries-based products – comparative analysis of Romania and France

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The study and understanding attitudes, knowledge and consumers behavior has a vital importance for policy makers in setting food policies, the relevant legislation and directions of development - research within society as a whole, but also for economic operators on the green food market. Ecological berries that have beneficial effects on consumer health are competitive on the market only if the consumers understand the benefits of these products.

Study on consumer behavior towards food and their production, how they purchase or obtain necessary food, their own attitudes towards diet and understanding, the links between diet and health are entirely parts of multidisciplinary research that intersect both social and natural sciences and represent synthetically consumer science.

In this study marketing research were conducted in order to determine the factors that influence consumer behavior towards products based on berries.

In order to conduct marketing research through the interview method, a questionnaire template was developed. This questionnaire included a set of 15 questions regarding demographic profile and consumer behavior and was distributed to Romania and France. It was received 275 answers from Romanian consumers and 281 from French consumers.

In Romania, less than half of the respondents, respectively 44.44% deciding which foods are bought in the household, while in France over 60% of respondents make this decision.

The Pctage of female respondents on this marketing research was higher for Romania, namely 79% in comparison to France where only 26% were women. Among the products based on berries listed in the questionnaire French prefer fresh berries, yogurt with berries and juice or smoothie with berries, while the Romanians prefer berries in jelly and jam, berries dry mixed with cereal or cereal bars and yogurt with berries.

Almost all consumers participating in the survey consider that taste and naturalness of the product are the most important aspects when buying products based on berries.

The majority of the respondents consider important issues as pack, price and certification of the products origin and not least the availability and store promotions. Less than half of French respondents are not impressed by advertisements, health benefits and extended shelf-life and more, they do not consider recommendations of other consumers while Romanian respondents take into account the recommendations of other consumers and also the novelty of the products.

Keywords: marketing research, questionnaire, berries

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Odorants increase sweetness perception in fruit juices

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Introduction. Consumer free sugar intake reduction is a reiterative recommendation from institutions (i.e.: World Health Organization) due to highly reported data that link free sugar intake with obesity, diabetes and caries [1]. Safety of sweeteners is also questioned because of their novelty, diversity and dosages used depending on food/beverage tested. Aroma itself is not able to substitute sugars/sweeteners achieving same sweet perception. However, congruent odor can contribute to modulate sweetness in some food/beverages [2], being an alternative for industries and consumers. The goal of the present study was to enhance sweet perception of fruit beverages without sugar added by using odors. The strategy was to modulate sweetness in fruit juice depending on quality and concentration of odors.
Materials and Methods. Olfactoscan is a novel coupled system (dynamic-dilution olfactometer-gas chromatography olfactometry) that allows on-line evaluation of odor mixture interactions [3]. In this approach, juice aroma delivered from an olfactometer and odors delivered from a gas chromatograph, are mixed and evaluated by orthonasal olfaction. Interaction of fruit juice aroma and 8 odorants (associated to sweetness in a preliminary experiment) at two concentrations were rated for induced-sweetness by 12 trained judges in duplicate.
Results and Discusson. Four odorants were found to increase sweetness perception of fruit juice aroma ($p < 0.01$). The sweetness enhancement in juice by odor is in the range of 20% to 70%. Fruit juice sweetness enhancement was related to the odor-induced sweetness intensity. Odor-induced sweetness depends on the quality and concentration of the odor. For example, for ethyl-2-methyl butanoate (fruity apple) sweetness enhancement ($p < 0.001$) was 72% and 42% at the highest and lowest concentration tested, respectively. However, for ethyl-butanoate (fruity butter) sweetness enhancement ($p < 0.01$) was 38% and 22% at the highest and lowest concentration evaluated, respectively.
Conclusions. This study allowed evaluating odorants which are able to increase significantly sweetness in juice. The next step will be to test the global flavor perception of non-sugar-added fruit beverage supplemented with these odors.

Keywords: aroma, sweetness, fruit juice, olfactoscan, gas chromatography olfactometry

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Do elderly people differ in their preferences? Sweet and acid preferred levels in apple purees.

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As European population is aging, the number of elderly people dependent for food-related activities and at risk of malnutrition is increasing. The aim of the European project OPTIFEL (optimized foods for elderly people) is to tackle malnutrition by developing nutritionally adapted products which are nutritionally relevant for elderly people and well appreciated (and so, consumed with pleasure). The objective of the presented study is to identify which levels of sugar and acid are the most preferred in apple purees and if these levels vary depending on the level of dependency.

A total of 130 autonomous elderly people living at home and 96 dependent elderly people living in nursing homes were recruited in three countries (France, Poland and Spain). Participants were asked to taste apple purées with different sugar or acid concentrations and to rate their liking. Participants also indicated the most liked and disliked samples. Due to a greater frailty and to avoid any heartburn, dependent elderly people did not taste soured apple purées.

Among autonomous elderly people, there was no significant difference in liking between the different sweet levels. $F_{(2,130)} = 2.36$; $p > 0.05$). This hides a disagreement among the elderly: whereas 35 tasters from 62 cited the sweetest sample as the most liked, 27/62 cited this same sample as the most disliked. Older and dependent elderly people were more consensual: liking scores were significantly higher for sweeter samples ($F_{(2,96)} = 7.52$; $p < 0.05$) and the sweetest sample was significantly more cited as "the most liked sample" and the least sweet as "the most disliked sample" ($p < 0.05$).

Regarding sour apple purees, the elderly are in agreement and the liking scores decrease as the acidity increases ($F_{(2,130)} = 41.82$; $p < 0.001$). The sourest sample (6.71 ‰ of acid) was significantly more cited as "the most disliked sample" compared to other ones ($p < 0.001$). Taking elderly people's specificities into account is important to adapt offer, maintain pleasure while eating and fight against malnutrition, and these results show specificities for the dependent elderly. These results will help to build a specification for producers including nutritional but also sensory guidelines. In a context of malnutrition, the most appreciated samples can be used as a matrix for proteins, fibres, vitamins or minerals supplementations.

Keywords: sugar, malic acid, Europe.

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Understanding and modelling vegetables consumption among young adults

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Introduction Although F&V consumption is highly recommended for a healthy, balanced and sustainable daily diet, several European countries report low intake. In Italy, which reported in 2000 the second F&V intake in Europe (450 g/d) and the highest consumption of processed vegetables (56 g/d), the picture changed during the economic crisis with a drop in per-capita F&V consumption. In 2014 the annual F&V consumption was lower than the recommended intake. Moreover, vegetables consumption decreases among young people: in Italy only 45% of the population between 20 and 24 years consumes at least one portion of vegetables per day [1]. Therefore, this paper aims to understand the main determinants of vegetables consumption among young adults in Italy to suggest possible intervention strategies to promote sustainable consumption.

Material and Methods A cross-sectional study was conducted on a samples of Italian students (n = 750), using the theory of planned behaviour (TPB) as a conceptual framework [2].A structural equation model (SEM) was developed to test the TPB predictors for vegetable consumption (i.e. "eating at least 2 servings of vegetables per day next week"), the beliefs underlying individuals' attitudes, and the role of habits in moderating for the relevant behaviour. A multi-group analysis was performed to assess the moderating role of habits.

Results and discussion The self-reported mean consumption was approximately 3 servings of vegetables per day; individuals who reported higher habits consumed a larger number of servings (3.6), compared to medium (3.1) and low habit participants (2.2). The results show that 81% and 68%, respectively, of intentions and behaviour variance is explained by the TPB model. The multi-group analysis shows that attitude significantly predicts intentions only for low habit individuals, while subjective norms affect intention to eat vegetables for low and medium habit groups. Intention significantly affected eating vegetable behaviour in participants with low and medium habits, but not in young adults with strong habitual behaviour. For those with high habit strengths, self-efficacy is the main predictor of behaviour.

Conclusions The results indicate that vegetable consumption may be intentional, as well as habitual, depending on the level of habit strengths. Suggestions are provided to define interventions to promote a sustainable vegetable consumption based on the behaviour determinants and relative beliefs for each habits group.

Keywords: Theory of planned behaviour, Habits, Attitude, Intention, Structural equation modelling

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Improving sensory perception by compensatory pathways on populations with sensory impairments

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For the ageing population, frequently the tasting ability is diminished, often as a side-effect various medications. Tasting ability may be impaired across all the five basic tastes or it may be that just one or two tastes are lacking. In the latter case, perception of foods can be drastically altered meaning individuals no longer enjoy their favourite meals and hence feel as though their quality of life has diminished. Accordingly, determining tasting ability and then finding ways to increase enjoyment of food can significantly improve quality of life. By adding strong aromas to certain foods, the smell acts in conjunction with taste as both are received in the taste centre of the brain, thereby bringing about a greater sensation. This is known as compensatory pathway stimulation.

Sensory analysis profiling was carried out on a group with swallowing difficulties (dysphagia) exploring the five basic tastes according to the ISO standard with two additionally stronger concentrations added in anticipation of the reduced tasting ability in this group. The detection and identification thresholds of each taste were recorded and compared with results of healthy volunteers.

To enhance the likelihood of identification of umami and sweet tastes, complimentary aromas were added to these solutions, namely beef (umami) and caramel (sweet).

The group with swallowing difficulties had significantly lower tasting ability than the general population for sour, salty, sweet and bitter tastes ($p < 0.05$), with concentrations outside the ISO standard required for identification. There was greatest variation in perception in umami tastes amongst the test group.

The compensatory pathway trial illustrated that addition of aromas enabled better detection of sweet and umami tastes compared to tastes (of the same concentration) alone, illustrating the impact of stimulating alternative senses to increase perception of taste, and therefore, enjoyment from food.

The results from this communication could be applied to other groups who require greater appetite stimulation. The current study was limited by the swallowing capabilities of the individual and the small sample size, therefore may not necessarily be broadly applied to all individuals with dysphagia. However larger study groups are planned for future research.

Keywords: Sensory profiling, dysphagia, Compensatory pathways

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Abstracts — Posters

1 / Innovative processes for improved sustainability

Extraction of carotenoids from carrots by bio-based solvents as alternative solvents to *n*-hexane: Theoretical and experimental solubility study.

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The present study was designed to evaluate five alternative green solvents (2-MeTHF, DMC, CPME, IPA and ethyl acetate), for the substitution of *n*-hexane in the extraction of carotenoids from carrots. Initially, a solvent selection was made through the physicochemical solvent properties and solubility theoretical results obtained using two simulation programs, the Hansen Solubility Parameters (HSPs) and the Conductor-like Screening Model for Realistic Solvation (COSMO-RS) that uses a statistical thermodynamics approach based on the result of quantum chemical calculation, for comprehension of dissolving mechanism. On the basis of the HSPs analysis, the non-polar or slightly polar solvents were the most suitable solvents for extraction of carotenoids. COSMO-RS analysis showed a higher probability of solubility of all the carotenoids from carrot in CPME, 2-MeTHF and ethyl acetate compared with *n*-hexane. The experimental results using a conventional solid-liquid extraction by maceration showed that the best bio-based solvents were CPME, 2-MeTHF and ethyl acetate in accordance with the predictive results from COSMO-RS. The highest carotenoid content (78.4 mg 100 g^{-1} DM) was observed in CPME where the 66% was represented by β-carotene and the 34% was α-carotene. The results support the potential of CPME and 2-MeTHF as alternative green solvents for extraction of carotenoids with applications in different industrial processes mainly in the food industry.

Use of mid-infrared spectroscopy to monitor shelf-life of ready-made meals

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The objective of this work is to evaluate the possibility of using mid-infrared spectroscopy as a rapid analytical method to monitor the change in stored ready-made meals over time, for example oxidation phenomena occurring particularly in ready-made meals in plastic packaging.

Six ready-made meals models (lentils, mashed potatoes, mashed potatoes with cheese, béchamel sauce, vegetable soup, Bolognese sauce) were prepared and packaged in plastic bags. They were stored at 23°C and at a partial oxygen pressure of 96 kPa to accelerate the oxidation phenomena. Two plastic packaging, Alu and Alox, were used presenting in these conditions an oxygen permeability of respectively 0.028 and 0.040 cm^3/(packaging.day). Three bags of each ready-meal x plastic packaging combinations were sampled at 6 different times: T_0 the start of the experiment, 20 days (equivalent to 3 months), 40 days (equivalent to 6 months), 59 days (equivalent to 9 months), 79 days (equivalent to 12 months) and 119 days (equivalent to 18 months). Samples were then frozen at −20°C until measurements. After thawing, samples were directly, without grinding, measured in attenuated total reflectance mid-infrared spectroscopy between 4000 and 650/cm performing five replications to evaluate the sample heterogeneity.

Multivariate analyses applied on spectral data allowed to highlight some changes in the global profile. For example, in the case of Bolognese sauce, samples were clearly discriminated (i) from 12 months, (ii) according to the packaging at 18 months with a greater oxidation in the Alox packaging. The eigenvectors allowed to identify several clear absorption bands which increased over storage, such as 2918/cm, 2850/cm, 1741/cm and 1164/cm. These absorption bands could be attributed to fats, which thus appeared to have a major effect in sample discrimination.

The Mid-infrared spectroscopy was shown in this study to be a simple, rapid and relevant tool for discriminating the oxidation state of canned ready-made meals and might be used to determine their shelf-life.

Keywords: FTIR-ATR, multivariate analyses, oxidation over time, two plastic packaging

Sustainable techniques used to extend berries shelf life – a review

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Berries are characterized by a shorter shelf life than other fruits, because of soft texture, higher susceptibility to microbial spoilage, increased respiration rate and ethylene production, which is stimulated by wounding of the tissue [1]. In addition, they may pose a food safety risk to the consumers because they are consumed also raw. Shelf-life is usually defined as the time during a food product remain safe, comply with label declaration of nutritional data and retain desired sensory, chemical, physical and microbiological characteristics when stored under the recommended conditions [2]. Therefore, to assess shelf-life objective indexes related to nutrition, microbiological or physicochemical characteristics of food have been typically measured. The most used method to keep berries fresh after harvest and to increase their shelf life is to keep them under chilling conditions. Most berries can last several days when a preserved at around 1°C, but this method is not always optimal or cost effective, so other innovative methods have developed in time to extend even more the berries shelf life [2]. Some new ways to extend the shelf-life are keeping the berries in controlled atmosphere, or using different techniques, such as: modified atmosphere packaging, antimicrobial edible coatings and films, high voltage electric fields (HVEF), UV light, irradiation and ozone, or dipping the berries in different solutions that contain opposite charged polyelectrolyte. Among all the techniques mentioned above, the development of antimicrobial edible coatings is the most studied method for improving the shelf life of different berries or other fruits [3]. In conclusion, finding more techniques to increase and improve berries shelf-life is a nowadays challenge for the producers, suppliers and consumers.

Keywords: shelf-life, prolonging, berries, processing.

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Drying kinetics and quality attributes of apple slices dried by hot-air and micro-wave

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Introduction Due to the high level of water (85%), apples can easily be spoiled [1]. Thermal processing is one of the most important methods of food preservation primarily intended to inactivate enzymes, deteriorative microorganisms and reduce water activity by dehydration [2,3]. As representatives of the traditional and innovative drying methods, hot-air (HA) and micro-wave (MW) drying were chosen to conduct this comparative study.

Materials and methods The temperature of hot air, the effect of microwave power on drying kinetics and quality attributes such as color, ascorbic acid of dried apple slices was investigated during HA and MW drying. Drying experiments were performed by using a convective pilot air dryer, that allows carrying out long drying experiments under well-controlled parameters. Drying agent temperature was ranged between 50 and 70°C and velocity of air was 2.0 m/s. The microwave oven has the capability of operating at different microwave output powers 300, 500, 800 and 1000 W.

Results and discussion Both drying processes occurred mainly in the falling rate period. Drying time in MW drying was 30 to 75% of the time of hot air drying. D_{eff} values of apple slices were varied from $1.38 \cdot 10^{-8}$ to $2.12 \cdot 10^{-7}$ m^2per s. Values of D_{eff} in MW drying were two times higher than HA drying. Apple slices dried by MW revealed better colour, higher retentions of ascorbic acid content than HA drying. The degradation of ascorbic acid followed a first-order reaction and the degradation rate is constantly increased when temperature increased from 50 to 70°C. Drying temperature significantly induced the increase of a^* and b^* colorimetric parameters due to non-enzymatic browning reaction.

Conclusion MW drying of apples was more efficient than hot-air drying. Drying temperature and moisture content affected effective moisture diffusivity. It was found that the total colour change (ΔE) of apples was higher at hot-air drying method. Apples were dried efficiently by micro-wave drying. Among the environmental variables that affect the vitamin C degradation, drying method, temperature and time are the most important parameters. Compared to HA drying, MW drying showed shorter drying time, higher drying efficiency and better quality of products.

Keywords: drying, effective moisture diffusivity, quality, , drying method

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Determination of reaction orders for ascorbic acid degradation during appertization using a new experimental device: the thermoresistometer Mastia®

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Sterilization is the most relevant technique to guaranty safety of shelf-stable highly hydrated food products at ambient temperature. Ascorbic acid is of interest due to its vulnerability and health benefits. Its degradation at sterilization temperature (>100°C) is poorly documented [1, 2]. Although ascorbic acid degradation is practically always considered as following first-order kinetics, kinetics and reaction order of ascorbic acid degradation during appertization processes are uncertain. Using a new instrumented reactor (thermoresistometer Mastia®) [3], the behavior of ascorbic acid was studied in food model solution at pH = 3.5, in aerobic and anaerobic conditions from 95°C to 125°C. All experiments were performed in a citrate-phosphate McIlvaine buffer at pH = 3.5 under the thermoresistometer Mastia®. Ascorbic acid content over time was assessed using an Agilent 1260 HPLC. The studied temperatures were 95, 105, 115 and 125°C. Initial concentration of ascorbic acid was 90 mg/100 mL. Anaerobic conditions were obtained by using nitrogen as headspace gas, aerobic conditions by using air. Under anaerobic conditions, 320 minutes of treatment were not sufficient to degrade all the ascorbic acid initially present, even at 125°C ($k_{125°C} = 2.88 \cdot 10^{-3}$ min^{-1}). First-order kinetics fitted well the data in these conditions ($R^2 > 0.99$). There was a clear impact of temperature and an activation energy of 95 kJ/mol could be calculated. Under aerobic conditions, the behaviour was totally different. At 95, 105 and 115°C, ascorbic acid disappeared after 240 minutes of treatment. All four temperatures gave almost the same degradation profile, except at 125°C. In these conditions, the temperature had a limited effect on the ascorbic acid degradation. Contrary to common literature, ascorbic acid degradation at 95–125°C in the thermoresistometer did not follow always classical first-order kinetics. Degradation under anaerobic conditions was slow and followed first-order kinetics, but in aerobic conditions it was rapid and appeared to follow 0.5-order kinetics.

Keywords: Vitamin C, shelf-life, modelling, kinetics, nutritional qualities

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Real time measurements of apple parenchyma thermal softening at different temperatures

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Thermal softening of fruit and vegetables involves different mechanisms: 1) loss of turgor pressure, characteristic of raw cells, by degradation of membranes; 2) enzymatic and chemical degradation of cell-walls, primarily of pectins. Endogeneous polygalacturonase (PG) is clearly linked to texture loss, while pectinmethylestaerase (PME) may facilitate PG activity but also strengthen tissues by enabling calcium cross-links.

Thermal softening of apple was measured in real time at different temperatures. Thin parenchyma stripes were immersed in water at 40°C to 80°C and simultaneously subjected to creep tests during ten or twenty minutes. The apple parenchyma being softer at high temperatures, different levels of stress were applied and then the results were expressed in terms of compliance as a function of time. The main advantages of this experimental device were very rapid temperature increase in the thin slab (about 20 seconds) and continuous data recording.

Below 50°C thermal softening was a one-step phenomenon and texture was little affected. At or above 60°C this first step was followed by a second mechanism, which could not have been evidenced with discontinuous experiments. The first step duration was reduced and the second step led to major increase of compliance for the highest temperatures. The order of magnitude of the compliances ($0.7 \cdot 10^{-6}$ Pa^{-1} and $4.3 \cdot 10^{-6}$ Pa^{-1} respectively for low and high temperatures) and the corresponding characteristic times (respectively 250 s and 120 s) were comparable to the literature.

The compliances for both thermal softening steps were modelled with classical three-parameter Burger equation and thermal dependencies of the parameters were evaluated. These kinetics data should provide pertinent information for scaling cooking process and the methodology could be applied to other products. Further work is required to link the thermal softening steps to (bio)chemical mechanisms.

Using High Pressure Treatments to Stabilize Vegetable-Based Smoothies

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Food industry aims to offer packaged smoothies that can be associated by consumers with products containing fresh fruit. The addition of vegetables could bring new taste and new nutritional properties. Therefore a vegetable smoothie was made with pumpkins, leek, zucchini, carrots and apple. In our formulation leeks and carrots were blanched before blending. Resulting smoothie were pasteurized by high pressure processing (HPP – 350 MPa/5 min) and by mild thermal treatment (MH – 80°C/7 min) and stored at 4 ± 1°C for 21 days (day 0, day 0_{AT}, day 7, 14 and 21). Microbiological, sensory and nutritional parameters were analyzed during storage and 2 replicates were carried out. The application of HPP and MH treatment resulted in significant reductions to the counts of aerobic mesophilic and psychrotrophic bacteria, yeasts and moulds and coliforms. During subsequent refrigerated storage (21 days at 4 ± 1°C) counts maintained at the level achieved after stabilization treatment. From the physicochemical and instrumental colour point of view, immediately after treatment, HPP smoothies were more similar to the fresh product than those treated by MH. During storage, colour of MH smoothies was more stable and showed lower browning index. In contrast, viscosity of HPP samples was more similar to the untreated product. Additionally, HPP provided smoothies with better sensory properties and higher nutritional quality than MH. In general, HPP smoothies were very much alike to the untreated product. However, HPP smoothies kept residual enzyme activity and lower antioxidant capacity which is likely to limit the shelf life of this smoothie.

Keywords: fruit and vegetables, HPP, smoothies, quality, shelf-life

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Application of high pressure processing for the stabilisation of shelf-stable acid foods

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Traditional thermal pasteurization may be prejudicial for the nutritional and organoleptic quality of plant-based, acid or acidified food products. High Pressure Processing (HPP) is suitable for room temperature pasteurization of foods, with poor destruction of bacterial spores. This study aims to evaluate the potential of combined two hurdles for the shelf-stabilization of acid foods : i) HPP treatments for the decontamination of vegetative cells of bacteria, yeasts and molds resistant to low pH (acidophilic floras), and ii) low pH as effective mean to prevent resistant spores from germinating.

Experimental work was performed on two products: *ratatouille* (a French tomatoes and vegetable stew) and pears in syrup. Vegetables and fruit were heat blanched prior to HPP treatment, to destroy any enzymatic detrimental activities. Industrial recipes of each product were prepared then acidified (using citric acid, pH target: 3.8 for pears in syrup and 4.0 or 4.2 for ratatouille) prior to inoculation, packaging and HPP processing (6000 bars; 3 minutes; room temperature). Incubation tests of 20 samples (32°C – 21 days) assessed the biological shelf stability of final products. Mix of lactic acid bacteria and mold spores were inoculated in ratatouille; mix of lactic acid bacteria, yeasts and mold spores was used for the pears (maximal concentration: 10^6–10^7 CFU/g). Non-inoculated products were also studied.

Shelf stability was observed for non-inoculated samples of both products. However, spoiled samples with endogenous species (not from the inoculum) of lactic acid bacteria or yeast were detected for the inoculated ratatouille samples at pH = 4.2, and inoculated pears, respectively. Identification of the endogenous species responsible for non-stability, indicated *Lactobacillus plantarum* for the ratatouille and *Pichia kudriavzevii* for the pears. These species are not known for their resistance to HPP and therefore reasons for these non-stabilities were not fully elucidated.

These promising results support the development of HPP process for acid shelf-stable food with an organoleptic quality close to minimally processed foods. However some uncertainties remain on the capacity of HPP to stabilize acid foods against specific acidophilic flora.

Keywords: high pressure, acid food, shelf stable, ratatouille, pear, pasteurization

Preharvest UV-C radiation increases vitamin C, anthocyanins and ester volatile content in strawberry

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Strawberry (*Fragaria* × *ananassa* Duch.) is one of the most appreciated fresh fruit, particularly for its combined attractive appearance and flavor. Producers and consumers are looking for economically and non-contaminant methods to reduce postharvest losses and improve fruit quality. UV-C radiation is largely known for increasing fruit quality when applied in postharvest fruit. In addition, recent studies have suggested that preharvest UV-C application may promote fruit quality and decreased decay incidence. In this study, strawberry fruit (*Fragaria x ananassa* Duch., cv 'Camarosa') treated or not (control) with UV-C during field cultivation were harvested at the 75% red stage of ripening, separated into two fractions tissues (internal and external) and, stored at −80°C until analyses. Phenolic compounds, including anthocyanins, were analyzed by LC-MS. Aromatic compounds by SPME-CG-MS and ASE-CG-MS. Vitamin C (acid ascorbic and dehydroascorbic acid) by spectrofluorometric method. Preharvest UV-C treatment promoted an increased in total phenolic content, mainly anthocyanins (cyanidin 3-*O*-glucoside, pelargonidin 3-*O*-rutinoside and pelargonidin 3-*O*-glucoside). Content of flavonoids, mostly anthocyanins, were higher in external tissue, while flavonols, procyanidins, degree of polymerization of PCA and coumaroyl hexoside acid shown higher content in internal tissue. While in external tissues the sum of polyphenols in UV-C fruit increase 20%, in the internal tissue does not difference between control and UV-C. UV-C treatment increased in 15% the total volatile organic compound production (VOC) identified. Among the identified VOC ester production had a 23% increment. In contrast, furane and mesifurane, important volatile aromatic character of strawberry, decreased in 40 and 52%, respectively upon UV-C treatment. Vitamin C content (ascorbic and dehydroascorbic acids) was 40% higher in external than internal tissue and, increase in both external and internal tissues due to UV-C treatment. In conclusion, preharvest UV-C treatment seems to improve strawberry metabolic quality, resulting in fruit with higher vitamin C, ester volatile production, and anthocyanins content.

Keywords: fruit quality, polyphenols, aromatic compounds

Kinetic modelling of enzyme inactivation and main pigments degradation in beetroot, carrot and celery juice during high pressure carbon dioxide treatment

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High pressure carbon dioxide (HPCD) is the novel non-thermal method of food preservation. The advantage of this method is the possibility of inactivation of enzymes present in plant tissues. The aim of this study was kinetic modelling of peroxidase (POD), polyphenoloxidase (PPO), polygalacturonase (PG) and pectinesterase (PE) inactivation and degradation of pigments in vegetable juices (pH > 5.95) under HPCD.

Material used were beetroot, carrot and leaf celery cloudy juices, freshly prepared before experiment and immediately processed by CO_2 at supercritical state, using Spe-edTM SFE apparatus (Applied Separations, USA) at up to 65 MPa, 30 min and 65°C.

POD, PPO and PG activity were measured spectrophotometrically, and PE activity was determined titrimetrically. Betalains content in beetroot juice was determined by HPLC, carotenoids and chlorophylls contents in carrot and celery juices were measured spectrophotometrically.

The most active enzyme in all juices was POD. The highest activity of all enzymes was noted for beetroot and carrot juices. HPCD allowed for decrease of tissue enzymes activity, although not all used parameters were effective. Inactivation of enzymes followed first order reaction. The *k-value*, calculated for all juices treated with HPCD, ranged from 0.16 to 0.60 · 10^{-2} min^{-1} for POD, from 0.17 to 0.90 · 10^{-2} min^{-1} for PPO, from 0.14 to 0.82 · 10^{-2} min^{-1} for PG, and from 0.50 to 1.15 · 10^{-2} min^{-1} for PE, depending on the kind of juice and process parameters. Taking into account results obtained for all juices and process parameters *D-value* calculated for tested enzymes ranged from 200.3 to 1645.0 min and R^2 ranged from 0.78 to 1.00. The highest degradation of pigments were observed at the most harsh conditions of the process: the 58 % loss of betacyanins, 32% of betaxanthins, 30 % of chlorophyll *b* and 15 % of chlorophyll *a* were noted. Carotenoids were the most resistant for HPCD treatment.

Stability of POD, PPO, PG and PE depended not only on the temperature but also on the kind of raw material. HPCD inactivation of tissue enzymes was less effective compared to thermal inactivation. Results indicate that inactivation of enzymes in vegetable juices of relatively high pH using HPCD is much more difficult than in fruit juices [1] and due to duration of the process (*D-value* >> 200 min) is not economical. Using additional factors facilitating this process, such as acidifying agents, may be necessary.

Keywords: oxidoreductases, hydrolases, inactivation kinetics, high pressure carbon dioxide

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Fermentation of pea proteins for new food design: Use of blend of dairy and plant microbial cultures to improve sensory properties

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Changing diets and demographic growth at the global scale, stand in complete opposition to a sustainable food system. One obvious solution is to increase the proportion of plant-based foods, with the objective to increase the ratio of plant proteins in our diets. However, this can only be successful through a food supply well adapted and appreciated by consumers. One of the main issues in using plant proteins in foods, is to suppress sensory defects of texture and aroma. This is in particular the case when using pea proteins which lead to perception of green notes, representing a main bottleneck to their introduction in human foods. Fermentation could be a solution, to produce in a sustainable way, more acceptable plant foods, as already produced in Asia, with the production of fermented soy (tufu) or cabbage (dua muo) [1]. Thus the aim of the present project was to develop "dairy" type fermented products containing plant proteins with improved sensory qualities and to develop a microbial formulation approach adapted to new food design.

Two types of solutions with 12% protein content were studied, with 100% pea protein and with a mixture of pea and milk proteins (50/50). Different gelations (thermal, chemical and enzymatic) were performed. A sensory procedure based on odor-assessment (Check-All-That-Apply method) allowed evaluating the contribution of 75 strains representative of taxonomic diversity of cheeses and fermented vegetables (Firmicutes, Actinobacteria, Proteobacteria and fungi) and selecting different microbial groups (300 combinations, composed of 1 to 9 strains were tested) showing attractive functionalities (growth and aroma profile).

Three types of gels with different structures and textures, containing only pea proteins or a mixture of pea and milk proteins were obtained and characterized. These gels offered textures ranging from a custard to a hard cheese. Fermentation results showed almost half of the studied strains are able to colonize the different solutions. According to assessment of odor quality, the most complex associations (9 strains) have produced mostly richer and the most interesting aromatic notes. The specific green notes of pea were suppressed thanks to fermentation. Roasted notes were typical of the pea solution and fruit and lactic notes for the mixed solution (pea+milk). This procedure allowed thus to select specific groups of strains, able to colonize and generate aroma of interest in a pea-based product. It could be applied in contexts such as elaboration of innovative food products.

Keywords: plant proteins, microbial ecosystems, aroma perceptions, CATA

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Characterization and anticipation of technological behavior of pulses for canning: Red beans

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Pulses display strong technological behavior heterogeneity, within and between batches, which causes significant variations in canned products quality. This study aimed to develop a rapid method for characterizing pulses lots and determine their technological behavior for canning: a anticipation of "breakage rate" (broken grains) after the complete process of soaking / blanching / canning.

To anticipate the behavior of canned red beans, macroscopic measurements and tests on hydrated grain were performed. During industrial process, soaking induces hydration of beans and promotes ions exchange with water. This hydration goes further during blanching then is completely achieved during final sterilization, related to the gelatinization of the starch and the absorption of calcium and magnesium ions by pulses inducing pectin's bridging. The analysis of different red beans lots during pilot sized canning process identified different groups:

- Two lots strongly hydrated during the process, leading to poor firmness and high breakage rate, which make them unsuitable for canning;
- Two lots displayed low breakage rate, along with the lowest hydration during the process. Those lots were suitable for the manufacture of good organoleptic quality preserves;
- An intermediate group with low breakage rate and limited hydration. These lots leaded to canned beans of acceptable quality.

Using a newly developed rapid cooking test in pressure cooker, without soaking, all properties measured on the red beans and cooking water show a progressive softening of the grains with the cooking time. They absorb water, break, and release some of their dry materials and ions. The cooking temperature (112 or 118°C) has no significant impact on this behavior. These rapid pressure-cooking tests show the same red beans groups as those identified after complete canning process, with a similar behavior in particular regarding the 'breakage rate'. The developed rapid cooking test (10 minutes at 112°C in pressure cooker, in excess water) can anticipate (R^2 of 0.84) the behavior of red beans during industrial canning (breakage rate after complete transformation) through two simple and fast measures: the cooking water electrical conductivity gain and the breakage rate of the cooked beans. However, assessment of the quality of cooked pulses is very subjective and dependent on the operator. A reference document for quality is required to standardize the test, particularly in the evaluation of the breakage rate. Moreover, using this method will require an adjustment work for each different industrial process to take account of all possible variations (calibration of the regression line).

Keywords: pulse, canning, pressure cooker, technological behaviour, breaking rate, quality

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Effect of single and combined UVC and UHPH treatments on inactivation of *Alicyclobacillus acidoterrestris* spores in apple juice

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Thermal treatments, which are being used as the main sterilization methods in foods, may cause changes in the organoleptic properties and losses in the nutritional components of fruit juices [1].Bacterial spores are highly resistant structures shown to survive most commercial heat treatments. *Alicyclobacilllus acidoterrestris* is a spore-forming bacterium that can lead to spoilage apple juice [2].The aim of this survey was to evaluate the ability of two emerging technologies, short wave ultraviolet light (UVC) and Ultra High-Pressure Homogenization (UHPH), applied single or combined, to inactivate spores of *A. acidoterrestris* in apple juice. Commercial pasteurized apple juice was inoculated with strain CECT 7094 of *A. acidoterrestris* at a level of 5.0,Log CFU/ml, and submitted to different combinations of UVC doses (1.8, 3.6, 7.2, 10.7, 14.3 and 21.5 J/ml) or/and UHPH pressures (100, 200 and 300 MPa). Previously juice samples were adjusted to different inlet temperatures (InT) (20, 40, 60 and 80°C). UHPH treatments at 200 MPa showed a significant lethality only when InT was degC80 and also when InT was 60°C at 300 MPa, reaching the maximum spore inactivation when InT was 80°C. UVC treatments at 1.8 and 3.6 J/ml doses hardly affected the spore counts, but pre-heating juice at 60°C increased the efficiency of UVC to inactive spores. Significant reductions were observed at doses of 7.2 J/ml and above achieving maximum lethality values when juice samples were treated at 21.5 J/ml. Despite UVC showed to be more efficient than UHPH inactivating *A. acidoterrestris* spores the combination of both methods increased the lethality when UHPH was applied before UVC suggesting that UHPH could reduce spore aggregates, increasing spore exposure to UVC. It can be concluded that the combination of UVC and/or UHPH with temperature (InT) may increase the inactivation of spores of A. acidoterrestris. Combination of these technologies is a novel treatment proposal that allows sterilizing juices in a continuous processing with a minimal heat stress. Future studies should investigate the effect of the treatment in the quality components of apple juice and evaluate the lethality of the treatment in different matrices.

Keywords: UHPH, UVC, sterilization, apple juice, *Alicyclobacillus acidoterrestris*

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Texture evolution during brine storage in sweet cherries

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Sweet cherries (*Prunus avium* L. cv. Napoléon) produced in Vaucluse are mainly intended for processing to glacé cherries. They must be harvested within a short time (3-4 weeks) and are then stored in brine for processing all along the year. Texture is a primary quality attribute of brined sweet cherries and control or modification of this texture is a major objective in modern food technology. Different harvest itineraries were applied: harvest at two different maturity stage, manually or mechanically, with or without peduncle. The cherries were immersed in brine and examined over a 12-months period for firmness, calcium and total soluble solids diffusion and cytological remodeling. Firmness was quantified with a texture analyser consisting to a compression test such as routinely applied to other fruit species, e.g. [1]. Calcium concentration in the brine was measured by Atomic absorption spectroscopy equipped with an acetylene/nitrous oxide burner. The total soluble solids (TSS) were measured in the brine with a Digital Refractometer. Cytohistological analyses were performed as also described [2]. Mechanical harvesting, late maturity stage and storage with peduncle decreased firmness instead of their respectively comparison. However only presence or absence of peduncle influenced salt and total soluble solids diffusion, whit peduncle absence facilitating the osmotic exchange in the first weeks of brine storage. Brine storage allowed a texture gain in the first two months in most cases compared to fresh cherries confirmed by a beneficial reshuffle of tissues and allows using cherries for candying over the whole duration between two harvest seasons. In addition to peduncle, treatment temperature could increase residual endogenous PME activity [3] in order to release significant free carboxyl group amount from pectic acid polymers for interacting with calcium salt to form secondary cross-bridges which influence cell wall strength, leading to a higher quality final product.

Keywords: Prunus avium L., harvest, firmness, storage, candied cherries

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Biotechnological strategies to improve safety, shelf-life and quality parameters of ready-to-use apples processed at industrial level

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This research was performed within an Italian national project "Novel strategies meeting the needs of the fresh-cut vegetable sector" –STAY FRESH– aimed to find out integrated solutions to optimise and innovate the fresh-cut productions. Particularly, in this experimental work, to increase safety, shelf life and quality parameters of sliced apples, the use of bioactive compounds and lactic acid bacteria was proposed as alternative to the traditional sanitization methods at industrial level.

To realize these aims, a local industry in Italy, involved in the production of ready-to-eat vegetables, was exploited. For the trials, apples *Golden delicious* were sliced and subjected to four different dipping solutions and processed according to a defined industrial protocol. The traditional dipping used as control was represented by 0.5 % of ascorbic and 1 % of citric acid. The other dipping solutions were the traditional dipping added of *Lactococcus lactis* CBM21 (7 log ufc/ml) ; traditional dipping added of hexanal and E-(2)-hexenal (125 + 125 mg/L) and the traditional dipping added of *Lactococcus lactis* CBM21 (7log ufc/ml), hexanal and E-(2)-hexenal (125 + 125 mg/L). The treated apples were packed in modified atmosphere and stored at 6°C. During the storage, the cell loads of yeasts, lactic acid bacteria and fecal coliforms were monitored. Also the presence of some pathogenic species was checked. The volatile molecule profiles of the obtained samples and a panel test were performed by GC/MS-SPME. In addition, also the determination of colour parameters was carried out.

The results obtained showed that the use of bioactive compounds or their combination with *Lactococcus lactis* CBM21 permitted to delay the growth of yeast which, after 26 days of storage, had not reach yet the spoilage threshold. The level of the *L. lactis* used as biocontrol agent remained at high level for all the apple shelf-life. The loss of quality for these kind of products were principally represented by the colour changes and oxidation. However, the use of bioactive compound or their combination with the biocontrol agent determined a delay of oxidation resulting in a shelf-life of at least 15 days. These last samples were also appreciated in the panel test performed. Although it is not still possible to replace the traditional dipping solution at industrial level, these results are very promising and with great applicative potential for the minimally processed vegetable manufacturing representing a innovative solution to replace the common disinfection agents.

Keywords: natural antimicrobials, biocontrol agents, scaling up, minimally processed apples

Use of high pressure homogenization for the production of natural antimicrobial based nanoemulsions to prolong the safety and shelf-life of apple juice

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In these last two decades, essential oils (EOs) and their components have gained much attention from researcher because gifted of several properties such antimicrobial, antioxidant and anti-cancer activities [1]. Despite the strong antimicrobial activity against foodborne pathogens and spoilage microorganisms shown by EOs, their practical application is currently limited due to their strong impact and changes they cause in food products. Moreover, they are subjected to a fast degradation. In this view, nanoencapsulation of bioactive compounds or EOs represents a viable and efficient approach to increasing the physical stability of the active substances, protecting them from the interactions with the food ingredients and, because of the subcellular size, increasing their bioactivity. Main aim of this research was to prolong the shelf-life of apple juice by using nanoemulsions of hexanal and E(2)-hexenal produced by high pressure homogenization at 400 MPa. The nanoemulsions were produced at Gea (Parma, Italy) according to the method proposed by Donsì *et al.* [2] by using ultra high pressure at 400 MPa. The nanoemulsions were used in apple juice at concentration of 20 and 100 ppm for E(2)-hexenal and hexanal, respectively. The juice was also inoculated with a mix of pathogenic and spoilage microorganisms and treated by high pressure homogenization with a Panda homogenizer at lab level at 100 MPa for 1,2,3 cycles and 200 MPa for 1 cycle. As control, the juice treated only at high homogenization pressure without the presence of encapsulated natural antimicrobials was used. In addition to microbiological analyses, also the colour and quality parameters were evaluated. The data showed that the major reduction of pathogenic (*L. monocytogenes*, *E. coli*) and spoilage (*S. cerevisiae* and *L. plantarum*) microorganisms were in presence of encapsulated natural antimicrobials at 100 MPa for 3 cycles and 200 MPa for 2 cycles. The analysis concerning the colour showed a major stability of juice samples containing antimicrobial nanoemulsions processed at the highest homogenization treatment. The results obtained have showed the potential of natural antimicrobial based nanoemulsion and high pressure homogenization in the sector of fruit juices representing also an innovative solution to prolong the product safety and shelf-life. In addition the exploitation of this approach can result in a replacement/reduction of thermal treatment and consequently of the damages related to it.

Keywords: nanoemulsions, natural antimicrobials, high pressure homogenization, apple juice

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Effect of bio-based compostable packaging and anti-browning solution on quality maintenance of minimally processed potato tubers

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In recent decades, consumer demand for convenient, ready-to-use or ready-to-eat food products, with a safe and fresh-like quality, has increased. Raw pre-peeled potatoes represent minimally processed ready-to-cook potatoes. However, their shelf-life is limited to 5–7 days at 4–5°C, due to microbiological, sensory and nutritional deteriorations. One of the main causes of quality deterioration in fresh-cut potatoes is enzymatic browning of the cut surface, which can be reduced or avoided by dipping peeled and sliced potatoes in anti-browning agent solutions [1]. Along with anti-browning agent, packaging may obviously help to extend the shelf-life of minimally processed products [2]. In the last decades, the solid-waste management related to the extensively growing production and the durability of plastic materials have encouraged the development of more sustainable alternatives. Recently, bio-based and compostable materials have been introduced into the market and new applications are under evaluation.

In this work, we compared the performance of two different materials: a bio-based and compostable film (BIO), provided by InnoviaFilms, and a conventional coextruded polyamide/polyethylene one (PA/PE), acquired by System Packaging. Additionally, we tested the effects of three anti-browning solutions: (i) sterile deionized water (control); (ii) 0.2% sodium bisulphite (SB); (iii) 2% ascorbic acid + 2% citric acid (AA+CA). We checked the quality maintenance of minimally processed early potato tubers (cvs. 'Bellini and 'Marabel), during refrigerated storage (4 ± 1°C) for 9 days. After 0, 3 and 9 days of storage physico-chemical, nutritional, physiological and microbiological parameters were evaluated.

Regardless of cultivar, tubers packaged in BIO film showed higher fresh weight loss, browning degree and microbial growth whereas lower moisture content of tubers, titratable acidity, total phenols, vitamin C than those packaged in PA/PE film. It was reasonably due to lower barrier properties (higher gas exchange) of BIO bags. In comparison to the other anti-browning treatments, tubers dipping in AA+CA solution, packaged in both BIO and PA/PE bags, showed higher water retention, vitamin C content, titratable acidity, lower browning degree and microbial growth. Overall, the preliminary results showed that the bio-based and compostable film was less suitable to guarantee quality and shelf-life of minimally processed potato tubers in comparison to conventional PA/PE. Nevertheless, for sustainable packaging additional researches are desirable. Consequently, other bio-based and biodegradable films with more appropriate barrier properties will be evaluated in order to extend the shelf-life of minimally processed potato tubers.

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Food Drying Acceleration Due to Ultrasonic Application – a Review

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Introduction. Food drying is a widely used preservation method. It slows down microbial and chemical deterioration. Moreover drying facilitates food transport and storage. The drying process is highly energy consuming and often can damage the dried food. Therefore, due to energy costs rising, increasing quality requirements and environment protection a new methods of drying are still developing. One of the ideas of drying enhancement is to use ultrasounds. The aim of the presentation is to do a review of actual results of ultrasonic applications in food drying.

Ultrasonic Intensification of Drying. The acoustic drying was proposed in the middle of twentieth century. The first studies showed, that the application of ultrasounds accelerate the process without causing a drastic increase in temperature. Therefore, the ultrasonic drying could be especially used for temperature sensitive materials, like food. The main drawbacks of examined systems were: low energy efficiency and high noise levels. However, the development of high power ultrasonic generators resulted in a renewed interest in the ultrasonic drying. In this section new ultrasonic dryers designs are described. Ultrasonic acceleration of drying resulting in drying time reduction and possibility of energy efficiency improvement is discussed.

Mechanisms of Ultrasonic Drying Acceleration. Waves absorption causes the heating effect. During drying process moisture is transported within the dried material to its surface (internal moisture flux) and then discharged to the environment through the boundary layer of drying medium (external moisture flux). Both fluxes could be enhanced by ultrasounds. All these mechanisms are discussed.

Influence of Ultrasounds on Product Quality. In this section influence of ultrasounds application on change of following parameters is discussed: dried food colour, texture, rehydration, water activity, vitamins and carotenoids retention, antioxidant activity and total polyphenols content and microbiological stability. It was found that ultrasounds generally caused slight improvement or deterioration of product quality depending on dried material, used technics and process parameters.

Conclusion. The review of the actual state of art of the ultrasonic assisted drying is presented. All the results show that the application of ultrasounds accelerates the drying process. Proper selection of drying technique also allows to increase the energy efficiency of the process without or with small reduction of the quality of the product obtained. However, further studies with a focus on the exact mechanisms of ultrasonic assisted drying processes are needed in order to clearly reveal the contribution of the different effects.

Keywords: food drying, process intensification, ultrasounds

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Impact of the frequency of high-power ultrasound on the microbial load and physical properties of carrots (*Daucus carota*)

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Ultrasound is a promising non-thermal clean technology in the fresh-cut industry of vegetables due to the inactivation of microorganism caused by cavitation [1]. Depending on the intensity of the ultrasound, time of application and temperature, reduction levels up to 1.3 Log UFC/g have been achieved [2]. However, there are fewer studies that evaluate the effect of the frequency of the ultrasonic wave and treatment time on the reduction of microorganism. The main aim of this work was to evaluate the effect of bath sonication treatments of 25 and 42 kHz during 10 and 20 minutes on slices of carrots. Experiments were conducted at 24.0 ± 1.0°C. The temperature of the water bath and carrot slices was monitored during treatments. Mesophilic aerobic microorganisms, yeast and moulds were evaluated in accordance with ISO 4833:2003 and ISO 7954:1987 protocols. Additionally, instrumental colour and texture of carrot slices were also evaluated. The higher the frequency–time applied the higher core temperature obtained. After 20 minutes at 42 kHz, the core temperature raised 7.3 ± 0.2°C. However, at 25 kHz half of the increase was found, 3.3 ± 0.2°C. The effect of ultrasound frequency and time was evaluated through two way-Anova analysis ($p < 0.05$). From our results there were no significant interaction between the studied factors ($p > 0.05$). The reduction of mesophilic bacteria was higher at 25 kHz but there were a significant effect of the time of application. The maximum reduction achieved was 1 Log_{10} at 10 minutes. There were no significant differences on the reduction of moulds and yeast and 1 Log_{10} reduction was achieved. Alegria et al. [3] obtained lesser microbial reduction in sonicated fresh-cut carrots (45 kHz / 1 min). The authors reported a maximum of 0.5 Log_{10} reductions for both mesophilic flora and yeast and moulds group. The instrumental firmness and colour of the all the sonicate carrot slices were no significantly different to the raw carrot ($p > 0.05$). From our results, ultrasonic treatment can be an alternative to reduce the microbial load in fresh-cut products with no effect on texture and colour. However, higher microorganism reductions may be needed by the fresh-cut industry. Further studies on the possible combination of clean treatments may be the solution to reduce the chlorine concentration used on these food products.

Keywords: fresh-cut carrot, ultrasound frequency, microbial load, sonication

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Investigations on ultrasound effect on polyphenol extraction: case of olive leaves

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Considering extraction at industrial scale, conventional processes have some major drawbacks, such as insufficient recovery of extracts, extensive extraction duration, intensive heating and/or mixing, resulting in high energy consumption. Within this context, green technologies such as ultrasound are being increasingly investigated, aiming both at process intensification and meeting the goals of sustainable processes. The effectiveness of ultrasound has been demonstrated by a great number of authors. More specifically, ultrasound is used for natural product extraction (e.g. bioactive components such as essential oil, antioxidants, oil and dyes).

Applied during extraction, ultrasound induce an increased extraction rate of monitored compounds compared to conventional extraction processes such as maceration. Reported mechanisms for this mass transfer enhancement are generally attributed to the effect of cavitation bubbles generated in the extraction media. Toma et al. [1] demonstrated that power ultrasound (frequency comprised between 20 kHz and 1 MHz) specifically impacted cellular structures such as excretion hairs of pot marigold.

Our study aims at a deeper understanding of ultrasound assisted extraction mechanisms. For this, we selected olive leaves as reference matrix. Effect of ultrasound has been assessed by submitting a single leaf maintained under an ultrasonic field (US probe, 20 kHz) at different treatment durations (5, 15, 30 and 60 min). Extraction was performed in an ethanol/water solvent (80/20, v/v), which is conventionally used to extract phenolic compounds. The media temperature was maintained at 25°C. After sonication, the solvent and extracted compounds was recovered to determine the polyphenol content and profile. Treated leaves were studied by histology and leaf surface observations.

Preliminary observations tend to indicate strong histological differences according to ultrasound duration. Polyphenol release in the solvent also seems impacted by the ultrasound treatment, with a sharp total polyphenol increase of 0.001 mg EO/ml to 0.050 mg EO/ml (in equivalent oleuropein (EO)) for untreated leaves and US-treated leaves, respectively. In this study, the expected outcome is to link the structural differences observed on the treated leaves to the polyphenol extraction obtained.

Keywords: olive leaves, oleuropein, ultrasound, histology, SEM

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Extraction of carotenoids from carrots chips using liquefied *n*-butane as solvent

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Carotenoids are organic pigments produced by photosynthetic organisms, divided in two major classes: "carotenes" (oxygen free) and "xanthophylls" (containing oxygen). Carotenes are widely used in food industry as natural apolar pigment (E160a) in drinks, cakes, desserts or butter. Carrots (*Daucus carota*) are one of the best sources of carotenes, mainly with β-carotene and α-carotene [1].

Extractions of carotenes from carrots are usually performed by organic solvents such as hexane, acetone, dichloromethane, ethanol [1]. Nevertheless, the REACH regulations incite producers to look for alternative safer solvents. In particular, *n*-hexane, widely used as apolar solvent in extraction processes, is known to be toxic for the central nervous system. For that reason, we tried to substitute *n*-hexane with *n*-butane which is a non-toxic solvent with similar solvent power and low boiling point (−0.9°C). To study the technical feasibility of this substitution, a theoretical modeling approach (Hansen solubility parameters and COSMO-RS) was coupled with lab-scale experiments.

The extractions with liquefied n-butane have been performed in a 1 liter stainless steel pressurized vessel at 20, 30 and 40°C (3 bar), during 2 hours without stirring. As a reference point, the extractions have also been performed in n-hexane at 68°C during 2 h. Then, the extracts have been analyzed using HPLC to identify the carotenes composition.

Finally, both Hansen parameters and COSMO-RS simulations have predicted a similar solubility of carotenes in *n*-butane or *n*-hexane. In accordance with the simulations, the experiments show that the ratio α/β-carotene remains unchanged (about 35:65) using either *n*-butane or *n*-hexane.

Nevertheless, the use of a pressurized flammable gas implies some safety precautions and so increases the price of the equipment, in comparison with classical extractions. But as a new process, some improvements will be done soon in order to get a safer and efficient process. But with comparable performances, the use of liquefied butane offers a new alternative to the classical extraction processes using hexane. Furthermore, the *n*-butane is an extraction solvent allowed by the European Union for the processing of food and food ingredients, without any restrictions (Directive 2009/32/EC – 23 April 2009). In that sense, the use of liquefied gas at low pressure and low temperature opens new possibilities and new market for the extraction of sensitive food ingredients.

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Decision Support Tool to predict food shelf life and optimize Modified Atmosphere Packaging of fresh fruits and vegetables

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Governmental efforts to promote health benefit of fresh fruits and vegetable remain hampered by the very short shelf life of this type of food product which perishability constitutes one of the main obstacles to their consumption and leads to considerable food waste and losses. Among innovative technologies throughout the food supply chain, food packaging is a particular key player as an alternative to energy consuming refrigeration to improve food preservation, quality, safety and retailing/consuming conditions, and thus to reduce food losses [1,2]. One of the packaging objectives is to maintain in the close surrounding of the product an atmosphere composition that prevents its decay. This technology is called Modified Atmosphere Packaging (MAP) and relies on the modification of internal packaging atmosphere due to an equilibrium between production/consumption of gases by the respiring product and gas permeation through the packaging material eventually combined with the use of gas or vapours absorbing or emitting materials. The mathematical modelling of these mass transfers in the food/packaging system is the basis for the development of virtual MAP modelling tools and decision aid tool for a better design and dimensioning of the food packaging system [3]. Up to now existing virtual MAP models predict the evolution of internal gas concentrations without any estimation of the gain of food shelf life reached by using MAP. However, shelf life prediction is an indispensible prerequisite for estimating the impact of new packaging material on food shelf life, quantifying effect of MAP on food losses reduction and decision-making in the field of food packaging. The objective of this work is to propose an innovative approach to predict shelf life of MAP food product. The modelling approach proposed here relies on the modelling of O_2, CO_2 and H_20 transfer (Fick's based laws), coupled with respiration (Mickaëlis-Menten model) and other equations of shelf life prediction (predictive microbiology and/or other empirical model for describing food spoilage). Temperature effect is also considered (Arrhenius law) as well as the impact of active agents (O_2 scavengers added in the pack). The virtual MAP tool is first used to dimension shelf life tests and once validated could be used as a predictive tool of food shelf life. Experimental validation is carried out on strawberries packed in conventional plastic films and experimental data are compared with predicted ones. The validity of the proposed shelf life equation is discussed and its interest in the development of sustainable food packaging detailed.

Keywords: modified atmosphere packaging, mathematical modeling, shelf life prediction

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Fermentation of Apple Juice by Lactobacilli – changes in amino acids and volatile compounds profile, acceptability test and resistance to polyphenolic compounds

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Fermented juices have been suggested as vehicles for probiotic bacteria intake. However, low pH and presence of polyphenols, challenge the fermentation of plant matrices. The goals of this study were to determine the volatile compounds and amino acids profiles and hedonic characteristics of fermented apple juices (AJ), besides the impact of polyphenols and cell walls from apple parenchyma on *Lactobacillus* growth.

Apple juices were inoculated with 7 log CFU/ml of single cultures of *Lactobacillus acidophilus* L10, *L. casei* L26, *L. paracasei* L33, *L. plantarum* 299v and *L. rhamnosus* LGG, and fermented for 48 h at 40°C. Volatile compounds were determined through headspace SPME/ GC-MS and flame ionization detector and free amino acids through HPLC-fluorescence detector, in triplicate. Overall assessment, odor, taste and visual appearance were appraised by untrained panelist ($n = 29$). AJs containing apple polyphenols (0–5 g/l), cell walls from apple parenchyma (0–1 g/l) and a mix of 0.5 g/l of polyphenols and 0.5 g/l of cell walls, were fermented.

Profiles of volatile compounds of AJ fermented for 24 or 48 h were similar. Hexanal was consumed and diacetyl produced by all strains ($P < 0.05$). Acetoin production was the highest in juices fermented by LGG. Average scores of hedonic parameters corresponded to 'like' or 'like moderately'. Amino acids profile in fermented juices was clearly dependent on the strain. Excepting L299v, all strains consumed methionine, phenylalanine, tryptophan, leucine and isoleucine. Glycine was produced by all strains and lysine by L10 and L33. L26, L33 and L299v were resistant to polyphenols up to 0.8 mg/ml of apple juice. Presence of cell walls was ineffective to improve lactobacilli growth but was protective against the effects of polyphenols for the strains L10 and L33. These observations point out the applicability of *Lactobacillus* strains for fermentation of AJ and indicate the strains the most resistant to polyphenols, which can be helpful to the fermentation of others fruit juices.

Keywords: probiotic, diacetyl, glycine

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Effect of osmotic pretreatment on selected properties of dried strawberries

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Osmotic dehydration is recommended as a processing method to obtain better quality of food products. One of the key factors determine the nutritive value of food product obtained upon osmotic dehydration is type of osmotic solution. Sparse investigations have addressed the use of osmotic solutions with the addition of natural enriching substances. In the few publications, concentrated fruit or vegetable juices were added to or were used as the osmotic solutions. The feasibility of using juice from chokeberry or other berry fruits characterized by a high nutritive value for osmotic dehydration of different fruits affords the possibility of extending their applicability in the form of dried products as an alternative to snacks having a high calorific and often low nutritive value.

The study of the osmotic dehydration as pretreatment before drying of strawberries on physical and sensory properties were performed to optimize the technological process towards obtaining nutrition value and the quality of the drought. The next stage will be evaluating the possibility of using plant extracts obtained from berry pomace.

For the study were used frozen strawberry Honeoye variety. Before osmotic dehydration the whole fruits were only partly defrosted without leading to leakage, so as not to affect the change in the structure of fruit and optimize the process on industrial conditions.

Osmotic dehydration was conducted in 60% sucrose solution with or without the addition 5 and 15% of chokeberry juice concentrate. The temperature of the solution was maintained at 30 and 50°C. Dehydrated samples were dried in two ways: convective (2 h/60°C) and next in microwave-vacuum dryer for puffing (400 W, 70°C, 3 min, 35 hPa) or freeze-dried (25°C/6,2 kPa) then were packed and stored in different temperature (5, 25, 40°C) during 6 months.

Innovation of the research is the use of convection drying method with microwave-vacuum (puffing) for obtain drought fruit similar to freeze-dried and the effect has been reached. Dried strawberries, regardless of storage temperature preserved their quality. There was little change in the colour, water content and activity. The biggest changes were noted in the case of study mechanical properties, because the samples partially lost their crispness. After storing the sample pre-dehydrated in sucrose solution with chokeberry juice characterized lower content of total polyphenols and antioxidant capacity, but higher changes were in freeze-dried then convective-microwave-vacuum samples. Osmotic dehydration of strawberries in solution of sugar partially substituted with concentrated juice from chokeberry enables increasing content of polyphenols and antioxidative activity of dehydrated products or semi-products.

Keywords: osmo-pretreatment, chokeberry juice concentration, drying, puffing

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Osmotic dehydration with ultrasounds of apples Braeburn variety in production of sustainable food products

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The new, attractive products might be a seasonal fruits as snacks, e.g. apple chips. One way to reduce adverse changes during drying and maintain high quality of fruit is the use of pre-treatment, such as osmotic dehydration. This method can be combined with the use of ultrasounds what influence on intensyfication of mass exchange and decrease of duration of pre-treatment and drying.

The aim of this work was to investigate the effect of osmotic dehydration conditions on properties of dried apples osmotically pre-treated.

Apples Braeburn variety were osmotically dehydrated in sucrose solution of 60% with/without chokeberry juice concentrate (CJC) (1:1) until 120 minutes in temperature 40 and 60°C. The ultrasounds were used during the first 30 minutes of process. Dehydrated samples were dried in two ways: convective (4 h/70°C) and next in microwave-vacuum dryer for puffing effect (400 W, 70°C, 3 min, 35 hPa) or freeze-dried (25°C/100 Pa). In osmotically dehydrated fruits water lost, solids gain, reduced water content and as well as colour changes and water activity of obtained drought were investigated.

The extension of dehydration time and the temperature increase caused increase in water loss. For solids gain (SG) results were ambiguous. After ultrasounds the value of SG was increased for apple dehydrated in sucrose solution and reduced for sucrose solution with CJC. Longer dehydration time decreased the reduced water content (U_{red}). The beneficial effect of ultrasound on the U_{red} was observed in higher temperature. Freeze-drying reduced the water activity (a_w) of droughts, but the use of ultrasound did not have appreciable effect on a_w, except in case of dehydration in sucrose solution at 60°C. The highest average absolute values of the colour difference (ΔE) were obtained for apples dehydrated in sucrose solution with CJC and freeze-dried. The use of ultrasound affect significantly colour changes of dried apples only for sucrose solution in comparison to samples without sonification.

The innovation was the use of osmotic dehydration in sucrose solution with addition of chokeberry concentrate combined with the ultrasounds before drying. The increase of temperature and time resulted increase of the mass transfer in apple. In most cases the addition of chokeberry juice concentrate did not change significantly effect. Also the use of ultrasound during osmotic of apple pretreatment did not significantly influence the values of obtained water loss, but contributed to increase in the solid gain in apple osmodehydrated in sucrose solution and decrease by using sucrose with CJC. Osmotic dehydration influenced on significantly colour change of dried apples. The absolute colour difference values were greater for freeze-dried apples.

Keywords: osmotic dehydration, apples, chokeberry juice, sucrose

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Acoustic, mechanical and sensory properties of dried pears

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In the world production of fruits pear takes the second place, just behind the apple. Peers contains a lot of vitamins and minerals. Due to the presence of roughage (2.1 g per 100 g of the fruit) and antioxidants as well as potassium, pears are indicated for heart. High quality of fruity snacks means not only the general appearance, colour, taste and smell, but also their texture which consists of the following features: hardness, crunchiness, sound emitted during biting. The objective of this study was to analyze the effect of two varieties of pears: "Konferencja" and "Lukasówka", drying technique and process parameters on textural properties of dried fruits assessed using acoustic, mechanical and sensory methods. Pears were cut into slices to have a thickness of 3 mm, then they were immersed in 1 % citric acid for 1 min at temperature of 25°C. Then the slices without any pre-treatment and these ones with pre-treatment were dried by four various techniques: convection at temperature of 60 and 70°C, air flow v = 1.5 m s^{-1}; convection-microwave in the dryer PROMIS - μLAB (at 30 and 40°C, using microwave power of 200 and 300 W) and freeze drying at 40, 50 and 60°C in ALPHA 1-4 freeze dryer. The moisture and water activity were determined in Hygroscope DT2. The density was measured in the Stereopycnometer. Three-point test was carried out in Zwick 1445 testing system at a constant speed. The acoustic emission (AE) was registered by a contact method. The variety of dried pears "Konferencja" was harder and louder than pears "Lukasówka". The amplitude and the number of events EA of variety "Konferencja" were higher than "Lukasówka" pears. Variety of pears did not affect the flavor of drought. The technique and parameters of the process of pears drying affected their textural properties. Increasing the temperature from 30 to 40°C, with microwave power of 200 and 300 W as well as from 60 to 70°C in the case of convection drying caused an increase in breaking work, number of AE events and sound amplitude. The pears dried by convection-microwave methods at higher temperatures had better texture evaluated sensorially. The freeze-drying samples characterized by low hardness and strong acoustic emission, as well as were sensorially evaluated as a fragile and received the highest marks for texture. Principal component analisys (PCA) showed the occurrence of four groups of dried pears, those groups differed in their textural properties.

Keywords: acoustic emission, mechanical, sensory, drying, pears

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Convective drying of kiwi (*Actinidia deliciosa*) pretreated by ultrasonic-assisted osmotic dehydration

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The aim of the studies was to investigate the influence of ultrasonic-assisted osmotic dehydration followed by convetive drying on the final quality of the biological product.

The drying process as a well known and proven method allows to preserve food. Recently, it has become extremely important in addition to economic benefits to achieve qualitative values of the produced food. The great importance is attached to, among others, WHO reports about the negative effects of commonly sugars used in the food production such as glucose and fructose, and also about reducing sugars intake by adults and children [1]. Another issue is that food producers adapt to the needs of the market, where the interest in food for diabetics or products with reduced sugar content is increased. In the literature there was taken into concideration ultrasonic-assisted osmotic dehydration, but focused mainly on solutions of monosaccharides [2,3]. In this study, an attempt was made to use of sugar alcohols and sucrose in healthy fruit snacks production.

The chosen material was kiwi fruit (*Actinidia deliciosa*), cut into round slices with 7 mm thickness and 32 mm diameter. The selected osmotic agents were sorbitol, erythritol and sucrose (aqueous solutions 50%). First, the examination of osmotic dehydration kinetics (at 35°C) with and without ultrasound was conducted. Second, the 30-minute osmosis with 300-minute convective drying was performed. Next, the quality assesment of the product was evaluated, i.e. total color change, water activity and retention of vitamin C, polyphenols and carotenoids. The obtained results allow to state that sugar alcohols are usable as excellent replacements for common sugars to obtain good quality products. Moreover, ultrasonic-assisted osmosis provides better results in drying kinetics as well as in quality.

Keywords: osmotic dehydration, ultrasound, convective drying, kiwi

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The effect of composition changes and aeration time on rehydration and color of innovative freeze-dried hydrocolloid gels

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Today's consumer is interested in attractive food products which combine quality, health and modernity. The selection of gel composition (e.g. incorporation of air) and preparation conditions allow to produce gels with controlled microstructure and properties. Such product can be used in developing new dietetic food, which can be preserved by the freeze-drying process, what ensures attractive properties. The aim of this work was to explain the influence of structure on physical properties of freeze-dried gels.

Low-methoxyl pectin (LMP), a mixture of xanthan gum and locust bean gum (KG+LBG) and a mixture of xanthan gum and guar gum (KG+GG) were used to prepare gels. The composition was modified by adding sugars and citric acid in values typical of strawberry fruit to obtain a strawberry model. The mixture of ingredients was aerated for 3 and 7 minutes, after gelation freezed and freeze-dried. For obtained samples rehydration properties, color, real density and shrinkage were investigated.

Investigations are the second stage of project designed to develop innovative strawberries product. In most cases the time of aeration has insignificant effect, which may mean that structure is created mostly during freeze-drying process. Samples with LMP obtained the lowest shrinkage value, what was correlated with the lowest real density. Also rehydration capacity was in the highest value. The highest shrinkage value was obtained for samples with KG+LBG, real density was the highest. The rehydration properties as expected were the lowest. All samples obtained lightness coefficient above 90 units. The yellow color coefficient was the highest for samples KG+LBG what can be affected by shrinkage. For KG+GG samples obtained values were indirect. The addition of sugar and citric acid increased investigated properties in comparison to samples without such ingredients, what was connected with structure changes.

Freeze-dried gels with low-methoxyl pectin seems to be the best to obtain innovative strawberry product with tailored structure. They absorb the most water and characterize the most attractive structure. Samples with the mixture of hydrocolloid were more compact. Aeration time didn't effect significant investigated parameters, while sugar and acid addition increased them.

Keywords: aeration, hydrocolloids, freeze-drying, rehydration, color

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Bioprocessing as a tool to develop new multifunctional plant ingredients

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Introduction Naturally functional is one of the biggest trends in the food industry and creates a global market pull towards natural and clean-label food products. As naturally functional foods, vegetables and fruits offer wealth of possibilities for food industry. Moreover, edible co-streams from their processing could be converted to higher value products to decrease the amount of food loss. Smart food technology applying bioprocessing with enzymes and microbes offers a natural and sustainable tool to upgrade technological and nutritional properties of agro-food materials. In this presentation various application examples of bioprocessing to valorize vegetable and fruit materials and co-streams will be shown.

Materials and methods Various vegetables and berries and their edible co-streams were used as raw materials. Bioprocessing was carried out with selected lactic acid bacteria (LAB) from VTT Culture Collection and food-grade enzymes using different time and temperature combinations. Microbial counts, various metabolites, sugars, phenolic compounds and bioactivities were analyzed depending on the application.

Results and discussion Edible plant co-streams were successfully used as production media of probiotic bacteria. High viable counts were reached (10^9 CFU g^{-1}) and the cells remained viable during 14 d cold-storage trial. In good quality probiotic products, the daily dose should be *ca.* 10^9 CFU. Application of exopolysaccharide (EPS) producing LAB showed that *in situ* produced EPS can act as natural hydrocolloids in carrot material. The use of specific LAB for cloudberry fermentation modified phenolic composition and bioactivities of the berries. Highly bioactive fractions were produced from the fermented berries by dry fractionation of the press cake. Fermentation and dry fractionation increased anti-inflammatory and anti-adhesion activity of cloudberry. Yeast fermentation increased significantly benzoic acid concentration in lingonberries, whereas enzymatic treatment reduced acidic flavor.

Conclusion This study showed for the first time that edible plant co-streams can be utilized to produce fermented probiotic vegetable ingredients. Our examples also show how wide range of new functionalities can be incorporated into plant raw materials using innovative bioprocessing. The results also highlight potential of the bioprocessed berries, vegetables and co-streams as natural multifunctional ingredients in pharma, food and feed applications. By process optimization the concentrations of wanted and unwanted metabolites may be adjusted to comply with various applications.

Keywords: Lactic acid bacteria, yeast, fermentation, berry, vegetables

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Chokeberry and cranberry diet drinks fortified with selected herbal extracts preserved by thermal pasteurization and high pressure carbon dioxide

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The use of herbs and herbal preparations is constantly gaining popularity. Many herbs have proved health promoting properties and can be used for fortification of i.e. fruit drinks, enhancing and complementing the positive impact of fruits on human body.

The aim of this study was to design innovative pro-healthy diet drinks, with a high content of fruit juice and with high antioxidant capacity. One drink, based on chokeberry (*Aronia melanocarpa*) juice, was supplemented with the extracts of cistus (*Cistus incanus*), green tea (*Camellia sinensis*) and nettle (*Urtica dioica*), and another was based on cranberry (*Vaccinum macrocarpon*) juice with the addition of horsetail (*Equisetum arvense*), birch (*Betula pendula*) and chamomile (*Matricaria chamomilla*) extracts. Drinks have been prepared in two lines: traditional – sweetened with sucrose and diet version of 30% lower energy value – sweetened with stevia extracts. Both drink lines contained 80% of cloudy juice.

Drinks have been preserved by innovative non-thermal technique, high pressure carbon dioxide method (HPCD), as an alternative for conventional thermal pasteurization (TP). HPCD preservation was conducted in glass jars (120 mL) using Spe-edTM SFE apparatus (Applied Separations, USA) at 65 MPa, 55°C for 30 min. TP process was carried out in glass jars at 85°C for 6 min.

Antioxidant capacity (AC) has been determined using ORAC, ABTS and DPPH tests, polyphenols (TCP) content was measured spectrophotometrically, whereas anthocyanins (TCA) content by HPLC.

The study has shown that addition of herbal extracts to chokeberry drinks in amounts used in traditional medicine increased the AC up to the level noted for 100% juices. AC of chokeberry drinks measured with ORAC method was 20% (traditional line) and 16% (diet line) higher than the sum of ACs of the individual components. Similar synergistic effect was found for cranberry drinks with sucrose addition. DPPH test also showed synergistic effect for sucrose sweetened drinks (14% for chokeberry and 8% for cranberry drinks).

HPCD treatment reduced TCA in drinks by ca. 2–3 times less compared to TP; sucrose had a significant protective effect. Changes of TCP as a result of preservation treatments did not follow a clear pattern. Obtained results indicate that fortification with selected herbal extracts can significantly enhance the antioxidant capacity of fruit drinks, in some cases the synergistic effect has been shown. HPCD technique allowed for better retention of anthocyanins and antioxidant capacity of fruit-herbal drinks in comparison with TP.

Keywords: antioxidant capacity, chokeberry, cranberry, herbal extracts, high pressure carbon dioxide

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Effect of uv-led irradiation on polyphenol oxidase (PPO) activity of apple juice

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As an alternative to consumption of fruits, drinking fruit juices is easy especially for very young, elderly and infirm people. Popularity of fruit juices is rising in terms of its nutritional value and additional health benefits.

The thermal pasteurization is the best known technique to produce microbiologically safe and shelf-stable fruit juice products. But increasing trend towards fresh-like products motivated the researchers to develop alternative processing techniques. One of the alternative non-thermal methods is UV-C irradiation. The antimicrobial effect of UV-C is very well known and this technique is used for disinfection of hospitals, water effluent, drinking water and surface disinfection of different fruits and fruit juice pasteurization. Generally low or medium pressure mercury vapor lamps which are known to be toxic effect for both environment and human body are used for UV-C irradiation. These lamps are mostly large in size and take up too much space. Additionally UV reactors need to be designed according to the shape of the lamps. Therefore, it is necessary to design new sterilization equipment in various sizes which do not contain toxic substances and have low energy consumption rate. In this respect, UV-LED irradiation is to be considered as an alternative approach with giving possibility to combine different wavelengths for better effect. Nevertheless, there are few studies about effects of UV on some enzyme activities, especially polyphenol oxidase (PPO), which is responsible for enzymatic browning in fruit and vegetable tissues containing phenolic or polyphenolic compounds. The objective of this study is to investigate the effect of UV LEDs for the inactivation of PPO in apple juice (AJ). For this purpose, fresh AJ (28.53_{254nm} cm^{-1}, 1619 NTU) was exposed to UV rays for 40 min by using a UV device composed of four UV-LED lamps with peak emissions at 254 and 280 nm and combination of emissions at 254/365, 254/405, 280/365, 280/405 and 254/280/365/405 nm. The residual activity of PPO was measured in UV treated AJ. The highest inactivation (70.43%) was achieved in UV-LED process which 280/365 nm wavelengths were combined. The coupling of UV-A and UV-B rays showed a higher inactivation effect on PPO enzyme than UV-C rays used alone.

Thus these preliminary findings highlight the enzyme inactivation potential of UV-LED system based on coupled wavelengths from UV-A and UV-C range.

Keywords: Apple juice, Ultraviolet light-emitting diodes (UV-LED), Polyphenol oxidase, Coupled wavelength

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New techniques used to improve berries shelf life

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Berries are characterized by a shorter shelf life than other fruits, because of higher susceptibility to microbial spoilage, increased respiration rate and ethylene production, which is stimulated by wounding of the tissue. In addition, they may pose a food safety risk to the consumers because they are consumed raw. Shelf-life is usually defined as the time during which a food product remain safe, comply with label declaration of nutritional data and retain desired sensory, chemical, physical and microbiological characteristics when stored under the recommended conditions. Therefore, to assess shelf-life objective indexes related to nutrition, microbiological or physicochemical characteristics of food have been typically measured. The most used method to keep berries fresh after harvest and to increase their shelf life is to keep them in a refrigerated state. Most berries can last several days when kept at around 1°C, but this method is not always optimal or cost effective, so other innovative methods have developed in time to extend even more the berries shelf life. Some new ways to extend the shelf-life are keeping the berries in modified atmosphere packaging, using antimicrobial edible coatings and films, using high voltage electric fields (HVEF), using UV light, irradiation and ozone, and dipping the berries in different solutions that contain opposite charged polyelectrolyte. Between those mentioned earlier, the development of antimicrobial edible coatings is the most studied method for improving the shelf life of different berries or fruits. In conclusion, finding more techniques to increase and improve berries shelf-life is a must for the producers, suppliers and customers.

Keywords: shelf-life, improve, berries

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Preliminary study of the effect of pulsed electric field as a pre-treatment on French-fries on qualitative and structural aspects.

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Pulsed Electric Field (PEF) treatment involves the application of short duration pulses (μs to ms) of high electric fields to a sample placed between two electrodes. The induced electroporation of cell membranes can lead to structural modification of plant tissues and can be exploited for the acceleration of mass transfer processes. The application of PEF has been related to a reduction of sugars in potato tissues [1], improving colour after frying [2]. The aim of this study was to evaluate the effect of PEF in combination with dipping as a pre-treatment to frying on some French-fries quality aspects. Potato sticks (1×1×2.5 cm^3) were immersed in a saline solution with a conductivity of 3 mS/cm and subjected to 10 series of 10 pulses (pulse width = 100 μs, spaced 10 ms) at 400 V/cm (1.2 kV between the electrodes). Part of treated samples were then dipped for 1 h in the same saline solution and fried at 175°C for 2 min. The individual and combined effects of PEF and dipping were evaluated compared to the un-treated sample on qualitative parameters such as weight gain, colour, oil content and on some structural parameters such as the water state through TD-NMR. PEF treatment influenced mass transfer during dipping, causing leaching of components into the solution, probably for an effect on membrane permeability. While PEF alone did not have any effect on the colour of fried samples, those that underwent PEF combined with dipping showed a lighter colour. Oil uptake was not influenced by PEF but increased in dipped samples. TD-NMR data highlighted an effect of the treatment on the water distribution in the different cellular compartments that could be attributed to the effect on both cell membranes and starch structure. The results obtained in this preliminary study show that PEF in combination with dipping is a promising treatment for improving French-fries quality. Further studies are needed in order to better understand the effect of the treatment, in particular on reducing sugars content and starch structure.

Keywords: PEF, French-fries, browning, oil content, water state

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Effect of high pressure processing and heat treatment on chemical composition and sensory quality of strawberry purées

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Strawberries (*Fragaria* × *ananassa*) are delicious, tasteful fruits with high contents of compounds with potential health benefits, such as vitamin C and polyphenols, among them anthocyanins which are responsible for the bright, red color of strawberries. Strawberries are prone to deterioration and have to be treated to inactive microorganisms and enzymes if they are to be stored. Thermal pasteurization is the most commonly used technology. However, heat treatment can lead to loss of nutrients and change of color, flavor and texture. Non-thermal technologies, like high pressure processing (HPP), are shown to better preserve molecules with low molecular weights such as vitamins, peptides, saccharides, pigments and flavor compounds. On the other hand, degrading enzymes are quite resistant to high pressure, which may affect the stability of chemical constituents during storage of the products.

The aim of the present study was to investigate the effect of HPP (500 MPa for 1.5 min) versus heat treatment (HT, 86°C for 2 min) of purées of two strawberry cultivars ('Polka' and 'Florence') as fresh and after storage (35 days at 6°C).

Heat treatment gave more reduction of bacteria compared with HPP. HT caused more reduction in 'Polka' than in 'Florence'; 3.5 and 2.5 log cfu/g, respectively. Both mould and yeast was present in the untreated samples, but after HPP and HT there were no detectable levels, even at the end of the storage period. Soluble solids, pH, color (L*, hue, chroma) and total monomeric anthocyanins (TMA) in newly made purees were not affected by processing (HT vs. HPP). Surprisingly, the concentration of vitamin C was higher in HT purées than in untreated- and HPP-purées, that is 41.1, 37.8 and 37.2 mg/100 g fw, respectively. After 35 days of storage low concentrations of vitamin C (1–3 mg/100 g fw) was left in the purées. In average 71% of TMA remained in the HT purees, while only 55% was left in the HPP-purees. More change in color was observed for the HPP-purées compared with HT-purees; HPP-purees became darker during storage. Sensory profiling revealed that HPP-purees had higher color intensity, as well. In addition, stored HPP-purées were less fresh and had lower scores for taste and flavor compared with HT-purées. In conclusion, anthocyanins and sensory quality was better preserved during storage in strawberry purées that was heat treated compared with HP-treated.

Study on the efficacy of edible coatings on quality of blueberry fruits during shelf-life

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Blueberries are appreciated for their high content in bioactive compounds such as polyphenols and anthocyanins that give them high nutraceutical properties. However, the fresh fruit deteriorates rapidly, due to dehydration, mould and/or putrefaction [1]. Edible films or coatings could be used as an alternative way of conservation, because of their ability to reduce respiration and transpiration rate, maintain firmness and generally delay fruit senescence [2]. To our knowledge, only few research works have been performed about the application of edible coating to fresh blueberries. The aim of this work was to evaluate the efficacy of the application of edible coating on blueberry in order to prolong their quality maintenance. The applied coating was composed of sodium alginate (2%), glycerol (1.5%) and Tween (0.2%). Its application on the berries was performed by one min dipping; raw fruits were used as control. Berry samples were placed in open plastic trays and stored at 10°C for 14 days. At 0, 2, 4, 7, 10 and 14 days of storage the control and coated samples were evaluated for weight loss, pH, titrable acidity, soluble solids content (°Brix), dry matter, colour, firmness, antioxidant capacity and microstructure with fluorescence microscopy. The results obtained showed that the application of sodium alginate coating influences some physico-chemical characteristics of the berries during storage, improving their post-harvest quality and potentially prolonging the shelf-life of the product. The growing demand of these fine fruits with beneficial properties make important to extend their shelf-life and the application of edible coating in fresh blueberries can be a feasible possibility. However, from technological point of view, some critical issue such as the homogeneous distribution of the coating has to be further investigated.

Keywords: edible film, blueberry, alginate, dipping, quality

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Vitamin D_2 enrichment in mushrooms by natural or artificial UV-light

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Vitamin D is a fat-soluble vitamin commonly occurring as ergocalciferol (vitamin D_2) or cholecalciferol (vitamin D_3). Mushrooms contain a significant amount of ergosterol (pro-vitamin D_2). vitamin D_2 in mushrooms can be synthesized from ergosterol through exposure to ultraviolet light. Cultivated mushrooms contain little vitamin D_2 due to the absence of sunlight in growing rooms. However, vitamin D_2 in mushrooms can be enhanced by irradiation with natural or artificial UV-light. Drying represents a fundamental processing step for the development of novel value-added products, which could also reduce the losses caused by surplus production. Therefore, the objective of this work was to study the effects of processing and drying on vitamin D_2 enrichment in cultivated mushrooms (*Agaricus bisporus*). In particular, the influence of the increased exposure surface area via slicing of mushrooms prior to a controlled period of UVB irradiation was examined. Also, the impact of sun exposure on the vitamin D_2 content of untreated mushrooms during natural sun drying and drying in a forced convection type solar dryer was investigated. In addition, UVB-irradiated mushrooms were dried by hot-air in a laboratory through-flow dryer at different temperatures and by freeze drying. Fresh raw mushroom samples were divided into three batches: The first batch of mushrooms was sliced to approx. 30 mm thickness and then subjected to either sun drying or solar drying in a forced convection-type solar dryer. The second batch of mushroom slices was irradiated with an UVB dose of 1.5 J/cm^2 at 25°C for 20 min before hot-air drying and freeze drying, while a batch of uncut UVB-treated fruiting bodies was used for control. HPLC analysis was carried out for the determination of vitamin D_2. The vitamin D_2 content of the UVB-irradiated mushrooms was not negatively influenced by the increased temperatures of the drying air. Slicing of mushrooms prior to UVB exposure induced a ten-fold increase in vitamin D_2 content. vitamin D_2 content of sun-dried and solar-dried mushrooms was about 36.40 and 38.86 µg/g dry matter, respectively. Apart from the irradiation dose or the exposure time, slicing of mushrooms before UVB treatment can maximize vitamin D_2 content as a larger surface area of mushroom's gills is exposed. Furthermore, drying in a forced convection type solar dryer can be a promising approach for vitamin D_2 enhancement in cultivated mushrooms.

Keywords: Processing, UVB irradiation, drying, mushroom, quality

Effect of High pressure homogenization on the quality of organic kiwi fruit juices

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Traditionally, the shelf-life extension and safety of juices have been achieved by thermal processing. Low temperature long time (LTLT) and high temperature short time (HTST) treatments are the most commonly used hurdles for juice pasteurization. However, thermal processes can reduce the product quality and freshness. Therefore, during the last couple of decades, some non-thermal pasteurization processes have been proposed, including high hydrostatic pressure (HHP), pulsed electric field (PEF), ultrasounds (US) and high pressure homogenization (HPH). In particular, this last technique seems to have great potential to provide "fresh-like" and safe fruit juices with prolonged shelf-life.

Thus, the principal aim of this research was to evaluate the effects of two HPH treatments performed at 200 MPa for 2, and 3 cycles by using a Panda Homogenizer (Gea, Italy) on the safety and shelf-life of organic kiwifruit juice. Moreover, a challenge test was performed inoculating the kiwi fruit juice with *Listeria monocytogenes*, *Staphylococcus aureus*, *Escherichia coli*, *Lactobacillus plantarum* and *Saccharomyces cerevisiae* (3 log cfu/ml) before HPH treatments. All the samples obtained were stored at 5, 15 and 25°C. During shelf life pH, soluble solids content (°Brix), titrable acidity, viscosity, colour, isothermal calorimetry TAM, vitamin C and antioxidant activity were performed on the juice samples.

The results obtained showed that all HPH treatments assured the safety features of all the samples during the considered shelf life period. Only the highest treatment (200 MPa for 3 cycles) was able to contain the yeast growth in the inoculated samples, even at the highest storage temperature (25°C), compared to its control (0.1 MPa), that spoiled after 10 days. The combination of HPH (200 MPa for 2 and 3 cycles) and refrigeration allowed to extend the juice stability for over a month. The results related to the others quality characteristics tested were in agreement with the microbiological ones.

Although the adopted process needs to be further improved introducing the aseptic packaging, the use of the HPH treatment allowed to obtain organic kiwi juices characterized by a low thermal damage also contributing to the expansion of this product sector.

Keywords: HPH, organic, kiwifruit juice, quality, storage

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Evaluation of the effect of roasting-drying process in different peppers varieties, on physicochemical and structural characteristics in dried and rehydrated product

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Roast-dried pepper, known as 'chile pasado'is a typical product consumed in Mexico, where is appreciated and demanded by consumers. This product is obtained by roasting and drying of the peppers, for a subsequent rehydration, and used as ingredient in the Mexican cooking. During processing, occur physicochemical changes that affect their quality and acceptability. These characteristics are related to the different pepper varieties. Currently, the varieties that are used have low yield and poor characteristics of quality and acceptability in the final product.

The aim of this study was to evaluate three different varieties of green peppers to determinate to potential use in the roast-dried process.

Lots of three pepper varieties (Anaheim, Mirasol, and a variety hybrid G1) were washed and characterized physicochemically. After were roasted using a rotatory roaster at fixed conditions. Then these were immersed in cold water (5°C) for skin remove. After that, roasted peppers were dried at 75°C in a tray dryer and stored until analysis. Yield, water activity, moisture content, texture, pH, acidity, microstructural analysis, antioxidant activity, phenolic and capsaicin content and pungency were evaluated in roasted and dried peppers. Rehydration ratio was additionally evaluated during the rehydration of roasted-dried peppers.

Three pepper varieties were different ($P \leq 0.05$) in some physical and chemical characteristics. New variety (G1) presented physical, chemical and structural characteristics similar to Mirasol peppers, but was significantly different to Anaheim variety. Roasting process caused texture loss (81.5%, 93.6% and 93.5% for Anaheim, Mirasol, and G1, respectively) and increased in antioxidant activity, phenolic and capsaicin contents. Three varieties were affected by drying process ($P \leq 0.05$). Firmness loss of dried-rehydrated tissue was from 94.1% to 96.8%, Anaheim peppers shown the lowest lost. Phenolic content and antioxidant activity decreased while capsaicin content increased in Mirasol and G1 varieties. G1 variety peppers showed a slight improvement in yield compared with Mirasol, but lower than Anaheim. However, their higher phenolic and capsaicinoids contents than Anaheim could improve the sensory properties. More studies are needed for genetic improvement of G1, which lead to similar yields like Anaheim peppers, but keeping Mirasol genetic line, which contributes to phenolic and capsaicinoids content.

Keywords: roast-dried, peppers, capsaicin, texture, pungency

The influence of technological processing for sugars and bioactive compounds in strawberries

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Fruits are a reach source of natural antioxidants and vitamins, but drying causes decrease of quality and loss of liable components. One of the processes eliminating these negative changes is osmotic dehydration conducted in different conditions. From nutritional point of view introduction of sugar as an effect of osmotic dehydration is not beneficial. It's seen more appropriate to replace sugars with different component which allows gaining similar results as well as impact positively onto some of the properties. One of the alternatives might be use of fruit juices (e.g. chokeberry juice) which are reach source of natural antioxidants.

Frozen strawberries*Fragaria* × *ananassa* Honeoye variety were osmotically dehydrated in 50% solution of: saccharose, inulin, mixture of saccharose and inulin (1:1), saccharose and chokeberry juice concentrate (1:1) or chokeberry juice and inulin concentrate (1:4). The temperature of the solution was 50°C. Dehydrated samples were dried in two ways: convective (60 min, 60°C) or freeze-drying (25°C, 100 Pa, 24 hours). For obtained samples dry matter, sugars, polyphenols and activity antiradicalagainst DPPH were investigated.

It was shown that the osmotic dehydration and type of osmotic solution had impact on the increase of dry matter. The most effective was saccharose solution, while the smallest increase of the dry matter was noticed in samples dehydrated in solution with chokeberry juice concentrate. Strawberry has a high content of polyphenols, which was increased in samples osmotically dehydrated and freeze-dried compare to the convectively dried samples. This could be caused by set temperature and lower waste of bioactive ingredients. The ability to binding of radicals DPPH difference depends of technological process as well as type of osmotic solution used, which vary from 55% (fresh strawberry) to 88% (dehydrated strawberry) in inulin solution as well as convectively dried. It was proved that higher dehydrating activity was observed in samples which were dehydrated and convectively dried compare to freeze-drying.

Achieved results shows capability of use inulin and chokeberry juice concentrate in the osmotic dehydration which have capability to increase the polyphenol level or prebiotic characteristic in finished product. Achieved dried products can be an alternative to snacks and additives in technological processes.

Keywords: strawberry, polyphenols, sugars, osmotic dehydration, drying

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Recent developments in sc-CO_2 drying on technology upscaling, nutrient preservation and in-situ microbial inactivation

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In the recent years, several innovative food processing technologies have been investigated and developed. Among these is a very interesting technology for drying of fruits and vegetables: drying using pressurized CO_2. This process addresses both the need for more ecologically sound food chains as well as the increasing wishes of European consumers for high quality foods that have been minimally processed. The currently available drying technologies always need to compromise between energy usage and product quality. For example, freeze drying is the benchmark for nutrient, flavor and texture preservation, but is expensive and energy intensive. Interesting aspects about sc-CO_2 drying are the low operating temperature (35–60°C), the oxygen-free atmosphere and the ability of high-pressure (80–150 bar) CO_2 to inactivate micro-organisms. The aim of this research was to (i) further elucidate the in-situ antimicrobial effect, (ii) to study the retention of nutrients in comparison with freeze drying and (iii) to overcome upscaling challenges.

Lab-scale sc-CO_2 drying tests were done using raspberries and tomatoes. Microbial loads and key nutrient concentrations of the raw material and the dried material were analyzed for both products. Additionally, a pilot sc-CO_2 dryer with a capacity of 80 kilogram per run was designed and constructed, which tackles many aspects needed for further upscaling by incorporating an innovative CO_2 recycling system.

For both raspberries and tomatoes, a log 2 reduction was obtained for mesophilic bacteria, whereas psychrophilic bacteria, coliforms, yeast and molds were reduced from log 4–6 to below the detection level. Furthermore, the design was improved by making a one-vessel drying system, reducing energy and investments costs of the equipment. Nutrient preservation in tomato was approximately 90% for lycopene, β-carotene and ascorbic acid. Overall, the nutrient preservation during sc-CO_2 drying of tomato was notably better compared to the freeze drying process. For raspberry, only small differences were observed in retention of anthocyanins, ascorbic acid, phenols and flavonoids between sc-CO_2 and freeze drying.

The potential of sc-CO_2 drying is further strengthened by the results of this research, showing similar or better nutrient preservation in comparison with the current benchmark freeze drying. Furthermore, in-situ microbial inactivation is an additional advantage of the technology. Important steps towards industrialization were made by improving towards a one-vessel drying system and by upscaling the technology including an innovative CO_2 recycling system.

Keywords: cleantech, sustainable processing, drying technology, antimicrobial technology, upercritical fluids

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Inactivation of *S. cerevisiae* in Verjuice by Using UV-C Irradiation assisted with Mild Heat Treatment

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UV-C irradiation, which has a germicidal effectiveness, can be used as an alternative to thermal pasteurization to provide safety and long shelf life without any change in the nutritional and sensorial quality of the juices. Verjuice obtained from pressing of unripe grapes can be spoiled easily by means of microorganisms such as yeasts and molds. The objective of this study is to evaluate the inactivation efficacy of acid adapted *S. cerevisiae* Y139 in verjuice by UV-C irradiation, mild heating and their combination. All treatments were performed by using lab scale continuous flow UV system. The synergistic effect of mild heat (MH) and UV-C irradiation on the inactivation of *S. cerevisiae* was determined in the same system. Temperature of the juice within the system was checked by a K-type thermocouple during the processes. When the juice had high (approx. 10^6 cfu/ml) and low (approx. 10^4 cfu/ml) initial load, UV-C treatment hardly achieved 0.40 ± 0.04 $\log_{10}$ and 0.54 ± 0.02 $\log_{10}$ cfu/ml reductions of *S. cerevisiae* at UV dose of 2.301 ± 0.002 J/ml. Mild heat treatment alone was reduced the number of *S. cerevisiae* by 3.13 ± 0.05 $\log_{10}$ cfu/ml (T_{juice}: 50.08 ± 3.26°C). On the other hand, the combined treatment of UV-C and mild heat (UV+MH) resulted in 5.16 ± 0.24 $\log_{10}$ cfu/ml reduction in the population of *S. cerevisiae* (T_{juice}: 51.24 ± 2.74°C) at UV dose of 1.006 ± 0.003 J/ml. The resistance parameters were calculated by fitting survival curves with the Weibull model. Synergistic inactivation effect was observed and predicted as 50.79% by applying UV-C irradiation and mild heat treatment simultaneously. The results showed that the lethal effect of UV-C irradiation on *S. cerevisiae* suspended in verjuice was increased synergistically by applying mild heat treatment. The UV-C irradiation at moderate temperatures can be suggested as an alternative to thermal pasteurization of verjuice by allowing inactivation of spoilage microorganisms and providing longer shelf life.

Keywords: UV-C irradiation, mild heating, verjuice, kinetic modelling, *S. cerevisiae*

2 / Quality at the heart of sustainable markets for F&V products

Effect of biopreservation and calcium postharvest treatments in the quality of minimally processed Conference pears

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In recent years, the consumption of fresh-cut fruits and vegetables has quickly increased [1]. Biological preservation has emerged as a promising strategy to extend the shelf life and to improve the microbiology safety of foods. Recently, our research group has isolated the strain CPA-7 of *Pseudomonas graminis* from apple, reporting that its application could reduce the population of foodborne pathogens in minimally processed fruits [2]. On the other hand, calcium plays an important role in maintaining quality of fruits and calcium postharvest treatments can determine their aptitude to be processed. The understanding of the process leading to quality changes is essential in developing better approaches to minimizing them and, hence, improving quality and shelf life for the consumer [3]. The objective of this work was to evaluate the effect of biopreservation with the strain CPA-7 of *P. graminis* and postharvest application of calcium on quality parameters of minimally processed pears. After harvest, "Conference" pears were treated with o without calcium for 10 min at 25°C and stored for 5 months at 0°C. Then, both batches of fruit were minimally processed with or without CPA-7 and stored at 4°C for 6 days. Physicochemical parameters, total phenols, antioxidant activity (DPPH$^{\bullet}$ and FRAP assays), PPO and POD activities and Vitamin C were evaluated. After refrigerated storage, enzymatic activities showed lower values for samples treated with CPA-7 and calcium in relation to untreated ones although initial values for PPO were higher. CPA-7 treated samples did not present significant differences for luminosity and browning index. A slight decrease for vitamin C content was observed in CPA-7 treated samples. In general, pears treated with CPA-7 and calcium did not show changes in total phenols content and antioxidant activity with regard control. Therefore, biopreservation combined with calcium postharvest treatment can help to maintain the quality of minimally processed pears during refrigerated storage.

Keywords: Fresh-cut pears, Biopreservation, Calcium, Quality.

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Phenolic extracts of bilberry: they protect lipid from oxidation in *in vitro* simulated digestion conditions

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Introduction. The oxidation of polyunsaturated lipids is responsible for not only the deterioration of food quality, but also for damage to tissues and the gastric compartment has been proposed as a major site for diet-related oxidative stress [1]. Plant polyphenols provided as fruit and vegetables or an extract have been shown to protect dietary lipids from oxidation during gastric digestion in minipigs [2]. Bilberry, a wild shrub, is used as food due to his nutritional value and richness in antioxidant vitamins and polyphenols. We had previously demonstrated that stems, leaves and fruits of bilberry are rich in monomeric and oligomeric flavanols, caffeoyl derivatives and anthocyanins, respectively. This study aims at evaluating the *in vitro* antioxidant activity of stems, leaves and fruits of bilberry extracts in lipid oxidation under simulated digestion conditions.

Materials and Methods. Firstly, the lipid oxidation in an *in vitro* gastric digestion model and its inhibition by bilberry aqueous extracts was performed using sunflower oil-in-water emulsions stabilized by bovine serum albumin (BSA) or egg yolk phospholipids (PL) as models of the gastric content. Oxidation was initiated by metmyoglobin (20 μM) at pH 5 and at 37°C, corresponding to the early step of gastric digestion. Secondly, a bilberry leaf extract was tested in the inhibition of lipid oxidation under simulated oral, gastric and intestinal *in vitro* conditions according to the standardized InfoGest protocol [3]. The formation of lipid-derived conjugated dienes was followed by UV spectroscopy at 234 nm.

Results and Discusson. Leaf and stem bilberry extracts (0.1 mg Dry Extract/mL emulsion) highly inhibited metmyoglobin-initiated lipid oxidation by 73% and 49% in the BSA gastric model and by 59% and 55% in the PL one. The fruit extracts (0.2 mg Dry Extract/mL emulsion) showed the least inhibitory effect in both model emulsions (30% inhibition). In the Infogest conditions, the fast lipid oxidation in the gastric step (BSA and PL systems) and the slower lipid oxidation in the intestinal step (PL system) were totally inhibited by the bilberry leaf extract (3 mg Dry Extract/mL in the gastric step).

Conclusions. Leaf, stem and fruit extracts of bilberry can play a protective role towards oxidation of polyunsaturated dietary lipids. In this work, an oro-gastro-intestinal static model of digestion was implemented for the first time combining both emulsion systems for food modeling and the best physiological conditions ever described through the recommendations by the network InfoGest.

Keywords: *Vaccinium myrtillus* L., antioxidant activity, oil-in-water emulsion, oro-gastro-intestinal digestion.

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Effect of maturity on the phenolic composition of pear juice

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Polyphenols are natural compounds from plants and are relevant in terms of quality. Procyanidins, also known as condensed tannins, are oligo and polymeric polyphenols that contribute to the organoleptic properties of some beverages, especially by their astringency and bitterness [1]. They are known to bind food macromolecules, proteins and carbohydrates, by non-covalent interactions [2]; procyanidins with high degree of polymerization are adsorbed onto cell walls. In grape [3], binding of procyanidins to grape skin has been shown to vary with maturity. The astringency of perry pear juice depends heavily on the fruit maturity, with over-ripening practices being commonly used for production of perry. The phenolic profile of perry pear parenchyma is very simple, mainly caffeoylquinic acid and procyanidins, the later being high polymerized and based on (−)-epicatechin units [4]. The aim of the present work was to characterize the phenolic composition and content of pear juices and to report differences that occur depending of the maturity stage of the fruits.

Juices were extracted from two perry pear cultivar 'De Cloche' and 'Plant de Blanc' from ripe and overripe fruits. The polyphenols were analyzed in the fruit, in the juice, and in the pomace by HPLC-DAD.

Procyanidins contents and compositions remained stable during the over-ripening of pears. In the juice, the procyanidins concentration varied with the maturity stage during fruit pressing. The extraction of procyanidins in the juice was largely limited by formation, spontaneously, of non-covalent adducts, via hydrogen bonding and hydrophobic effects, with pear cell walls.

Keywords: *Pyrus communis* L., procyanidins, over ripening, cell walls, polysaccharides, interactions

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Vitamin enhanced apple purée for elderly

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Apple is the most popular fruit of temperate climatic zones, and it is grown readily all over Europe. For this reason, apple and apple based products such as apple purée are well known for European consumers and particularly for elderly. Given the low vitamin content of apple purée, a vitamin supplement (MV2) can be inserted to improve the nutritional quality of apple base products. Therefore the objective of the study was to evaluate the permanence of vitamins in samples treated by high pressure processing (HPP, 600 MPa for 3 min) and autoclave (TT, 93°C for 16 min). Before treatment, 0.25% and 0.5% of MV2 were incorporated in the apple purée. Physicochemical parameters (colour, ºBrix and pH), microbiological counts (mesophilic bacteria, psychrotrophic bacteria and yeasts and moulds) as well as vitamins (Vitamin C, retinol and α-tocoferol) were measured before and after treatment. Results have shown that HPP and TT reduced the levels of mesophilic and psychrotrophic bacteria and yeasts, and moulds at least by 2.5 $\log_{10}$[cfu]. Final value of mesophilic being between below detection limit for TT treated samples and 1.6 $\log_{10}$[cfu] for HPP treated samples. For psychrotrophic bacteria and yeasts, and moulds final value being below detection limit for both treatments. Regarding physicochemical parameters, the introduction of MV2 induced a small pH increase and a colour modification was observed between treatments. Addition of MV2 produced a linear increase in vitamin C. However, the application of HPP or TT had a negative impact reducing level of vitamin C of 10 to 20%. For retinol and α-tocoferol the same correlation was found and pasteurisation treatments tended to have an effect on the final vitamin content. It is possible to obtain a pasteurized apple purée enhanced with vitamins with increased nutritional value using either HPP or thermal treatment. Both treatments have a small effect on colour and vitamin content but this effect is largely compensated by the amount of vitamin supplement introduced in the product.

Keywords: vitamins, apple purée, HPP, elderly.

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Processing and olive oil addition in tomato sauces increase the bioavailability of flavanones, flavonols and hydroxycinnamic acids

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Introduction. Tomatoes, one of the most commonly consumed agricultural commodities, are rich in bioactive compounds. Regular consumption of tomatoes has been correlated with a reduced risk of developing several types of cancer and cardiovascular disease. These beneficial effects are attributed to carotenoids, particularly lycopene and β-carotene, and phenolic compounds. Food matrix is one of the external factors that affect the bioavailability of the different functional components. Although it is known that processing and the presence of a lipid matrix increases the bioavailability of carotenoids, there is still little information about the effect of processing and the addition of olive oil during tomato sauce preparation on microbial metabolism of phenolics in the small intestine.

Materials and Methods. An open, controlled, randomized and crossover feeding trial with forty healthy volunteers was carried out to analyze the metabolites in plasma and urine after the consumption of tomato and tomato sauces, with (ROOE) and without refined olive oil (oil-free: OF).

Results and Discusson. Ten phenolics in plasma and ninety-three metabolites in urine were quantified. Processing tomatoes into sauce enhanced the bioavailability of flavanones, flavanols and some hydroxycinnamic acids, as reflected by the increase in the area under the plasma vs. time curve. An increase in their plasma half-life was also observed, particularly after ingestion of ROOE, possibly favored by enterohepatic circulation. A wide variety of gut microbial metabolites was also detected, namely flavanones, hydroxycinnamic acids, flavonols, hydroxyphenylpropanoic acids, hydroxyphenylacetic acids, and hydroxybenzoic acids.

Conclusions. Mechanical treatment and addition of a fatty matrix to the tomato sauce enhanced the bioavailability of flavanones and flavonols contained in the fruit, favouring their beneficial effects in cells and tissues. Further studies in which the matrix effect is extensively evaluated in other fruits and vegetables should be performed.

Keywords: pharmacokinetics, microbiota metabolites, naringenin, quercetin, phase II metabolites.

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Prediction of tomato SSC and reducing sugars by FT-NIRs: development of common models for different varieties and stages of maturity.

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Introduction and background As the same for most fruits and vegetables, measure the quality of tomatoes throughout the supply chain is destructive, time and cost consuming and based on small sample sizes. Such process of quality control is not fully adapted to the traceability requirements of the agri-food industry which concerns all the actors of the supply chain (producer, industrials and distributors). In such context, a non-destructive and rapid method allowing to measure tomato quality would be an asset. The present study aimed at to evaluate the FT-NIR spectroscopy to elaborate prediction models of sugars on entire tomato fruit and juice usable for various tomato varieties and maturity stages.

Materials and Methods. Near-infrared spectra have been collected on entire tomatoes and tomato juices by using a FT-NIR spectrometer (MPA Multi-Purpose FT-NIR Analyzer, Bruker, Germany). Spectra of entire tomatoes have been acquired in diffuse reflectance by using an auto-sampler while spectra of juices have been acquired in transmission mode. OPUS software (Bruker, Germany) has been used to perform chemometrics between spectral data and chemical analyses of sugar content.

Results and Discusson. The obtained results show the good ability of FT-NIR to predict the soluble solids content of tomato fruit (non-destructive) (R^2 = 0.86, RMSECV = 0.46 °Brix, A first attempt of sucrose, fructose and glucose prediction on juice gave accurate and robust results with R^2-values of 0.93 (RPD = 3.64), 0.93 (RPD = 3.55) and 0.83 (RPD = 2.36), respectively.

Conclusions. The results of this study are promising because they show the ability to predict SSC of tomato regardless of the variety and maturity stage. This possibility opens up prospects of applications in the supply chains of fresh and processed tomato. The next steps of this work will be the strengthening of developed models by introducing new factors of variability involving the cultivation and storage of tomatoes.

Keywords: glucose, fructose, soluble solids content, PLS, wavelength selection.

Color stability and antioxidant activity of anthocyanin extracts from berries in juice model solution

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Nowadays, consumers prefer natural food additives against the synthetic ones, including food colorings. Anthocyanins are natural coloring agents in the red range. Also, they influence other sensory properties such as astringency and bitterness [1]. Anthocyanins have a high antioxidant capacity that contributes to beneficial effects in reducing the risk of heart disease, cancer and stroke [2]. Especially berry fruits are rich in anthocyanins. This study is focused on anthocyanin extracts obtained from berries, estimation of their colouring ability as well as evaluation of antioxidant activity. Berries of five species: blackberry (*Rubus fruticosus*), serviceberry (*Amelanchier spicata*), black currant (*Ribes nigrum*), blueberry (*Vaccinium myrtillus*) and grape (*Vitis vinifera*, cv. Merlo) were harvested at commercial maturity stage, lyophilized and grounded. Their anthocyanins were duple extracted with 0.1% HCl in ethanol. The juice model solutions were prepared by the dissolved lyophilized residue in buffer solution (KH Ftalato-HCl 0.1 M) at pH 3.7 containing 0.1% (w/v) of citric acid. These model solutions were stored in darkness at 4°C. Color variations were evaluated by differential colorimetry (CIELAB including). Identification of anthocyanins was performed by HPLC-UV-MS analysis. Antioxidant activity was tested by ABTS assay [3]. The model solutions from berries extracts contain different antocyanins: blackberry (only cyanidin derivatives), serviceberry (cyanidin derivatives without acylated substitutes), black currant (delphinidin and cyanidin derivatives), blueberry (malvidin and delphinidin derivatives) and grape (malvidin, delphinidin, cyanidin, peonidin and petunidin derivatives). Total anthocyanins content ranged from 0.25 to 1.56 mg in malvidin-3-*O*-glucoside per ml. Mean values of antioxidant capacity varied between 4.9–11.7 in mmol Trolox equivalent per ml. Total anthocyanins content, color parameters and antioxidant activity of model solutions have not changed during three months storage in the given conditions. These results are important for the food industry where the treated berries might be used as natural food colorants due to a high amount of pigments, coloring ability and their high antioxidant potential.

Keywords: anthocyanin, berry, color stability, antioxidant activity

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Impact of cold storage and freeze-drying on nutritional quality of barley, lentil, mung bean, radish and wheat sprouts

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Consumers, food nutritionists and also producers are becoming increasingly interested in the health related effects of the produce they consume. The use of seed sprouts as food has spread in the past two decades in several European countries including Italy. Sprouting is an effective and simple tool, for enhancing the nutritional quality (i.e. amino acids, vitamins and minerals) of cruciferous, legumes and cereals [1]. These qualitative changes are associated with activation of enzymatic pathways, new structures building as well as the metabolism of functional compounds (e.g. hormones). The quality of the sprouts could be significantly affected by several factors such as seed quality, germination as well as postharvest storage conditions. Sprouts are usually eaten fresh; however to maintain the quality of the product, they are stored in a refrigerator at 4°C (home consumer conditions). To our knowledge, few published data is available concerning the effect of postharvest storage in particular cold storage and freeze drying on the nutritional composition of sprouts belonging to the families of *Brassicaceae* (radish, *Raphanus sativus* L.), *Fabaceae* (mung bean, *Vigna radiata* L. Wilczek and lentil, *Lens culinaris* Medik.) and *Poaceae* (wheat, *Triticum aestivum* L., and barley, *Hordeum vulgare* L.). The five species were selected based on the results of a preliminary experiment carried out on 14 species. The aim of this study was 1) to assess the influence of cold storage at 4°C for 1, 2, 3, or 4 days and also 2) to compare fresh and freeze dried (i.e. lypophilised and stored for 30 days) sprouts in terms of protein content, mineral composition, total soluble solids, lypophilic and hydrophilic antioxidant activities (LAA and HAA, respectively) of the five selected species. Irrespective of the days of storage, the highest protein, P and K contents, LAA, HAA and the lowest nitrate content were observed in radish followed by mung bean sprouts. When averaged over the five species, the storage of 7-day-old sprouts at 4°C for 4 days decreased significantly the P and K concentrations as well as the LAA. The nutritional qualities of freeze-dried sprouts in particular protein content, mineral composition, total soluble solids, LAA and HAA were similar to the fresh sprouts, whereas the nitrate content was inferior. Moreover, the rehydratation test showed that freeze-dried sprouts recovered in five minutes more than half of their initial water content. These findings will allow for a better understanding of the variation in nutritional values of selected seed-sprouts, from a nutritional or consumer perspective, and will assist producers in identifying the optimum species-specific postharvest storage for achieving high nutritional value in a sustainable way.

Keywords: Antioxidant activity, postharvest storage, proteins, refrigeration, sprouting

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Impact of cooking and storage on apricots fruit microconstituents

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Apricots are a rich source of phenolics and carotenoids that may contribute to reduced risks of chronic diseases. However, because of the seasonal availability, apricots are commonly consumed after processing and storage. The different thermal processing methods have been shown to reduce polyphenolic and carotenoid levels in fruit. However information is lacking on how different methods and storage influence the phenolic and carotenoid composition and their content in processed apricots.

Four apricot cultivars were processed in two different ways: home cooking (85°C) and industrial processing (95°C). Cans from industrial processing were analyzed immediately and after storage of 2 months at ambient temperature. Phenolics and carotenoids were quantified by HPLC with diode array detection.

Industrial processing caused a significantly higher loss of total phenolics compared to domestic cooking. Upon cooking, procyanidins were retained in apricot tissues while flavan-3-ol monomers and hydroxycinnamic acids were partially leached into the syrup. Due to leaching of flavan-3-ol monomer procyanidin's DPn significantly increased from fruit to canned products. Anthocyanins were not significantly altered by heat treatment. Total carotenoids exhibited no significant change after heat processing. However among carotenoids, a cis-β-carotene isomer was significantly increased after industrial processing, but with lower amounts after domestic cooking.

No significant losses were observed for total phenolic compounds after two months in cans at ambient temperature, this was mainly due to procyanidins which were stable over time. However, flavan-3-ol monomers, hydroxycinnamic acids and anthocyanins were significantly lower in the fruit after storage. Total carotenoids compounds significantly decreased over the storage period.

Based on HPLC data, carotenoids were more stable than phenolics after heat treatment. Carotenoids and phenolics in fruit decreased with storage time. More interestingly, this study indicates that apricots are a rich source of procyanidins, having profiles similar to those found in apples. Processing changed not only the content of procyanidins in apricot products but also the relative ratio of the different molecular weights.

Keywords: processing, procyanidins, β-carotene, β-carotene isomerization

Apricot texture: variability as a function of cultivar, influence of maturity and impact of cooking

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Apricot (*Prunus armeniaca* L.) is a fleshy fruit of real economic and nutritional interest. The rapid loss of fruit firmness is a decisive factor for quality and to decide apricot use (fresh or processed) and commercialization ways (short or storage). To better understand the texture heterogeneity in apricot, we studied the impact of the harvest stage and the effect of a heat treatment (cooking) on a large range of cultivars. Specific measurements on different areas of fruit flesh aimed to select the best criteria to type cultivars and to identify those suitable for an industrial process.

Twenty apricot cultivars were characterized at three maturity stages before and after cooking (85°C in light syrup). A compression test allowed to sort the fruits according their pressure value and to obtain homogeneous batches between cultivars. Puncture tests were performed on different areas of the flesh for fresh and cooked apricots and Kramer shear tests provided global firmness of cooked fruits [1].

Texture loss upon cooking varied greatly between the twenty varieties assessed. Among the four areas studied, the median areas (pistil and equatorial) of apricot flesh were the best areas to discriminate varieties suitable for processing. Maturity stages were better characterized by the indicator «Work to Limit (J)" of the under-epidermal pistil area of cooked fruits and as well as by the shear test.

Comparison of fresh and cooked characterizations allowed us to classify the apricot cultivars and to define a typology according to their ability to tolerate an industrial process at the most appropriate maturity stage.

Keywords: Prunus armeniaca L., Penetrometry, Flesh firmness, Flesh heterogeneity

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Contribution to the valorization of Algerian wheat (*Triticum aestivum* and *Triticum vulgar*) through the study of its antioxidant and cytotoxic properties.

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Introduction. *Triticum aestivum* and *Triticum vulgar* are one of the most important staple cereal crops that cultivates worldwide due to their highly nutritious values. They were used primarily as a source of energy [1].

Materials and Methods. Ethanol extracts of durum wheat (*Triticum aestivum*) and wheat common (*Triticum vulgar*) were studied for their different contents of antioxidants (total phenolics, flavonoids, flavonols, ortho-diphenols, proanthocyanidines, vitamin C and carotenoids) and antioxidant activities using radical species ($DPPH^{\bullet}$, $ABTS^{\bullet+}$, $OH^{\bullet}$, $NO^{\bullet}$, $O_2^{\bullet}$, ROS), non-radical (H_2O_2), reducing power tests (ferricyanide, phosphomolybdate and FRAP). Iron chelator power, xanthine oxidase and antiproliferative activities were also determined.

Results and Discusson. *Triticum aestivum* was found to be the richest in flavonoids, flavonols, proanthocyanidins and orthodiphenols with 987.521785 mg E Q / 100 g, 71.677 mg E Q / 100 g, 143.333 mg EC / 100g and 2108.583 mg EAG / 100g, respectively. While *Triticum vulgar* contained more phenolic compounds (4688.615 mg EAG / 100 g of powder), vitamin C (36.29 ± 0.49 mg AsAc / 100 g.) and carotenoids (4.85 µg EβC / 100 g). Antioxidant activity assays showed the best radical scavenging effects against DPPH, ABTS, OH, ROS, NO and XO was attributed to *Triticum aestivum*. This wheat was also able to scavenge efficiently H_2O_2 and in FRAP, phosphomolybdate and iron reduction assays. Higher ferric chelating power and O_2 scavenging activity were exerted by *Triticum vulgar*. Cytotoxic effect against tumoral human glioblastoma cells (U87-MG) was considerable in the presence of Triticum aestivum extract with 53.96 ± 5.89% of cell viability.

Conclusions. Obtained results indicated that *Triticum aestivum* contained more antioxidant components and exhibited higher antioxidant capacities than *Triticum vulgar*. *Triticum aestivum* inhibited also strongly the growth of cancer cells (U87). Wheat species may be a promising alternative to synthetic substances as natural compound with high antioxidant and antiproliferative activities.

Keywords: Wheat, Antioxidants, Antioxidant activities, Cytotoxic effect

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Mediterranean long storage tomato as a source of novel products for the agrifood industry: nutritional and technological traits.

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Introduction Long storage tomato is a crop traditionally cultivated under no irrigation in the semi-arid areas of Italy. It provides a niche product that combines a good taste with excellent nutritional properties [1,2]. Recently, consumers and local industries have great interest on this crop as a new source of products for industrial purposes. A research was carried out to assess some characteristics which affect the fruit suitability to processing, in two landraces of long storage tomato, as compared to the Hy. 'Brigade' of processing tomato.
Materials and methods Plants were grown during summer 2012 in a flat site of South Italy. Water was applied at transplanting only (41 mm). For the control, two water regimes were applied: irrigation at transplanting (dry) and irrigation for the whole growing season (irrigated). At harvest, tomatoes were sampled and analyzed for fruit size, total solids (TS), total soluble solids (TSS), pH, titratable acidity (TA), sugars, firmness, Vitamin C (AA), carotenes (lycopene and -carotene), polyphenols, antioxidant activity.
Results and discussion Long-storage tomatoes produced total yields lower than control. This last, however, had up to 45% yield loss under no irrigation. TS in local types were as high (10.4 g/100g, on average) as those of dry control (10.2 g/100g). To this regard, long storage tomatoes are suitable to be processed (for juice or concentrates). The high TSS content (>8.0 °Brix in both landraces) is an important aspect in tomato crop since it is well known that a high TSS content of the fruit improves the efficiency throughout the industrial process. The high TSS content compensates for the moderate yield levels of the plant, resulting in a TSS yield (>1.5 t /ha) greater than that of dry control (0.9 t /ha). The high sugars, vitamin C and polyphenol content, greater that those of control, highlight the high nutritional fruit quality in long storage tomato.
Conclusions The results reveal the suitability of long storage tomato fruits to processing industry, both as whole canned (due to the small fruit size) or concentrates (due to high TS). Also, tomatoes with great TSS content require less energy to evaporate water from fruit, with interesting economic implications.

Keywords: Long storage tomato, total solids, soluble solids, polyphenols, carotenes, vitamin C

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Modified atmosphere for preventing browning and preserving quality of Deglet Nour date

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Date fruit (*Phoenix dactylifera* L.) possess a socioeconomic and nutritional importance for Sahara population especially in Arabian word. The Deglet Nour variety is very appreciated for its soft honey-like taste, its translucent aspect and its high nutritional value in addition to its therapeutic virtues. Producers of Deglet Nour keep it in cold storage to prevent drying and slow the browning before sale. However, the fruit browns quickly after it got out of the cold room, its taste changes and becomes bad, thus, loses its organoleptic properties and market value.

The effect of two modified atmospheres (MAPs) low in oxygen on browning and quality of harvested Deglet Nour date previously stored in cold, was studied for one month through analysis of the modification of color and weight, contents of water, ascorbic acid, total soluble solids and quinones with pH and titratable acidity. Gas mixtures injected were: 2% O_2, 20% CO_2 for the first modified atmosphere (MAPI) and 2% O_2, 5% CO_2 for the second one (MAPII).

Till the 14th day of storage a significant decrease in quinones content was observed with samples of the two modified atmospheres against control (air conditions) and an increase of ascorbic acid. Control samples were the lowest in weight and water content, with comparable pH, titratable acidity and total soluble solids to both atmospheres' samples. External color changed slightly (an increase in a* and a decrease in L*) for the two modified atmospheres' fruits compared with control. Both atmospheres, especially MAPII maintained fruit quality by slowing browning and loss in water, total soluble solids, titratable acidity and ascorbic acid. This limits the amount of waste dates and economic losses due to the deterioration of this precious functional food.

Keywords: Phoenix dactylifera, modified atmosphere packaging, browning, nutritional quality

Vitamin C degradation during thermal treatment: reaction pathways in an aqueous solution and multi-response modelling

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Vitamin C is an essential nutrient mainly found in fruit and vegetables, with contents around 20 to 200 mg/100 g. Two forms of vitamin C can be encountered naturally, ascorbic (AA) and dehydroascorbic acids (DHA) which constitute the reduced and oxidized forms of the molecule, respectively. AA is rather unstable and its degradation depends on environmental parameters (pH, temperature, light, oxygen concentration, and presence of metallic catalysts). The reactions involved in vitamin C degradation in real food products are difficult to identify due to the multiplicity of pathways. It is therefore necessary to perform studies focused on solutions designed to mimic the pH and ionic strength of a fruit.

The experiments were conducted in a reactor equipped to control precisely temperature (50 to 90°C) and oxygen partial pressure (10 to 30%) in the solution. A malate buffer (20 mM pH 3.8) was used as reaction support. It was equilibrated in temperature and oxygen concentration before injecting an AA or DHA concentrated solution to start the reaction. Samples were then taken at several times and used to quantify AA and DHA. AA was measured by spectrophotometry at 243 nm after a 1/50 (V/V) dilution in metaphosphoric acid (3%). DHA was measured similarly after reduction into the AA form.

Specific experiments were conducted in order to check the activation of the different reactions pathways identified in literature. AA can be thermally degraded without oxygen to form furfural [1]. In aerobic conditions, AA is oxidized in DHA which is unstable in solution and further degraded [2]. The reduction of DHA into AA is also possible [3] and was demonstrated in anoxia. The degradation kinetics of AA showed a coherent behaviour with faster degradation at higher temperatures and oxygen Pctages, and DHA being formed and disappearing. The same temperature dependence was observed for DHA degradation. All the reaction pathways found in literature were shown to be active in the studied temperature and oxygen domains, leading to the definition of a multi-response modelling with the four elementary reactions and able to predict the vitamin C evolution (AA and DHA) in simple aqueous solutions.

The model adequacy with experimental data was very good but some limits remain concerning the chemical sense of some parameters, questioning the transfer to food at this stage of development and needing to be further explored.

Keywords: Ascorbic acid, dehydroascorbic acid, kinetics, thermal degradation, redox systems

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Apple procyanidins inhibit lipid oxidation in in vitro gastric digestion: effect of the emulsifier, pepsin and pH.

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Background: The gastric tract may be the first site where humans are exposed to postprandial oxidative stress and antioxidant activity by plant micronutrients. After food intake, dietary iron, dioxygen and emulsified polyunsaturated lipids come into close contact and substantial lipid oxidation may take place [1,2]. The primary lipid oxidation products, i.e. hydroperoxides, may not reach the intestine but rather decompose in the stomach into hydroxy fatty acids, aldehydes and epoxides [3], which once absorbed may participate in the atherogenicity of LDL.

The aim of this work is the in vitro investigation of lipid oxidation possibly taking place in the gastric compartment and its inhibition by common dietary polyphenols. In particular, oligomeric procyanidins (PCs), whose content in the diet is probably largely underestimated, deserve more detailed investigations.

Material and Methods: Sunflower oil-in-water emulsions stabilized by proteins (bovine serum albumin, sodium caseinate) and/or egg yolk phospholipids were designed in order to model the physical state of lipids after ingestion of a western diet. pH was set at 5 or 3 to simulate the initial and the middle phases of gastric digestion, respectively. Lipid oxidation was initiated at 37°C by metmyoglobin, the red pigment of meat and lipid-derived conjugated dienes and aldehydes were kinetically monitored. Epicatechin (the PC monomer) and two apple oligomeric fractions of PCs were probed for antioxidant capacity in comparison to the highly antioxidant flavonol quercetin. In a further step, the digestive enzyme pepsin was added to go closer to real gastric physiology.

Results/Discussion: Over 3 h of *in vitro* digestion at pH 5, pepsin decreased slightly the strong antioxidant capacity of polyphenols in the PL model without affecting that in the BSA model. At pH 3, polyphenols no longer inhibited lipid oxidation whatever the presence or absence of pepsin. This suggests a large inability of the phenolic compounds to interact with the hematin cofactor released from metmyoglobin at pH < 4. Moreover, no protection was afforded in systems containing NaCas.

Conclusion: Overall, lipid oxidation in gastric-like conditions mostly depends on the emulsifier type when the inhibitory effect of dietary polyphenols appears effective in the early stage of digestion.

Keywords: polyphenol, emulsion, antioxidant capacity, *in vitro* modelling,

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Effects of the processing technique on the retention of bioactive compounds and volatiles in organic and conventional strawberry jams

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Strawberry (*Fragaria* × *ananassa* Duch.) is a common fruit, widely consumed both fresh and processed. Nutritional properties are related to the content of ascorbic acid and secondary plant metabolites, such as phenolic compounds (mainly anthocyanins and ellagitannins). Thermal processing of strawberry is known to cause detrimental effects on the nutritional and sensory quality. Whatever the processing method chosen, retention of these compounds decreases with longer processing time and higher processing temperatures. The aim of this study was to analyze the influence of an innovative mild technology for jam production, carried out under vacuum and at low temperature (e.g., 50°C), on the preservation of bioactive compounds and volatiles. Jams were prepared from strawberries grown with organic and conventional cultivation system. Additionally, the effect of the mild technology was compared with a traditional home-made jam made from organic strawberries. Fresh strawberry (cv. Asia) jams were compared with "control jam" made up with freeze-dried strawberries and not subjected to thermal heating. Ascorbic acid (AA) was quantified by HPLC-UV/VIS while anthocyanins (ATH), total polyphenols content (TP, Fast BB Blue method) and Folin-Ciocalteu index (F-C) were determined by spectrophotometer. For the volatile analysis, samples were extracted using HS-SPME and analyzed with GC-MS. Cultivation showed no influence on AA and F-C, while ATH and TP were significantly lower in conventional compared to organic strawberries. The content of AA decreased in the jams obtained with the mild process, with a greater loss in conventional jams (−83.5%) compared to organic ones (−62.6%). The same trend was observed for ATH (−75.3 and −68.3%, respectively). Home-made jams showed significantly higher losses of both AA (−86.1%) and ATH (−90.3%) compared to jam obtained with the mild technology. TP appeared stable after processing, except in home-made jam where TP decreased by 44.9%. F-C did not vary after mild processing while it decreased in home-made jams (−26.3%). Volatiles were generally higher in organic products (e.g., mesifurane), albeit the variability among samples did not allow to reveal statistically significant differences. The volatile profile seemed mostly affected by the processing rather than the cultivation system. As an example, methyl butanoate almost disappeared in processed strawberry jams. Interestingly, we observed that esters of organic strawberries were mostly retained in traditionally home-made jam. This study showed that the proposed mild technology could better preserve the bioactive compounds, particularly in the case of organically grown strawberries.

Keywords: phytochemicals, ascorbic acid, anthocyanins, nutritional quality, thermal heating

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Dissolved oxygen in aqueous solution of ascorbic acid and dissolved oxygen in apple purée at 80°C

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Oxygen is known to accelerate ascorbic acid degradation [1,2] Up to 100°C oxygen is still soluble allowing ascorbic acid oxidative degradation. In addition, ascorbic acid is not the only molecule that is oxidisable in a food matrix. In apple purée, polyphenols for example can be supposed to consume oxygen too. Oxygen availability is known to be a limiting factor at low temperature, but up to now for oxidation of ascorbic acid quantification of dissolved oxygen at high temperatures was very difficult. A double walled system was employed that permitted to maintain temperature and measurement of oxygen at precise locations. Oxygen sensor spots specially calibrated for intermediate temperatures were therefore stuck at the inside and measurement was conducted from the outside without disturbing the system. Oxygen was followed at the bottom, near the surface and the headspace. Besides, convection vs. diffusion processes were compared by using a colorant. Oxygen contents in ultrapure water heated up to 80°C were of 0.07 ± 0.00 mmol/l. Oxygen values in the sensor of the headspace were equal to those in the medium which can be linked to water saturation of the headspace. When ascorbic acid was added, oxygen values in the medium decreased initially then slowly rose again. Oxygen content curves in the two locations in the medium were equal. The curves approached asymptotically the level in ultrapure water but did not achieve it completely within eight hours. In apple purée, values dropped down within 15 min to almost anaerobic conditions (0.01 ± 0.00 mmol/l) and remained constant over the measurement time. Besides, darker coloration compared to the rest of the medium was noticed only at the very top layer of apple purée. By putting the blue colorant methylblue at the surface of the heated apple purée convection processes could be excluded to appear in apple purée as the colorant was spread in regular circles indicating diffusion. This was linked to the viscous matrix of apple purée as in the liquid supernatant of centrifuged apple purée convection was observed. To conclude, dissolved oxygen in apple purée at 80°C is quickly consumed and thus oxygen's diffusion from the headspace and ascorbic acid's diffusion to the surface limit ascorbic acid's degradation.

Keywords: Vitamin C, intermediate temperature, dissolved oxygen, applesauce

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The color space of French ciders

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The French ciders present different hues and are more or less saturated: the color of classical ciders lies between pale yellow to orange/brown, mainly due to neoformed compounds coming from the oxidation of polyphenols. Recently appeared on the market "rosé ciders", that are produced using red-fleshed apples varieties. The pink color of these ciders is usually due to anthocyanins and/or their derived compounds.

To describe the color diversity of French ciders, color data (L*a*b*) of 161 ciders were used. Cider were centrifuged (7500 g 15 min) and filtrated (cellulose ester membrane - 0.45 µm) and the colour parameters - Hue, Value and Chroma - were measured using a Minolta spectrophotometer CM 3600d (Minolta Co. Ltd, 3-13, 2-Chome, Azuchi-Machi, Chuo-Ku, Osaka 541, Japan).

The projection of ciders on the equatorial plane a*b* (at L* = 0), showed that most of conventional ciders are spread along the b* axis (from 8 to 65) at low values of a* (from −3 to 13). These color data L*a*b* can also be expressed as polar coordinates (L*C*h) using terms that are more common for color description: the hue (h°) that is given by the angle, lies between 78° and 98° corresponding to yellow / orange, and the chroma that is given by the distance from the center of the space to the cider position, lies between 8 and 66. The lightness (L*) ranges between 75 and 98 but most of ciders were located over 80 indicating a very bright color. This lightness parameter was strongly correlated to chroma and to the interaction chroma / hue. Given this strong link with the hue and chroma, it is possible to describe the ciders color using only the two dimensions h° and C*, the third one (L*) being calculated as a function of hue and chroma. This function can also be used to calculate the lightness of "rosé" ciders. These ciders are mostly situated at lower hue angles (from 49° to 80°) with high dispersion: in fact, these ciders constitute a continuum of color between red/pink and orange hues of classic ciders. The color being the first sensorial perception of the consumers, this characteristic could become a central concern for cider marketing, especially in the case of rosé ciders. Based on the description of the color space of ciders, this study established a color chart that can be used by cider makers to describe their ciders in order to better control the visual characteristics of processed products.

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Characterisation of phenolic compounds in Algerian honeys by RP-HPLC coupled to electrospray time-of-flight mass spectrometry

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Introduction. Honey is produced by honeybees from the nectar of plants [1]. Honey possesses valuable nourishing, healing and prophylactic properties, which result from its chemical composition. It has potential therapeutic value in the treatment of heart disease, cancer, cataracts and several inflammatory diseases. Although the major components of honey are sugar and water, it has a wide range of minor constituents, such as phenolic compounds, which may possible be responsible for the biological activities of honey.

Materials and Methods. Twenty five g of honey were thoroughly mixed with 5 parts of acidified water (pH 2 with HCl) until completely fluid and filtered through cotton to remove solid particles. The filtrate was then passed through a glass column (50 x 5 cm) filled of amberlite XAD-4 resins (20–60 mesh, mean pore size 40 Å. The separation of the phenolic compounds from honey extracts was performed using an Agilent 1200 Series Rapid Resolution Liquid Chromatography system (RRLC, Agilent Technologies, CA, USA) equipped with a vacuum degasser.

Results and Discusson. Several phenolic compounds are identified in Algerian honeys by HPLC-ESI-TOF-MS. These compounds are characterized by their retention times (3.7 to 28.59 min) and absorption in the UV. Phenolic acids are eluted at first (before 16.50 min), exception for cinnamic acid (20.74 min). Myricetin is the first flavonoid eluted. Retention, in general, followed the expected reversed-phase pattern of benzoic acids < cinnamic acids < flavonoid glycosides < flavonoid aglycones. Honey samples share 9 phenols (4-hydroxybenzoic acid, isorahmnetin, luteolin, chrysin, galangin, apigenin, pinobanksin, kaempferol and pinocembrin). Caffeic, *p*-coumaric and vanillic acids were detected in 34 samples, exception for M09, syringic acid in 33, benzoic acid in 32, quercetin in 30, ferulic and 4-hydroxyphenylacetic acid in 29 and isosakuranetin in 27 honey samples. Cinnamic and 3,4-dihydroxyphenylacetic acids, genistein in 22 honey samples.

Conclusions. The present study has confirmed that RP-HPLC-ESI-TOF MS is a powerful tool for the identification and quantification of flavonoids in a complex matrix like honey. The results are promising and show that Algerian honeys contains a lot of phenolic compounds. A more extensive analysis is needed in order to establish others floral markers.

Keywords: Honey, Botanical origin, Phenolic compounds, HPLC-MS

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Perspectives of the contents of organic acids in Bio rhubarb

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Rhubarb is a perennial crop well adapted to the temperate climate but it is not well known and cultivated as a traditional crop. The main quality characteristics are the taste and aroma, and these depends on the chemical composition. A special interest has been shown by scientists regarding the quantitative and qualitative content of the organic acid. In the scientific literature are mentioned 32 organic acids in rhubarb products [1]. Malic acid is a predominant one, and citric acid and oxalic acid are present in a smaller quantity in the rhubarb stems [2]. Because the malic acid is degraded more quickly than other acids, it is also clear that the rhubarb's edible parts lose their acidity and therefore storage lasts a short period. The citric and tartaric acids in fruits and vegetables are the hardest to degrade, and a higher content in these acids favors and maintains a higher Pctage of the ascorbic acid content. The aim of the present study is to highlight the influence of the rhubarb cultivar and crop density on the content of some organic acids (malic, tartaric, oxalic, citric, ascorbic) in an organic crop. This research was carried out in the experimental field of the Agricultural University from Iasi. To achieve the goal and objectives of this research, a bi-factorial trial was established: Factor A–cultivar (cv.) with two graduations, "Glaskin's perpetual" (GP) and "Local population" (LP) and factor B–plant density, with two graduation, 9090 plants·ha^{-1} and 12 120 plants·ha^{-1}. The trial was organized in a split plot design, with three replicates. The organic acids in the samples were separated and determined using absorbance, then quantified with the calibration graphs, on wavelengths of 254 nm for ascorbic acid, and 214 nm for other organic acids [3].

The significance of acid content and yield was established by ANOVA, based on the Fisher test. The highest content of organic acids was determined in LP at a density of 9090 plants·ha^{-1}; the following quantities of acids for 100 g fresh weight (FW) were determined: tartaric – 486 mg, oxalic – 343 mg, citric – 41 mg, malic – 686 mg and ascorbic – 437 mg. In this present paper, we have demonstrated that content of organic acids from edible rhubarb parts varies according to crop density and cultivars, except for malic acid.

Keywords: Cultivar, density, tartaric, oxalic, citric, malic, ascorbic compounds

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Poly-phenols and antioxidant capacity of the sweet pepper under microbiological and conventional fertilization

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Vegetables growing, mainly in the greenhouses and plastic tunnels use more chemical inputs, which are often detrimental to the accumulation of active principles in the edible parts of plants. Sweet peppers belong to the genus *Capsicum* which is reported to be an excellent source of polyphenols, particularly flavonoids, such as quercetin and luteolin [1].

The aim of this experiment was to obtain the necessary answers if the fertilization regime can or can't influence polyphenol and flavonoid contents as well as antioxidant capacity from sweet pepper fruits. To achieve this goal, during 2015 an experience at the Agriculture University from Iasi was organized, in a split plot design with three replications using the Brilliant cultivar. The four sweet pepper samples were analyzed at their consumption maturity. The fertilizing regime as well as three variants like: V_1 – soluble chemical fertilizer applied by drip irrigation; V_2 – chemical fertilizer applied classically and V_3 – microbiological fertilization, were compared with a Control (V_4). The total content of poly-phenols was spectrophotometrically analyzed, using the Folin–Ciocalteu method. The calibration curve was performed using Gallic acid as a standard (100–1400 µg/mL). The total flavonoid content was determined using the colorimetric method based on its reaction with aluminum chloride. The calibration curve was made using as a standard routine (50–500 µg/mL).

The antioxidant capacity was determined through two methods: DPPH and $ABTS^+$ assay [2]. The antioxidant activity was determined through the method of inhibition of free radicals DPPH. The $ABTS^+$ assay determining antioxidant capacity, uses radical cation 2,2-Azino-bis (3-ethylbenzothiazoline-6-sulfonic) acid ($ABTS^+$). The phenolic compounds total content, total antioxidant activity and color of dried products, obtained by spouted bed and tray drying techniques, were compared using Tukey's test to determine significant differences among the values at the level of 95% [3].The highest total polyphenol content was registered in the fertirigation version (355 mg GAE/100 g dw), followed by a version where a biological fertilizer (254 mgGAE /100g) dw was used. The total content of flavonoids, higher was registered in fertilized variant microorganisms, respectively 110.35 equivalent rutin /100 g dW. The antioxidant capacity determined by the two methods was higher for the biological fertilized variant, 214.6 µmol /100g dW ($ABTS^+$) and 182.1 µmol /100g dW (DPPH). In the fertigation version the lowest values of antioxidant capacity were registered, regardless of the method of determination. The methods of fertilizer were applied to the crop of peppers and fertilizers used on the crop of peppers in greenhouses, along with different influences antioxidant capacity and the flavonoid polyphenol content of fruit.

Keywords: Capsicum annuum L., phenolic compounds, antioxidant capacity

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Determination of kinetic constants and degradation products of formyl folates derivatives, during heat treatments and oxygen exposure.

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Folate is a vitamin group consisting of water-soluble vitamers, which differ by the nature of the substitution (N5 or N10), the oxidation degree and the length of the glutamate tail. A sufficient supply is effective in reducing neural tube defects, cardiovascular and neurodegenerative diseases. Green vegetables are a major source of folates in European diets. They are most often consumed after processing (industrial or cooking), which can lead to folate losses due to heat degradation and oxidation. The main folate vitamer studied in model solution or during industrial processing still is 5-methyltetrahyrofolate. Therefore, we aimed to determine the kinetics parameter and the degradation products for two other vitamers abundant in green vegetables, namely 5-formyltetrahydrofolate (5-HCO-H_4folate) and 10-formylfolic acid (10-HCO-PteGlu), during heat treatment and in the presence of an oxidation catalyst.

Kinetics were carried out in ammonium buffer pH 5 and 7 and in water at room temperature, 85°C and 100°C. Kinetics were also carried out in the presence of hydrogen peroxide. Samples were collected for 4 hours and analysed by LC-MS and FT-ICR. Kinetics were modelled, degradation rate constant (k) and activation Energy (Ea) were determined according to the first order equation. As compared with 5-HCO-H_4folate, 10-HCO-PteGlu remained quite stable over 4 hours with a maximum of loss of circa 50% in maximum. 5-HCO-H_4folate was highly degraded during the kinetics. The main factors involved in losses during the kinetics were the temperature and the concentration of hydrogen peroxide. Degradation and transition products of 5-HCO-H_4folate were identified by LC-MS as 10-HCO-PteGlu, methenyltetrahydrofolate, and para-aminobenzoyl glutamic acid. Further compounds were detected by LC-MS and tentatively identified by FT-ICR. Our study enabled to identify the degradation kinetics constant and degradation compounds of formyl folates, which is relevant for understanding folate degradation mechanisms during vegetables processing.

Keywords: folates, heat treatment, oxidation, degradation, kinetics

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Effect of mild heat shock treatments against pink discoloration on physiological parameters of fresh-cut iceberg lettuce

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Pink discoloration of fresh-cut lettuce is one of the major quality issues occurring when produce is exposed to oxygen. Nowadays fresh-cut industries apply a so-called active modified atmosphere in the package. Starting with a low oxygen atmosphere in the hermetically closed package this leads within 3 days to virtually anaerobic conditions. The absence of oxygen prevents the oxidation of phenolic compounds responsible for pink discoloration. Although effective in preventing pinking, these storage conditions lead to other major quality losses such as fermentation, production of off-odour and growth of lactic acid bacteria. the application of mild heat shock treatment on fresh-cut lettuce has been shown to reduce the activity of the Phenylalanine Ammonia Lyase (PAL) responsible for the production of phenolic compounds and of pink discoloration symptoms. However, little is known about the effect of heat shock treatment on the vitality of the plant tissue. In the present study we have investigated the effect of several heat shock treatments on the desensitisation of lettuce to pink discoloration and on tissue vitality. The optimal heat shock treatment that significantly reduced pinking without damaging the tissue was found within a really narrow range of temperature and application time. The heat shock treatments claimed in literature as being optimal were often in our study too strong and irreversibly damaged the cell membranes of the treated fresh-cut lettuce. Once the optimal heat shock treatment has been selected, we investigated its effect on the PAL activity and on the respiration rate of the fresh-cut lettuce during the complete storage period. We concluded that heat shock treatment permitted to significantly reduce the PAL activity during the first 5 days of storage. This resulted in significant reduction of the pink discoloration of the produce. In the meantime, heat shock treatment increased the respiration rate of the produce during the complete shelf life period compared to the non-treated fresh-cut lettuce. It was concluded that packaging should be optimised to suit the heat shock associated higher respiration rate parameters of the treated product in order to be able to extend significantly its shelf life.

Keywords: fresh-cut lettuce, PAL activity, Electro-conductivity, Heat-shock treatment

Bactericidal Effectiveness of Mild Heat on Resident Flora of cv. Salak Apricot

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Apricot takes a significant place in human diet in terms of its vitamin, mineral and phenolic content. Turkey is the main apricot producer of the world. One of the most important production centers in Turkey is Igdir province which produces 17,782 tons/year. 85% of the apricots in this area are Salak variety and it is specific to the region. However, Salak apricot has a short shelf life due to its climacteric nature and favourable conditions for microbial growth. Drying is one of the traditional processing techniques to prolong the shelf life of apricots. Yet, it is not applicable for Salak variety due to its low dry matter content. Therefore alternative methods are urged to be used to increase the shelf life of this specific apricot type. Mild heat (MH) treatment is one of the alternative ways to conventional heat applications. Heat treatments were reported to effectively inhibit enzymatic reactions and reduce microbial loads. Nonetheless, adverse impacts of heat on flavour, texture and other quality parameters of the products discourage its use. Thereby application of MH is of great interest. This technique avoids negative effects of heat treatment.

To the best of our knowledge, there is no study about the microbial quality improvement of Salak apricot by MH treatment. Hence, the aim of this study was to elicit the influence of MH application on the inactivation of resident flora of Salak apricots.

Salak apricots were firstly characterized in terms of some physicochemical properties. Then MH treatment at different time (10–60 min) and temperature (40–60°C°C) combinations was applied in a temperature controlled water bath. Samples were vacuum packed before dipping into the water to prevent structural damages and loss of solutes. Microbial loads were determined using standard plate count method.

As a result, Salak apricots were categorized as very big sized (average weight of 59.316 g), mature, cylindrical shaped and yellow coloured fruits. Application of 60°C for 60 min ended up with a 3.87-log reduction in total aerobic count whereas yeasts and moulds were not detected on plates when temperatures above 50°C was applied. It can be concluded that mild heat treatment was able to effectively reduce natural flora of the apricots. Results are promising in terms of shelf life extension of the fruit. However the best time-temperature combination in terms of fruit quality needs to be further investigated.

Keywords: cv. Salak apricot, mild heat, resident flora, inactivation

Microstructural changes in cooked apricots related to the loss of texture

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Introduction. The quality of the apricot products is largely defined by their texture, which is significantly lost upon processing. The pectin properties of apricots may play an important role in this loss of texture, even more than the initial firmness, but this is not yet well understood [1]. This study aims to identify a varietal differentiation in the texture-loss properties and to link them with microstructural changes, with a final goal of understanding the mechanisms that influence the texture loss in apricot.

Materials and Methods. Fruits were selected from four varieties at similar ripening stages, which were determined by their firmness using a compression test [1]. The apricot halves were cooked at 85°C in sugar syrup and their texture was measured by the maximum force in the penetrometry test [1]. Microstructure changes were revealed by ruthenium red staining (pectin) and LM19 immunolabelling (unmethylated and low-methylated pectin) [2].

Results and Discusson. Variety largely influenced the loss of texture. Orangered was the variety with higher resistance to the texture loss (67% of the initial firmness), followed by Hargrand (74%), Iranien (75%) and Goldrich (86%). The tissues did not show severe damaging after cooking, however, some microstructural changes could be observed. The cells lost turgor as demonstrated by the higher sinuosity of the cell walls. Some intercellular spaces swelled, creating round-shaped microstructures filled with unmethylated pectin, as showed by LM19. Their presence across the varieties showed to be in line with their resistance to the loss of texture. Varietal differences in the biochemical properties must have prompted the ease of pectin to be leached from the tissue or to be retained within the intercellular spaces.

Conclusions. We identified a link between the creation of intercellular microstructures and the loss of texture. This study opens the possibility of understanding the creation of these microstructures and the biochemical properties that are implied, which is in the interest of the food industry for the elaboration of higher quality apricot products.

Keywords: fruit softening, thermal treatment, pectin, cell wall

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Suitability of the "calçots" (*Allium cepa* L.) for minimal processing

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"Calçots" are the floral stems of the second-year onion (*Allium cepa* L.) resprouts with an economical importance in Catalonia (northeast Spain). The demand and interest in exporting "calçot" as a ready-to-cook product has motivated producers to develop a new agricultural commodity. The development of a high-quality fresh-cut "calçot" requires considering their suitability for minimal processing and providing optimal processing conditions.

Pre-conditioning steps consisting of trimming short or cutting completely roots, cutting off external leaves (1, 2, 3 or 4 cm) from the edible white part and removing the outer peel were compared in terms of respiration rates and visual quality. Optimization of the packaging material was carried out comparing films with different permeabilities (100 to 5000 $cm^3m^{-2}(24\,h^{-1})\,atm^{-1}$). Sanitizing methods consisting of 100 ppm sodium hypochlorite (NaClO) (1 or 5 min) or hot water at 55°C (1 or 2 min) immersed treatments were evaluated. Microbial counts, colour, firmness, headspace gas composition, weight lost and visual quality were evaluated in all fresh-cut samples throughout 15 days of storage at 4°C. Pre-conditioned "calçots" with short roots and external leaves cut at 4 cm achieved the lowest respiration values and the highest visual quality scores. Removing the outer peel reduced significantly the natural harvesting microbial load. Products packaged using a film permeability of 5000 $cm^3m^{-2}(24\,h^{-1})\,atm^{-1}$ reached balances of 5% of O_2 and 3% of CO_2 after 15 days maintaining excellent visual quality. About 2 log reductions in the aerobic mesophilic bacteria counts were achieved after NaClO or hot water sanitizing treatments, irrespective of the washing time. In terms of moulds and yeast populations, no differences were observed between the decontamination treatments reaching almost 2.5 log reductions after washing. No proliferation of microorganisms was observed during the storage period. Fresh-cut "calçots" immersed in hot water (1 min) kept higher lightness values than chlorine-treated products during storage. Both thermal treatment and cold storage might induce inactivation of oxidative enzymes and slow the browning rate. Firmness values of all samples increased during 15 days of storage and was positive correlated with a slight loss of weight indicating surface dehydration. Since "calçot" presents good aptitude for minimal processing, exploration of new sanitation and processing strategies for this horticultural product could have additional quality benefits.

Keywords: "calçot", minimal processing, sanitation, quality

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Temperature control and other treatments to maintain the quality of fresh-cut nopalitos

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Nopalitos, the tender green stems of the Prickly Pear cactus (*Opuntia* spp.), can be grown under conditions unfavorable for production of other nutritious green vegetables. Currently at supermarkets, nopalitos are trimmed, spines removed, and chopped for a value-added product with a short shelf-life. A fresh-cut product with longer shelf-life is needed to increase the competitiveness of nopalitos in the value-added vegetable category. While modified atmospheres have been shown to be useful, this study focused on the potential benefits of processing treatments and storage temperatures. Nopalitos (20 cm long) were obtained from Milpa Alta, Mexico, cooled, and processed at 7.5°C by rinsing in 200 ppm NaOCl 5 min, removing spines and trimming ends and sides with sharp stainless steel knives, and cutting into strips 1–1.5 cm wide. The pieces were then rinsed in 100 ppm chlorinated water, treated with hot water (50°C, 5 or 10 min), or dipped in 5 or 10% ethanol or other solutions. The fresh-cut nopalitos were placed in unsealed LDPE packaging and stored at 5°C. In other tests, the fresh-cut nopalitos rinsed in chlorinated water were stored in unsealed bags at 0, 2.5 or 5°C up to 18 days. Nopalito strips were evaluated periodically for marketable quality (9 = excellent appearance to 1 = unusable, with 6 the limit of marketability), decay, and cut-edge browning (1 to 5 scale, 1 = none, 5 = severe) with 3 replicates of 10 strips each per treatment. L*a*b* color values were measured on the cut edges, and respiration rates were measured at 5°C. Storing the fresh-cut nopalitos at 0°C retarded discoloration and increased shelf-life to 18 days compared to 12 and 5 days at2.5°C and 5°C, respectively. A hot water dip increased shelf-life of fresh-cut nopalitos to 14 days at 5°C compared to 9 days for untreated, ethanol, or zinc chloride dipped pieces. Neither the hot water dip nor other processing treatments affected the respiration rates of the nopalitos. A 10% ethanol dip was more effective than 5% to control discoloration. Dips with zinc chloride alone and combined with ethanol or naturally produced sulfurous volatiles in a modified atmosphere package also retarded discoloration. As with other fresh-cut vegetables, good sanitation and low temperature storage are requirements for quality retention of fresh-cut nopalitos, while other treatments may provide additional benefits for quality retention.

The combined effect of US and enzymatic treatment on nanostructure, carotenoid retention and sensory properties of ready-to-eat carrot chips

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Introduction. Recent studies, describing the possible positive effect of ultrasounds on carotenoid retention during plant material drying, are emerging as an innovative technological option for novel food programming. The presented study is aimed at evaluating the changes to nanostructure, sensory perception and other characteristics of carrot chips, after ultrasound application.
Materials and Methods. The carrot variety 'Belgrado' was cut into 2 mm slices. Before the drying stage (85°C) slices were subjected to 20 min US pretreatment (25 kHz, 0.4 W/cm^2) and then soaked in a light sucrose solution (110 g/L) with (US-EN-S) or without (US-S) the addition of pectin lyase preparation (2 g/L). The carotenoid content was determined using the HPLC method. The cell wall pectin fractions were determined using the colorimetric method. Cytological studies of chromoplasts were carried out using an optical microscope, while the molecular structure of pectins was characterized by atomic force microscopy. Final product was subjected to sensory assesment.
Results and Discusson. Both US and enzymatic treatment caused noticeable changes in pectin fractions of carrot. The most considerable, being a decrease in galacturonic acid content after enzymatic treatment. Both ultrasounds and enzymes caused molecular transformations of diluted alkali soluble pectin fraction in the form of shortening the skeleton length. Moreover, ultrasound application resulted in decrease, whereas enzyme action – substantial increase in the diameter of pectin polymers. US turned out to be a less effective factor in enhancing carotenoid retention during the drying process of carrot chips than the enzymatic treatment (0.20 and 0.26 mg/100 g dm, respectively). However, applying both factors simultaneously (US-EN-S) resulted in significantly higher carotenoid retention (0.35 mg/100 g dm). In the case of US treatment the carotenoids in chromoplasts were kept in big crystals, while in sample cells treated with enzyme big carotenoid aggregates underwent disintegration and even dilution.
Conclusions. Although some degradation of molecular structure of pectin polymers in carrot cell walls was observed after tissue sonication, their chemical composition was not significantly influenced. In the case of enzymatic treatment, similar degradation of pectin self-assembly was noticed, however, a considerable increase of pectin solubilisation was found. Finally, the combination of US and enzymatic treatment resulted in obtaining dried carrot chips of highly vivid and attractive colour as well as good bioactive component retention.

Keywords: sonication, carotenoids, AFM, structure, quality

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Influence of drying methods on sensory and mechanical attributes of strawberries fruits

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Technological processes designed to extend the shelf life of food, should maintain its sensory and mechanical properties to provide the best quality and attractiveness of the product.

The purpose of this work was to examine the effectiveness of drying methods (vacuum drying (VD: 35, 45, 55°C), hot air drying (AD: 45°C) and freeze drying (FD: 45°C) for strawberry fruits while considering sensory and mechanical attributes. The sensory evaluation of dried strawberry samples was performed using the quantitative descriptive analysis (QDA). Mechanical properties were tested using the TA-TX2 2i texture analyzer for deformation of 25% of the height at the cross-head velocity of 0.3 mm/s. Dried strawberries with low moisture content ranging from 0.17 to 0.75 g(g dm)$^{-1}$ were sustainable.

It was found that dried strawberries significantly differed in their sensory profile due to the drying process. Evidently the lowest intensity of aroma attributes was reported for AD fruits. Along with lowering the set temperature in a vacuum drying method the intensity of the aroma of cooked and fresh strawberries increased and the intensity of dried strawberry aroma decreased. The dried fruits obtained by vacuum and air drying represented a similar intensity of the cooked strawberries flavour. The lowest intensity of cooked strawberries aroma with high-intensity of fresh strawberries flavour, higher level of sour taste and lower sweetness were obtained in FD. Moreover, with lowering the temperature in VD, the sensation of crispness and crunchiness decreased, and the impression of gumminess increased in dried strawberries. The highest quality had strawberries dried by FD method, while the lowest by AD. Analyzing dried materials, obtained at the same temperature (45°C) by using different drying methods it was found that VD strawberries were characterized by higher hardness than those obtained by AD, but significantly lower than dried fruits obtained by FD. Strawberries obtained by vacuum method at 55°C were harder than fruit dried at lower temperatures. In addition, the drying process at the highest temperature was characterized by the compression curve with a lot of refractions, which may be a result of presence of large spaces in the dried cellular structure caused by evaporation of water at the highest set temperature. The highest compressive force had VD strawberries (45°C), the lowest – AD strawberries.

The presented research will give the answer which drying method is the best for drying strawberries and what is the relationship between physicochemical and sensory properties for sustainable products.

Image analysis of defrosted strawberries during vacuum drying

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Structure changes of strawberries during drying can be evaluated by collecting photos and analysing dimension changes of samples using simple visual inspection or in detail with the application of computer image analysis with the appropriate software.

The purpose of this work was to examine the influence of drying conditions on the kinetics of dimensions and shape attributes. Defrosted strawberries of the Senga Sengana variety were dried in vacuum and convective dryers. These analyses present variants of vacuum drying for the constant setting parameters of two drying temperatures (70 and 50°C) and two pressures (4 and 16 kPa) and for variable drying parameters with a step change of temperature or pressure. Furthermore, with the appropriate chosen temperature, two stages of combined process vacuum-convective and convective-vacuum drying were also carried out. Changes in the quality of strawberries have been described by fruit shape factors. Measurements of strawberries were performed with the use of MultiScanBase software (CCS, Warsaw, Poland). The shape factors of strawberries were calculated based on the fruit dimensions (diameter, height, surface) obtained by imaging from a side camera. The shape attributes have been calculated only in the vacuum stage of drying. Linear models and ANOVA were used to interpret the results. Tukey's test was carried out to examine the statistic assumptions.

The chosen linear models confirmed the influence of drying parameters on the changes in shape attributes of strawberries during drying. Drying experiments show that at lower temperatures strawberries were more labile with the pressure level. The influence of the drying temperature on shape attributes is lower at lower pressures. Shape attribute changes were more significant for convection-vacuum than for vacuum-convection drying. The most favorable drying conditions were gained at a drying pressure of 4 kPa and a drying temperature of 70°C. Experiments show that such a high temperature is required only at the beginning of drying. Step changes in the temperature to lower values for drying under a 4 kPa pressure did not significantly affect shape attribute changes. Incidental step changes to a higher drying pressure in the vacuum dryer caused a rapid decrease in the fruit size. The linear models with different coefficients for each type of presented drying revealed that the method and parameters of drying have an influence on the size and shape attributes of strawberries. It follows, therefore, that shape attributes could be used as an indicator of quality degradation in the drying process of strawberries.

Apple enrichment with β-glucan by vacuum impregnation and PEF treatment

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During last years the metabolic activity of oat beta-glucan has been studied more and more extensively what reveals its antioxidant and anti-inflammatory activity regardless the molecular weight besides its multidirectional potential in the reduction of LDL cholesterol, blood glucose levels, bowel transit time, preventing the constipation and reducing the risk of colorectal cancer and degenerative disease such as obesity, hyperlipidemia, cardiovascular and hypertension [1]. Several attempts have been made for incorporation of β-glucan in the formulation of processed foods as dairy, fruit juices, sausages, bakery products or chocolate. However, few data have been found about the incorporation of β- glucan inside the matrix of biological tissues and the interaction between them. Therefore, Vacuum Impregnation (VI), which consists on the replacement of air in porous tissue (such as apple) by an external solution [2], and low-voltage Pulsed Electric Fields (PEF) which consist on the poration of the cell membrane [3]could create an interesting opportunity and suitable method to incorporate β-glucan inside the biological matrix.

The aim of this research was to evaluate the possibility of the introduction of β-glucan inside the apple tissue by VI and coupled with PEF. In this context, apples were impregnated with sucrose (13%), β-glucan (0.5%) + sucrose (13%) and β-glucan (0.5%). PEF treatment was carried out by applying an electric field strength of 100 V/cm and 60 number of pulses. β-glucan content, water mobility by Nuclear Magnetic Resonance (NMR), a_w, x_w, texture and image analysis were performed. The results showed that it was possible to enrich apples with β-glucan (5.1–7.4% w/w), improving their health benefits. NMR results showed a redistribution of water through the substructures of the cells according to the different treatments. Texture and colour of the apples were mantained after both VI and PEF treatment.

Nowadays, there is a growing demand of products with high nutritional values. To the our knowledge this work is the first one aimed to enrich apple with β-glucan, however further studies need to be done to face the limitation of the treatment cost and the stability of β- glucan during the storage.

Keywords: apple, Pulsed Electric Fields, β-glucan, vacuum impregnation, NMR

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Traditional cooking affects the microstructure and starch digestibility of potatoes: an *in vitro* study

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Potato (*Solanum tuberosum* L.) is an important supplier of carbohydrates in the human diet. However, it has been classified as a high glycemic index (GI) food. Early studies have been showed that the GI of potato could be significantly affected by cooking methods [1]. In the present study, the effect of cooking methods, including boiling, frying and Chinese stir-frying with vinegar, on starch digestibility and the microstructure changes in potatoes (Heshiwu) were investigated with an *in vitro* digestion model [2] and scanning electron microscopy (SEM).

The cooked potato starch was minimally hydrolyzed in a simulated stomach; the hydrolysis Pctage increased during small intestinal simulation. The hydrolysis rate was 82.21% (boiling), 68.19% (stir-frying), and 53.45% (frying). The SEM assay indicated that the microstructure of potato starch granules swelled to optimum levels after boiling, whereas mud-like surfaces were observed after stir-frying with vinegar and oil-immersed and compact surfaces were observed after frying.

Our results indicated that potato starch digestibility should be influenced by the modification / destruction of the microstructure during domestic cooking [3]; Chinese stir-frying with vinegar can be suggested as an alternative cooking method to slow down starch digestibility.

Keywords: potato, domestic cooking, *in vitro* digestion, microstructure, starch digestibility

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Multiblock Analysis Used to Establish the Relationship Between the Optical Parameters of Apple Fruits and Their Textural Properties.

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Non-destructive measurement of the characteristics of fruit is one of the cornerstone lines of research in sustainable assessment of fruit quality. Among them, the measurement of optical properties spectroscopy is a very promising emerging technique. This work examines the relationship between the optical properties of absorption and scattering of light with their particular organoleptic characteristics of texture and mechanical parameters. Three data blocks were thus established from the experimental data and analyzed using the multiple co-inertia analysis. The spatially resolved laser spectroscopy was applied to two hundreds fruits within two varieties of apples (Golden Delicious and Gala). In parallel, sensory texture analysis and penetrometry measurements were implemented on the same fruit. The results highlighted the importance of the scattering optical parameter μ's to discriminate those two varieties. This parameter was also negatively correlated to the maximum force and to sensory attributes such as firmness and crunchiness.

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Improved sweet cherry varieties obtained by crossing "Picotas" with other cultivars

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Introduction. Some appreciated varieties of Spanish sweet cherries namely "Picotas" (Ambrunés, Pico Negro and Pico Colorado) protected with the designation of origin "Cereza del Jerte" are decreasing in their production. Their main characteristic is a good abcission of the stalk during harvest. Most of their physicochemical properties are well considered by the consumer, but its size is generally lower than other commercial varieties. In order to improve Picota cultivars about 2000 crosses with other parentals were made. 19 of these crosses were selected by their good agronomic characteristics. Physicochemical and physiological characteristics of these selected new cultivars were compared with their parentals (Hudson, Sweet Heart, Staccato, Utah Giant and Picotas).
Materials and Methods. Methods used in the determination of the quality parameters are mentioned in parentheses. Weigh, force necessary to stalk separation (Texturometer), colour and texture (Durofel), solid soluble content (SSC) (Refractometer), titratable acidity (Titrator), ethylene and respiratory metabolism (gas chromatography).
Results and Discusson. Picotas showed a low average weight (7 g) while commercial parentals presented 10 g, only 2 cultivars showed over 9 g. 4 new cultivars had force of stalk separation similar to Picotas (4–6 N). However the other varieties reached similar values to the other parentals. The tested crosses did not show significant changes in color (top value, Ctifl scale) and texture (>80%, durofel scale). It is remarkable that although all parents had dark colour, 3 of the varieties were bicolor. Approximately 50% of the varieties showed high SSC values (>20 °Brix), similar to Picotas. All cultivars showed higher acidity than Picotas parentals, some of them over 1% of acidity (expressed as malic acid). Most of cultivars have respiratory intensity (<60 mg of CO_2/(kgh)) lower than common levels in Picotas. No noticeable differences in ethylene production were found between parentals and varieties.
Conclusions. Only 3 of the studied varieties (2 Ambrunés × Utah Giant and 1 Ambrunés × Sweet Heart) showed the typical characteristics of Picota, mainly stalk abcission, while improving their size. Ambrunés seems to be the most adequate parental to obtain new improved Picota cultivars. Shelf life of most varieties had been improved, since the respiratory metabolism was lower than those found in Picota parentals.

Keywords: Sweet cherry, Picota, new cultivars, postharvest characteristics

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Impact of mechanical treatment and particle concentration on fruit suspensions stability

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From a physical point of view, fruit juices and purees are suspensions of plant cells particles. The quantity of cell walls necessary to clutter up the medium is about 1%. Understanding fruit and vegetable suspensions rheology is very challenging since the particles are highly deformable with no specific volume (particles are able to pack). Nevertheless, particle content and size have been identified as major parameters for rheology and texture of processed fruit and vegetable suspensions. The objective of this work is to confirm the structural parameters that control the rheological behaviour of plant cells dispersions related to the texture of the products and to pave the way for stabilization methods of fruit suspensions limiting the use of additives. Two species presenting different cellular structure were studied as examples: apple (*Malus domestica* Borkh. cv Golden Delicious) and acai (*Euterpe oleracea* Mart.).

On the one hand, a large range of reconstructed apple suspensions varying in particle content (from juices to purees) and particle size was prepared. Three particle size distributions were obtained by mechanical treatment only to avoid any impact of thermal treatment on the rigidity of the cell walls. Then, a separation-reconstruction step was realized to formulate suspensions in their own aqueous phase varying in particle content. Twelve levels of particle content were prepared. On the other hand, the impact of homogenization on the stabilization of acai juices without any additive or with a natural one (lecithin or xanthan gum) was carried out. Two treatments were undertaken: laboratory scale colloidal mill (rotor-stator) and high pressure homogenization (HPH).

This study confirms that solid content, particle size and shape have a major impact on rheological behaviour and stability of fruit suspensions. Rheological parameters with the particle content. Three concentration regimes were highlighted depending on the concentration of insoluble solids, in both flow and dynamic measurements on apple suspensions:

Diluted domain: Particles size and shape have little effect on rheology.

Semi-diluted domain: Existence of a weak network between particles.

Concentrated domain: The dependency between viscosity and concentration decreases. Particles begin to pack and their volume becomes lower than their equilibrium volume.

These results suggest that a very small amount of particles allows structuring the medium by creating a weak gel, which was confirmed by the results obtained on acai juices. For original juices without additive or treatment, a strong decantation appeared in the first 30 minutes. Using rotor-stator homogenizer or HPH allowed the decantation to be avoided for 2 weeks, by the establishment of a weak network of dispersed particles.

The two selected examples illustrate the potential of mechanical treatments to better control the rheology and texture of concentrated suspensions such as purees, or the stability of more dilute systems such as fruit juices. The functionalization of dispersed particles by mechanical treatment is a key parameter for innovation in fruits and vegetables domain.

Quality of processed tomatoes in response to water stress

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Tomato (*Solanum lycopersicum* L.) is one of the largest horticultural crops in the world with more than 160 million tons produced per year. A large proportion of tomatoes is processed and represents important sources of phytonutrients in the human diet. Processed tomatoes require a lot of water, and therefore, in the context of global climate changes, constitute a valuable target for water saving strategies in agriculture. However, reducing water may impact not only yield, but also modify the reactivity of tomato to the process by modifying fruit tissues structures or soluble and structural component. Therefore, we design a study to evaluating the effects of two water irrigation treatments on tomato production and fresh fruit quality, also including strategic industrial quality attributes of processed tomatoes, i.e. puree viscosity, dry mater content and colour after processing. The objective was also to investigate the putative crosstalk between quality parameters of fresh cut tomatoes and processed tomatoes. Two industry-type-tomato genotypes differing in fruit color, dry weight and soluble material content and over a period of 55 days were grown in a glasshouse with 100% of replacement of evapotranspiration. After 56 days, the irrigation was reduced to only a replacement of 60% of the ETP for the stressed plant while irrigation remains constant for controls. From the anthesis of the first flowers, soil humidity, leaf water potential, leaf conductance and fruit growth were monitored on control and stressed plants. Then after, 12 fruits per genotype and water treatment were collected, evaluated for their colour, fresh and dry weight, and processed in a hot break way. Colour, soluble solids, treatable acidity, viscosity and dry weight of purees were then evaluated. We found that the water stress impacted significantly all quality parameters of fresh or processed tomatoes whereas the genotype only affected the colour parameters and the percentage of dry weight of fruits and purees. Interestingly, the water stress increased the a* value, the viscosity, and the soluble solids of the purees by 69.06%, 106.97% and 105.65% respectively. In addition our results revealed that the a* value of purees and the treatable acidity were linked to the a* value of fresh fruit. The percentage of dry weight of fruit was a good indicator of puree viscosity in our study. The results indicate that a reduction of in water can bring increases in desirable characteristics sought by the industry and contribute to a rational use of water source.

Keywords: viscosity, soluble solids, treatable acidity, color, irrigation

Fate of the main quality, nutraceutical and taste active compounds in conventional and organic tomatoes (Solanum lycopersicum L.) subjected to different drying techniques

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Tomato is well known for its large content in healthy compounds and it is widely used in the food processing industry. Drying is a very popular way to process tomatoes, also in small scale plants or as home-made technique. Processing can lead to positive modifications of the main quality and sensorial characteristics, however it can have a detrimental effect on nutraceutical compounds, affecting phytochemicals differently. In order to evaluate the fate of these compounds, fruits of a commercial variety ("Perbruzzo") and a local variety ("Saab-CRA"), from conventional and organic cultivations, were subjected to two drying techniques, one conventional in forced-air oven (OD samples), and one innovative in a miniaturized plant (http://mieri.entecra.it) utilizing solar irradiance (SD samples). Both kind of samples were compared to control freeze-dried (FD) samples. Sugars, organic acids, vitamin C and polyphenols were quantified by HPLC, while total carotenoids were determined by spectrophotometer. Selective extractions monitored by TLC analysis were performed in order to detect amino acids or small peptides (the putative taste-active compounds), whose identification is currently ongoing. The main sugars, i.e. glucose and fructose, decreased after drying, with a better retention in SD (60%) than in OD (5%2) compared to FD. "Saab-CRA" showed a lower sugar loss with respect to "Perbruzzo". In OD samples, fructose was much more preserved than glucose (62% and 41%, respectively). Compared to FD, the organic acid content decreased in OD but not in SD. However the solar drying had a significant effect on the organic acid composition, since citric acid was reduced by 60As expected, vitamic C was strongly depleted after drying, while carotenoids were well retained or increased in SD (+48%). Quercetin-derivatives appeared partially preserved in dried samples, particularly in OD (88% of retention compared to 50% in SD). Interestingly, in SD "Perbruzzo" maintained quercetins better than "Saab-CRA" (64% vs 36%), while in OD a greater retention was found in organic (99%) with respect to conventional (67%) samples. Naringenin-chalcone completely disappeared after both drying, while 5-hydroxymethyl-furfural, a marker of thermal process, appeared only in OD. These results highlight that compounds may be differently affected by the type of drying, as sugars and carotenoids are better preserved in SD, whereas quercetins are largely retained in OD. Consequently, the choice of the appropriate processing can be a key factor in preserving certain classes of quality or nutraceutical compounds.

Keywords: processing, small scale plants, quality changes, phytochemicals

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Preparation, characterization and enzymatic degradation of edible tender cladodes "nopalitos" (*Opuntia ficus-indica*) cell walls and their impact in the development of healthy foods

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Edible tender cladode "nopalito" has been consumed for centuries as a vegetable in Mexico in its fresh or processed form [1,2]. In this study, edible tender cladodes (*Opuntia ficus-indica*) were processed for alcohol insoluble solids (AIS) preparation. AIS materials were characterized for enzymatic degradability with polysaccharide degrading enzymes, by means of infrared spectroscopy (IR), color, and liberated reducing sugars. A commercial enzyme preparation, pectinase and/or purified enzymes feruloyl-esterase and laccase were tested. AIS yield was 2.47% and IR spectrum showed absorption signals in the region of 1731 cm^{-1}, which indicated the presence of low methoxylated pectic substances. Signals corresponding to the polysaccharides fingerprint in the region of 1600–1700 cm^{-1} were observed. Color parameters were L* 85.67 ± 1.29, a* 2.35 ± 0.17 and b* 15.73 ± 0.27. According to reducing sugars liberated, pectinase enzyme preparation degraded the AIS from nopalito cell walls, and combinations of pectinase/laccase showed synergy among them. Feruloyl-esterase and pectinase did not improve the release of reducing sugars from AIS of cladode. The greatest degradation was achieved by pectinase, followed by the combination of pectinase/laccase due to the enzyme activity that the enzyme preparations contained. Modification of edible tender cladode "nopalito" with polysaccharide degrading enzymes promote generation of tailor-made carbohydrates for development of Mexican healthy foods.

Keywords: Pectinex Ultra-SPL, pectin-galactan, nopal

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3 / Constraints on F&V processing: microbial, safety and waste management issues

Effect of ethylene scavengers on firmness and colour of globe and cherry tomatoes stored at two temperatures

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Tomato (*Lycopersicon esculentum*) is a climacteric fruit that produces ethylene and is sensitive to exogenous ethylene. Ethylene can induce negative effects including senescence, over-ripening, accelerated quality loss, increased fruit pathogen susceptibility, and physiological disorders, among others. The aim of this study was to evaluate the effect of ethylene scavengers on tomato firmness and colour. Freshly harvested globe tomatoes at ripening stage 4 and 7 and cherry tomatoes without vine was packaged in sealed containers with and without ethylene scavenging sachets. The packages were perforated with an acupuncture needle in order to gain close to air atmospheric conditions with maximum 5% CO_2. The packages were stored at 10°C for 10 days, and at day 10, half of the packages were moved to 20°C for further storage simulating both chill and room temperature storage in the grocery shop. Due to higher respiration rate at 20°C than at 10°C, a higher number of needle holes was made in the packages stored at 20°C. During the storage time for 24 days, samples were withdrawn at day 0, 10, 17 and 24 for analysis of gas concentration, firmness and colour. The gas concentrations in the packages stabilised at approximately 16 to 19% O_2 and 3 to 5% CO_2, respectively. The packages with ethylene scavenging sachets had no ethylene, whereas the packages without scavengers had ethylene concentrations between 1 to 8 ppm. The firmness of the tomatoes was in the order global (ripening stage 4) > global (ripening stage 7) > cherry tomatoes, and the mean firmness decreased with 4.6 units (N) from day 0 to day 24. The globe tomato with ripening stage 7 showed the largest firmness reduction. The areas with the greenest colour (hue° at approximately 90) developed a red colour (hue° in the range 40 to 50) within 10 days of storage at 10°C. The ethylene scavenger had significant effect on lightness, whereas no significant effect was found for the changes in chroma and hue angle. The main findings was that ethylene scavenging sachets removed ethylene in the packages, but no significant effects of the ethylene removal was detected on the firmness or colour development of the tomatoes during the storage period.

Keywords: gas analyses, Minolta colour measurement, texture analyser

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Impact of different thermal preservation technologies on the quality of apple based smoothies

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Increased consciousness about the importance of health promoting compounds in processed fruit products lead to creation of novel products as smoothies, containing the majority of phenolics and fibers from raw fruits, compared to e.g. clear juices. Smoothies can be enriched by less known fruits which could push up the health value of these products, however all these products have to be preserved by physical methods to ensure safety and long shelf life during marketing.

Typical pasteurization of viscous product is immersion pasteurization which due to thermal resistance of liquids and package takes a long time. In contrast flow pasteurization needs only a few seconds to raise the temperature to inactivate enzymes and kill microorganisms, which should improve the retention of health promoting compounds. These two typical processes were compared to microwave flow pasteurization which is a novel preservation technology. Pasteurization technologies were tested on apple based smoothies of different composition: apple smoothie containing 10% of rose hip juice and 0.02% of beta carotene or 20% of wild blueberry juice. Experiments were made in two technological replications. Total phenolics, anthocyanins, ascorbic acid, carotenoids, pectic substances and viscosity were measured in smoothies after production. Sensory tests were also made.

Total phenolics content in smoothies after production depended only on type of juice added to apple base. Smoothies with wild rose hip juice exhibited higher content of total phenolics than those with blueberry addition. Sum of beta carotene and their isomers originating from wild rose hip juice was stable irrespectively of the thermal treatment method and was on the average 0.35 mg/ 100g of product. Anthocyanins content was measured in smoothies with blueberry addition and it strongly depended on the preservation method used; the highest anthocyanins content 17.7 mg/ 100g was found in microwave preserved smoothies while in batch pasteurized samples there was only 12.8 mg/ 100g. Ascorbic acid in juices was the highest in flow pasteurized juices (29 mg/ 100g), while microwave treatment lead to a significant decrease (21 mg/ 100g).

The effect of thermal processing on viscosity of smoothies was also observed; microwave pasteurized smoothies were characterized by significantly higher viscosity than for other methods (296 cP vs. only 207 cP). These results are in agreement with the results of pectic substances determination which contents was the lowest for batch pasteurization and the highest in microwaved smoothies. This may suggest that the process can interact with microstructure of the smoothies and may affect the quality during shelf life. However, sensory evaluation made after processing did not reveal any significant effects of the preservation method on products quality.

Keywords: apple smoothie, thermal treatment, phenolics, viscosity, carotenoids

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Lemon grass essential oil as natural food preservation: investigation on volatile compounds, in vitro antifungal activity and control of *Saccharomyces cerevisiae* in real fruit juices

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In spite of the use of all available means of food protection, spoilage of foods is still a major problem in different parts of the world. Yeasts and filamentous fungi are widely distributed in nature and are responsible for the microbiological spoilage of an extensive range of food. Alternative sources of safe, effective and acceptable natural preservatives need to be explored, such as essential oils. Natural antimicrobials can be used alone or in combination with other novel preservation technologies to facilitate the replacement of traditional approaches in food preservation.

The antifungal activity of Algerian Lemon grass (*Cymbopogon citratus*) essential oil (LGEO) was evaluated against several food spoiling yeasts and molds through disc diffusion and vapour diffusion methods.

The chemical profile of EO, characterized through Gas Chromatography-Mass Spectrometry (GC–MS) analysis, revealed geranial (42.2%) and neral (31.5%) as major components.

LGEO exhibited promising antifungal effect against *Candida albicans*, *C. tropicalis* and *Aspergillus niger*, with different inhibition zone diameters (IZD) (35–90 mm). Significantly, higher anti-Candida activity was observed in the vapor phase. The yeasts *C. albicans* and *C. tropicalis* were inhibited completely by the LGEO vapors at 60 µL per disc. Moreover, the zone of inhibition increased with increasing oil volume.

Furthermore, the anti-yeast efficacy of LGEO oil alone and in combination with thermal treatment was evaluated in a real food system (Orangina juices). The samples treated with a combination of LGEO at 0.2% and 0.16% and thermal treatment enhanced the reduction viability. Present results established the superior performance of integrated (thermal-LGEO) treatment over the individual exposure (LGEO alone) for Orangina juice preservation. Results confirmed the effectiveness of LGEO in providing an immediate and significant protection of Orangina juice to yeast proliferation.

Keywords: Essential oils, Food preservative, Lemon grass, Orangina juices, Thermal treatment, Yeast

Development of a "dry" bio-refinery for total valorization of fruits and vegetables by-products.

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Fruits and vegetables (F&V) are an important source of valuable molecules, including flavonoids, polyphenols, terpenes, vitamins or dyes. After processing, current F&V industry generates considerable amounts of by-products that contain highly valued compounds [1,2], yet that are generally considered as waste. The valorization of food by-products has become a new challenge for industry and academics, which resulted in the development of the bio-refinery concept. Inspired by petrol chemistry refinery processes, it aims at recovering various materials from a single biomass [3].

Here presented work is based on the original "dry" bio-refinery of food by-products. The novelty of this work relies on the extraction of compounds achieved without addition of solvent or water. The only water used in the process was the constitutive water extracted from the very biomass. To recover different fractions, bio-refinery concept was applied using green extraction processes (microwave and ultrasound assisted extraction) and quality of the corresponding extracts was determined. Ultimately, the performances of bio-refinery using green extraction and conventional extraction were compared as far as extraction performance, process time, energy consumption, quantity of waste and quantity of solvent, are concerned.

The bio-refinery concept was applied to several F&V products. As far as ginger by-products (press cake recovered after juice processing) are concerned, the "dry" rather than the conventional bio-refinery appeared to be a greener process as it resulted in shorter time of extraction and in lower energy consumption and quantity of organic solvent used and in reduced amount of waste. Even though the extraction performance was lower as compared to the conventional bio-refinery, the objective of the study was achieved as the valorization of ginger by-products was total and it resulted in highly valued products without the use of additional solvents. Indeed, ginger rhizomes yielded in a juice, an essential oil, an extract rich in phenolics, and a solid residue rich in fibers and phenolic acids.

Keywords: bio-refinery, fruits and vegetables, valorization, microwave, ultrasound

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Growth ability of psychrotrophic *Bacillus cereus* in carrot broth and laboratory medium

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Improving elderlies' nutrition is an increasingly important stake in European countries considering the ageing of the population. The aim of the FP7-OPTIFEL project is to create new food products based on fruits and vegetables, supplemented with specific nutrients to fight elderlies' nutritional deficiencies. The microbial safety of these products is of great importance due to the high risk of foodborne disease in the elderly population. The foodborne pathogen *Bacillus cereus* can resist to pasteurization treatments and psychrotrophic strains can multiply during refrigerated storage. Understanding its behaviour during the life cycle of food products, particularly during cold storage is essential because the new food products developed in OPTIFEL would have a shelf life of 4-5 weeks under refrigeration. The aim of this study was to determine the growth ability of psychrotophic *Bacillus cereus* in different types of medium with various conditions.

Growth of the psychrotrophic *B. cereus* strain KBAB4 in a carrot-based substrate was measured at cold and optimal temperatures, in presence and absence of oxygen, and compared to that obtained in a laboratory medium (BHI) providing optimal nutrient supply to the bacterium, to infer the ability of carrot to support *B. cereus* growth in the tested conditions. Then, impacts of food additives relevant to the FP7-OPTIFEL project have been tested.

Combination of aerobiosis, pH < 5.7 at 10°C, or anaerobiosis at any pH and temperatures <8°C prevented psychrotrophic *Bacillus cereus* growth in BHI. However, the psychrotrophic *B. cereus* strain KBAB4 did not grow in a heat sterilized carrot substrate, even at optimal temperature, presumably because of the strong heat treatment applied on the carrot. These data on *B. cereus* behaviour will be confronted and will be used as guidance to help new product development.

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Decontamination of dry foods by Vaporized Hydrogen Peroxide (VHP)

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The food industry widely uses dry and dehydrated ingredients and additives (fruits, vegetables, spices, starches, proteins, hydrocolloids, etc.) for the formulation of heat preserved foods. Some of those raw materials display however a poor microbiological quality, related to their contamination in heat resistant spore forming bacteria, unsuitable for proper use in the canning industry. Decontamination of dry ingredient leads in many cases to technical difficulties, due to their high sensibility to heat, moisture, together with the high heat resistance of spores in a dry state. New decontamination technologies and processes, alternative to moist heat or ionization, are therefore needed for the decontamination of dry food products.

Liquid H_2O_2 biocide solution was injected in automated dispersion system and vaporized in suitable proportions in warm dry air stream : an air + steam gaseous mixture (Vaporized Hydrogen Peroxide – VHP) was then obtained for uniform distribution of the sporicidal agent The low moist, warm gas is then kept in direct contact with dry food for several minutes in close containers. The effectiveness of VHP for the destruction of heat resistant spores, vegetative bacteria and viruses was demonstrated in several studies. Destruction is achieved through chemical oxidation at low temperature (60°C) and low relative moisture (<5% steam), therefore with moderate impact on dry ingredients.

Exploratory work confirmed that different VHP treatments were likely to destroy highly resistant spores forming bacteria, (wild strains of *Moorella*, *Thermoanaerobacterium*, *Geobacillus stearothermophilus* and *Bacillus coagulans* isolated from spoiled canned foods) when the spores were deposited in dry state on biological indicators (stainless steel samples) *G. stearothermophilus* spores were destroyed with suitable efficiency, better than *Moorella* spore. Following steps were performed on five artificially contaminated dry food products – spices and dehydrated vegetables, submitted to VHP treatments. In some cases, nature of the food (i.e. garlic powder) impacts the decontamination effectiveness. Our results shows that more than 2,5 logs of heat resistant spores can be destroyed within less than 10 minutes treatments at low temperature: the VHP treatment is efficient and likely to decontaminate dry and dehydrated products with limited impact on the food characteristics.

Keywords: dry food, spores, decontamination, hydrogen peroxide, vaporized.

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Growth and sporulation conditions of *Moorella thermoacetica* ATCC 39073 and spore heat-resistance

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Moorella thermoacetica, a thermophilic anaerobic bacterium, is found in 36% of 55°C non-stable spoiled LACF analyzed between 2001 and 2010 by CTCPA [1]. This species can form spores able to survive sterilization process and germinate, leading to food alteration. A better understanding of the growth and sporulation abilities of this bacterium according to conditions encountered during canning process would provide clues to limit non-stability occurrence without increasing sterilization temperatures.

Thus, growth and sporulation were studied for *M. thermoacetica* ATCC 39073 at optimal temperature with or without pH regulation. Heat-resistance was also determined for spores produced on rich solid medium. Non-regulated cultures were performed in AMSCO flasks at 55°C in DTBmod medium under CO_2 atmosphere. Regulated growth was conducted in pH-controlled batch fermentor at 55°C in DTBmod continuously sparged with CO_2, inoculated either with a late-exponential-phase pre-culture or a heat-activated spore suspension. Growth was followed by optical density (OD) measurements, total bacterial and spores counts. Growth parameters (maximum growth rate, μmax and lag phase) were determined using modified Gompertz model [2] applied to OD measurements. Three batches of spores of the reference strain were produced on MLA plates at 55°C and heat resistance was determined in phosphate buffer at pH 7.0.

During growth of *M. thermoacetica* in regulated conditions, a strong decrease of pH from 7 to 4,5–5 was noticed. Surprisingly, the initiation of sporulation was triggered during early exponential growth which could result from the pH decrease of the medium, as observed for solventogenic Clostridium organisms [3]. However, *M. thermoacetica* also sporulated under regulated optimal conditions, showing that the decrease of pH was not directly responsible for the initiation of sporulation. Moreover, a strong decrease of redox potential from about −300 mV to −500 mV was noticed during regulated growth. In regulated and non-regulated conditions, the μmax was similar. The lag time was estimated at 8.3 h and 17 h for regulated cultures inoculated with cells and spores respectively. Spores produced at 55°C exhibited a mean $D_{130°C}$ of 5.7 min.

Our results showed that *M. thermoacetica* ATCC 39073 was able to trigger sporulation during early exponential growth phase at optimal temperature whether pH was regulated or not. Spores of *M. thermoacetica* were shown to be highly heat-resistant. This also highlights the potential of *Moorella* to form highly resistant spores in canned food industry. Further work is running to understand high heat resistance of *M. thermoacetica*.

Keywords: fermentor, spores, heat-resistance, spoilage, LACF

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Valorisation of mango by-products

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Mango (*Mangifera indica* L.) fruit is popular for its taste, its organoleptic qualities but also its nutritional interest. They are sources of various polyphenols with important antioxidative activities. The presence of polyphenolic compounds in the human diet is associated with protective effects against some chronic-degenerative diseases related to oxidative stress. Each part of a mango tree, such as its leaves, flowers, bark, fruit, pulp, peel and seed kernels contains essential nutrients that can be utilized [1]. The concentration measurements of peels have shown significant differences between the cultivars [2]. These differences can to be explained by the origin of the samples, cultivars, stage of maturity and the extraction method used. Peels and seed kernels of mango constitute an important part of the fruit. However, only the pulp is concerned by mango processing industry used. Those by-products generated are a major source of waste and becoming a source of pollution. Because they are rich in flavonoids, xanthones, carotenoids, fats, pectines and many others utilizable components, peels and seeds can be converted to value addition in some food or nutraceuticals products. Valorisation of by-products allows to generate more revenue and reduce environmental pollution [3].

Keywords: Mango, by-products, polyphenols, peel, kernel

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Antimicrobial potential of commercial silver nanoparticles and the characterization of their physical properties toward probiotic bacteria isolated from fermented milk products

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The application of nanotechnology in the agriculture and food sector is relatively new approach in comparison with its usage in medical sector. Therefore, this paper presents a study of the effect of silver nanoparticles on probiotic bacteria based on the example of *Lactobacillus acidophilus* LA-5, *Bifidobacterium* BB-12 and *Streptococcus thermophilus* ST-Y31 isolated from fermented milk products. Probiotic bacteria are one of the most crucial groups of bacteria for the food industry, because of their claimed health-promoting properties. Studies have shown that the type and concentration of silver nanoparticle solutions have a significant impact on the tested probiotic bacteria which are profitable for the digestive system. In particular, *St. thermophilus* was relatively more sensitive to the Ag nanoparticles than *Lactobacillus* and *Bifidobacterium* in the dilution method as opposed to the disk-diffusion method. The concentrations of 2 μg mL^{-1} and 0.25 μg mL^{-1} had the highest antibacterial activity and statistically significant impacts on the tested probiotic strains. To our knowledge, this is the first report on potential antimicrobial effect of nanosilver against the health-promoting probiotic bacteria *L. acidophilus* LA-5, *Bifidobacterium* BB-12 and *St. thermophilus* ST-Y31 isolated from fermented milk products.

Keywords: Silver nanoparticles, lactic acid bacteria, antimicrobial effect, packaging, probiotic

Research and innovation strategies for fruit and vegetable processing

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The availability of high-quality and safe processed fruit and vegetables in a sustainable way is a tremendous challenge for societies in the 21th century. University of Hohenheim performs research to broaden the knowledge base in the fields of "Agricultural Sciences", "Food Sciences", "Economic and Social Sciences" and provide innovative solutions. Fundamental research is focused on the needs of society at local, national, regional or global level. Special research interest represents the optimal use and processing of plant raw materials from agricultural production into foodstuffs with high standards of quality and safety on the basis of modern technological developments. Specific research activities include the design of processes for plant materials that are sources of valuable micro-constituents as well as the multifunctional use of their by-products or crop residues. Research on water-saving strategies and renewable energy supply systems are also major activities. The value-added food chain is considered as a whole and the complex interdependencies between primary production, ingredients, processing, functionality of foodstuffs and food waste is intensely investigated across all departments of Agricultural- and Natural Sciences. Research in Hohenheim is performed in an interdisciplinary context with complementary disciplines. To support knowledge transfer to practice, results are verified and adjusted in applied research. Continuous feedback from practice application guarantees that fundamental research is addressing relevant and exigent problems. The combination of fundamental and applied research, frequently in cooperation with industry, enables the development of innovative technologies ready for market. The Research Center for Bioeconomy is a central inter-faculty research network of the University of Hohenheim aiming to strengthen the University's scientific potential in the field of Bioeconomy with special emphasis on the Agri-Food Chain. The Research Center for Bioeconomy brings together the numerous scientific activities from Agricultural Sciences and Food Sciences to Business and Socio-economic Sciences in order to establish new interdisciplinary research projects.

Keywords: Processing, quality, safety, sustainability, Bioeconomy

Valorization of carrot pomace for enhanced conversion of lignocellulose to bioethanol

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The rapid increase in environmental problems using fossil fuels for energy generation orientates the research focusing towards the pursuit for alternative energy resources. The use of low-cost raw materials, especially the exploitation of waste materials, is becoming more attractive. Bioethanol is regarded as the most promising alternative to fossil fuels that has been produced for a long time from sugary substances, such as sugarcane and corn, while lignocellulosic biomass can be used as an alternative to the traditional feedstocks. The fruit and vegetable juice industry generates large amounts of wastes that could be used as feedstocks for the production of valuable products. Considering the sugar amount, vegetable pomaces which are the waste of vegetable juice industry are very convenient and cheap raw materials for bioethanol production. In the carrot juice extraction process, one third of the raw material becomes pomace which is produced in large quantities. Carrot pomace is a lignocellulosic material composed of 28% cellulose, 2.1% pectin, 6.7% hemicellulose, and 17.5% lignin on dry weight basis [1]. Although this agro-industrial waste can be utilized as animal feed, it is usually discarded as waste. Therefore the objective of this study is the valorization of carrot pomace as substrate for bioethanol production by enhancing the fermentable sugars using certain strains of filamentous fungi. In this respect, (i) a renewable alternative for fossil fuel will be created, (ii) a viable solution to multiple environmental problems will be provided simultaneously creating a sink for waste utilization and (iii) bioethanol will be produced from carrot pomace pretreated with filamentous fungi. To best of our knowledge, this is the first effort for valorization of carrot pomace to bioethanol production via filamentous fungi.

Keywords: Carrot pomace, vegetable waste, bioethanol, filamentous fungi

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Influence of saline reclaimed water on the grapefruit postharvest quality

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In semi-arid Mediterranean regions the shortage of water resources available for agriculture makes indispensable to asses alternative water sources such as saline reclaimed water. The maintenance of the quality in postharvest depends to a great extent on the conditions of storage and conservation. However, environmental conditions and agronomic factors, such as the quality of irrigation water, also have a marked influence on the quality of fruits and on their postharvest behavior (Fischer, 2000). Water stress or mineral nutrition determines aspects such as fruit development, its pigmentation, sugar concentration or juice Pctage. The objective of this work was to evaluate the influence of water quality on the postharvest quality of grapefruit.

In the experimental design, two irrigation sources were performed, transferred water (TW; EC≈ 1.3 dS m^{-1}) and reclaimed water (RW; EC≈ 3.0 dS m^{-1}). The fruit quality was evaluated in 150 samples per treatment randomly selected in order to measure: weight, perimeter, peel thickness, firmness and soluble solids content (SSC). To simulate postharvest conditions, fruits were stored in darkness inside refrigerated chamber at 10°C and RH ≈ 85%. Sampling was carried out at 0, 10, 17, 24, 31 and 38 storage days, taking 15 fruits per treatment each date. In order to determine the loss of weight, 10 fruits were marked and weighed in every sampling.

At beginning of storage, there were no significant differences between treatments in fruit weight or juice volume. However, after 38 storage days, these parameters decreased 9% and 11%, respectively in fruits from RW respect to the TW ones. RW increased significantly the fruit weight loss in the 17 day. This behavior was kept until 38 day (last day of sampling) when its Pctages were 8.7 and 10.2% for TW and RW, respectively. The higher fruit weight loss in the RW treatment could be related with the higher Pctage reduction of peel thickness along the experiment, being of 11.5 and 15.1% in the 38 day for TW and RW treatment, respectively. At 0 day, water quality did not affect fruit size [60% size code 3 (100–119 mm) and 40% code 4 (93–100 mm) in both treatment]. However, after 38 days, RW decreased the Pctage of higher fruit size with respect to the TW ones (code 3: 8 and 0%; code 4: 83 and 40%, code 5 (84–93 mm): 8 and 60% for TW and RW, respectively). The water quality had also effects on fruit firmness and after 38 days at 10 ºC, fruits from RW treatment were 10% less firm than fruits from the TW ones. Finally, RW treatment increased around 15% the fruit SSC respect to the TW one (8.6 and 10.1 °Brix at 0 days). This significant difference remained until the end of storage period (9.7 and 11.2 °Brix at 38 days for TW and RW treatment, respectively).

The use of saline RW has considerable potential as a sustained future-supply of supplemental irrigation water in the agricultural sector of Mediterranean area. In this work, the effects on postharvest grapefruit quality were evaluated and the main results obtained showed that saline RW have notably decreased peel thickness but a significant loss of fruit weight and firmness was occurred.

Keywords: weight loss, peel thickness, postharvest conditions, saline stress

High hydrostatic pressure extraction of bioactive compounds from pomegranate peel: Experimental design, modelling and optimization

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Currently, food industry generates substantial waste materials, which are frequently used to feed livestock or send to sanitary landfill. However, pomegranate by-products may present an important economic valorisation based on their bioactive compounds profile. The high temperature frequently used in the extraction procedures may be detrimental to the final bioactivity. The use of high pressure as extraction method of bioactive compounds, from by-products is recent but is one of most alternative promising techniques. High pressure extraction involves no heat (can even be carried out at refrigeration temperatures), is faster than conventional extraction processes, and can be used with any kind of solvent.

In this study, high hydrostatic pressure was used to obtain extracts from pomegranate peel and total antioxidant activity by ABTS, DPPH and FRAP methods, total phenolic, tannins, flavonoids and anthocyanins contents were quantified. A Box–Behnken design was applied to evaluate the effects of three independent variables (pressure, extraction time and ethanol concentration used as solvent) at three different levels each. The optimal extraction conditions were obtained by response surface methodology. The correlation analysis of the mathematical-regression model indicated that a quadratic polynomial model could be employed to optimize the high-pressure extraction of total compounds. Only the model developed for total anthocyanins presented coefficient determinations lower than 0.90. From response surface plots, pressure, extraction time and/or ethanol concentration had independent and interactive effects on the concentration of all compounds. The optimum extraction conditions were influenced by the method used, however were not significantly different from each other. They ranged between 381 and 595 MPa, between 33 and 56% of ethanol solvent (except for total anthocyanins, which was 80%) and an extraction time of 30 min (except for total anthocyanins which was 23 min). Analysis of variance indicated a high degree of adequacy of the models used and the success of response surface methodology for optimizing high-pressure extraction. This applied methodology can be an interesting approach to assure sustainable valorization of pomegranate peel by-product.

Keywords: industrial by-products, high pressure, extraction time, ethanol concentration, antioxidant activity.

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Biorefining of sea buckthorn pomace and seeds into valuable components by using high pressure and enzyme-assisted extraction methods

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Introduction. Sea buckthorn (*Hippophae rhamnoides* L.) berry fruits are cultivated for dietary and pharmaceutical purposes mainly in North Europe and Canada. The production of juice, beverage, jam and jelly from berries results in high amounts of pomace and other by-products annually, which are a potential source of higher added value substances. However these by-products are utilized very inefficiently up, mainly due to a lack of innovative approaches of their valorization. Thus this study was aimed to develop multistep biorefining protocol for sea buckthorn pomace and seeds valorization into higher value food-grade ingredients

Materials and Methods. Supercritical carbon dioxide extraction (SFE-CO_2), pressurized liquid extraction (PLE) and enzyme-assisted extraction (EAE) with cellulolytic (Viscozyme®L) and xylanolytic (CeluStar XL) enzyme preparations were used for biorefining. The products obtained were assessed by using several in vitro antioxidant capacity assays. Phytochemical composition was analysed by using chromatography with various detections systems (UPLC/ESI–QTOF–MS).

Results and Discusson. First step of biorefining process by SFE-CO_2 (45 MPa, 60°C, 120 min) yielded 14.6% and 13.5% of lipophilic fraction from sea buckthorn pomace and seeds, respectively. Further PLE of SFE-CO_2 residues with ethanol (10.3 MPa, 70°C, 15 min) recovered 15.8% (w/w/) polar constituents of pomace and approximately 5-fold lower amount from the seeds. Finally, Viscozyme L and CeluStar XL assisted extraction of PLE-EtOH residues (enzyme to substrate ratio 6% v/w, 40°C, pH 3.5, 7 hours) facilitated additional cell-wall breakdown and increased the amount of extractable constituents by 24–80% as compared to control samples (no enzyme added). The antioxidant potential of various soluble fractions and solid residues from different steps of biorefining process was evaluated measuring total phenolic content (2.1–30.2 mg gallic acid/g DW), ABTS cation radical scavenging properties (8.6–249.8 mg Trolox/g DW) and oxygen radical scavenging capacity (7.2–73.4 mg Trolox/g DW). UPLC/ESI–QTOF–MS resulted in identification and quantification of numerous valuable constituents in pomace extracts.

Conclusions. for the first time the obtained results indicate that all fractions from sea buckthorn pomace and seeds could be utilized as a low-cost source of antioxidants and valuable nutrients with potential applications in food and pharmaceutical industries.

Keywords: sea buckhorn (*Hippophae rhamnoides* L.), by-product valorization, high-pressure extraction, enzyme-assisted extraction, antioxidant capacity

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Mining valuable molecules from berry juice pomace by using high pressure and enzyme-assisted extraction/fractionation processes

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Introduction. Many berry species are known for their excellent flavour and abundance of healthy compounds possessing antioxidant and other beneficial properties. However, due to a rapid decay after harvesting, the majority of berry crops are processed into juices and other products. Pressing of juice results in large quantities of by-products, called pomace, press-cake or marc. These residues contain various valuable compounds such as polyphenolics, vitamins; however, currently they are used rather inefficiently and in many cases wasted, mainly due to a lack of scientific and technological valorization of their processing methods.
Materials and Methods. This study provides examples of biorefining of black currant (*Ribes nigrum*), chokeberry (*Aronia melanocarpa*), raspberry (*Rubus idaeus*) and European cranberry bush berry (*Viburnum opulus*) pomaces into high value functional ingredients by using high pressure and enzyme-assisted extraction/fractionation methods. The residues are further extracted by using pressurized liquids, e.g. water or its mixtures with ethanol, while remaining non-soluble substances are treated with various enzymes to obtain additional water soluble products. The composition and antioxidant properties of the fractions obtained were analysed by chromatography and mass spectrometry, while antioxidant properties were evaluated by the batch *in vitro* assays (DPPH, ABTS, FRAP, ORAC, Folin-Ciocalteu values) and the on-line HPLC-UV-DPPH radical scavenging assay.
Results and Discusson. The results indicate that the fractions isolated from berry pomaces contain valuable bioactive compounds, which might find applications in functional foods, nutraceuticals, cosmetics and other products. Firstly, lipophilic fractions, consisting mainly of triacylglycerols, were extracted with supercritical carbon dioxide. At optimal conditions the yields of oily extracts from berries were from 3 to 15%. These extracts were rich in polyunsaturated fatty acids and tocopherols. Higher polarity fractions were extracted from the residues and the total yield of extracts was up to 80%. These fractions contained various phytochemicals; most of them were strong antioxidants.
Conclusions. the concept of biorefining, which is defined as '*a sustainable processing of biomass into a spectrum of bio-based products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat)*' may be successfully applied to berry pomaces for the development of high added value functional ingredients; technological and economical aspects of upscaling the processes should be in the focus of future research.

Keywords: berry pomace, supercritical fluid extraction, pressurised liquid extraction, enzyme-assisted extraction, antioxidant capacity

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Viability of vacuum impregnation as an operation to improve the stage of enzymatic hydrolysis of some fruit and vegetable industrial residues

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Due to the big amount of residues generated by the food industry, the interest in the degradation and use of these waste materials increases. Nowadays, one of the most developed alternatives is the use of agroindustrial residues or byproducts in biofuels production. Previous studies show that it is possible to obtain biofuels from fruit and vegetable lignocellulosic materials. Particularly, the yield of the fermentation stage is significantly influenced by degree of hydrolysis and the subsequent access of the fermenting bacteria to the fermentable substrates. In the present study, the viability of using vacuum impregnation to improve the stage of enzymatic hydrolysis is studied with the aim of improving the use of these residues generated in the food industry.

Four different residues (orange, banana, artichoke, bean) were selected taking into account production values of the total residues, availability during the progress of the present work and porosity characteristics. Apparent density, water activity, humidity, Brix degrees and impregnation capacity on the sliced and minced residues with different solutions: hypotonic at different grades and isotonic, were determined for all residues. The minced residues impregnated or not, were submitted to a treatment of enzymatic hydrolysis and degree of hydrolisis was evaluated by measuring Brix degrees and the sugars fructose, glucose and sucrose, which were determined by ion exchange chromatography.

Both, impregnation capacity and results of enzymatic hydrolysis suggest that, in general, the impregnation of the residues is more successful when these are minced and, in most cases, vacuum impregnation results in an improvement of the hydrolysis stage. Only in the case of the orange peel, the use of the isotonic solution prepared with mannitol provides better results when vacuum impregnation is not used.

Therefore, the general conclusion of the present work is that the optimization of the vacuum impregnation operation applied previously to the stage of enzymatic hydrolysis of certain agro-industrial residues could imply an increase in the hydrolysis performance, which would result in an increase in the bioethanol production process.

Keywords: food industry waste, lignocellulosic biomass, vacuum impregnation, enzymatic hydrolysis, bioethanol

Clean processing by extracting pectic polysaccharides from the wastewater of citrus canning industry

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As a delicious and convenient fruit productioncanned citrus is popular around the world with a trade value of more than 2 billion dollar one year. The citrus canning factories, mainly distributed in China and Spain, produce a large amount of wastewater with high COD (chemical oxygen demand) value during the citrus segment membrane removal process by acidic and alkaline solution. With the aim of sustainable processing, extracting pectic polysaccharides from the above "wastewater" (it's process water in nature, safe for recycling) to decrease COD and increase citrus resource efficiency was conducted innovatively. The COD value of "wastewater" was monitored, and other water quality indexes such as microorganisms and ammonia nitrogen were also determined. Pectic polysaccharides were recycled by a similar method with commercial citrus pectin process but chemical extraction step could be omitted, since the "wastewater" was already in the form of extract liquid. The yield and properties of pectic polysaccharides were calculated and determined. The results showed that acidic and alkaline water COD were about 7500 and 7000 mg/L respectively, and none microorganisms were detected. Recycling of pectic polysaccharides made a significant contribution to decreasing COD with the yield of about 3 g/L from wastewater. The polysaccharides mainly contain galacturonic acid (partly esterificated) and arabinose. The results of molecular weight combined with rheology properties suggested these recycled polysaccharides could be a potential food thickening and gelling agent with large benefits to environment and economy.

Keywords: Citrus canning wastewater, COD, sustainability, recycle, pectic polysaccharides

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Value adding to Japanese Quince (*Chaenomele japonica*) By-products

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Background. The aim of this study is to establish additional value of Quince by-products after initial processing of the fruit. Quince waste left after fruit processing is highly suitable for further product development minimizing waste treatment and disposal costs and possibly generating alternative income streams by finding secondary markets for 'waste' products. Cold pressed *Chaenomeles japonica* seed oils are one of the richest sources of natural micro-constituents such as fatty acids, carotenoids, squalene, polyphenols, phytosterols, tocopherols and other compounds with high biological activity [1]. Due to the difficult process of seed removal and the low quantity, less than 10% of weight, as well as low oil, 12.20 ± 0.13%, in the seeds, seeds are usually considered waste product and not economically viable to process. After processing quince through blanching and straining 98% of the waste constitutes of seeds. This waste is suitable for cold pressing for oil production, after cold pressing the waste, oil cake remains. Oil cake is highly suitable for further processing into animal feedstock and fertilizers.
Materials. *Chaenomeles japonica* by-products: marc of blanched quince, quince seeds .
Methods. The content of total phenolic compounds was determined by the Folin–Ciocalteu method. Antioxidant activity was determined by DPPH and FRAP methods.
Results. *Chaenomeles japonica* waste, marc left after straining of blanched quince, total phenolic compound content (mg CAE/100 g) 230.0 ± 0.9. In fresh seed total phenolic compound 49.62 ± 0.80. Antioxidant activity after blanching is 7.59 ± 0.12 µmol TE /g (DPPH method) and 10.58 ± 0.60 µmol TE /g (FRAP method). Antioxidant activity of fresh seeds was 3.44 ± 0.12 µmol TE /g (DPPH method) and 2.1 ± 0.1 µmol TE /g (FRAP method).
Conclusion. The results obtained from this study demonstrate that by-products of quince are rich source of biologically active compounds that might be further utilized for the production of value added food and non-food products.

Keywords: Quince seed oil, *Chaenomeles japonica*, waste reduction, blanching

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Chemical composition of high-pigment tomato puree with lycopene extract from tomato by-products

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The industrial processing of tomatoes into tomato products generates large amounts of by-products, such as peel, pulp, and seeds. These by-products creates a major disposal problems for the industry in terms of costs and potential negative impact on the environment, but they also represents a promising, low-cost source of carotenoids (primarily lycopene) which may be used in the end-products because of their favourable nutritional and technological properties [1]. Nowadays the development of more attractive functional food is important for the consumers' health. The use of concentrated carotenoids extracts from tomato by-products in traditional foods may improve functional properties of the product while increasing the efficiency of the industrial processing of tomatoes [2]. In red tomatoes lycopene is almost exclusively found in the all-*trans*-form, but during processing lycopene can undergo isomerisation which may enhance its antioxidant properties and biological functions. Therefore, the aim of the research was to evaluate and select tomato cultivars with the highest content of pigments and to study the chemical composition of the processed tomato product (high-pigment tomato puree) enriched with lycopene extract from tomato by-products.

Carotenoids and its *cis*-isomers (lycopene and β-carotene) in tomatoes and extract from tomato by-products were determined by high performance liquid chromatography (HPLC/DAD). The antioxidant activity of extracts was evaluated spectrophotometrically.

The carotenoids were analysed in freeze-dried fruits of five different tomato cultivars (tomatoes were grown in LRCAF Institute of Horticultural (Lithuania) greenhouses collection). The highest amount of lycopene (9.5 mg $100g^{-1}$ fw) was established in red colored fruits of Lithuanian cultivar 'Svara'. Tomato puree made of 'Svara' fruits and enriched with supercritical CO_2 extract from tomato by-products had the highest content of carotenoids and the highest antioxidant activity. The oleoresin added to tomato purees increased carotenoids content and antioxidant activity of the product, thus improving its functional properties. In the final product the content of more bioavailable *cis*-lycopene was up to 3 times higher.

Keywords: lycopene isomers, β-carotene, tomato by-products, supercritical fluid extracts

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Extraction of phenolic compounds from chokeberry pomace with supercritical carbon dioxide

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Polyphenols are a group of plant metabolites exhibiting health-promoting activities, often connected with their antioxidative properties. Chokeberries (*Aronia melanocarpa*) have been recognized as a very rich source of these compounds (0.7–2.5 g per 100 g of fresh weight).

The study covered attempt of optimization of extraction of polyphenol compounds from chokeberry pomace with supercritical carbon dioxide. The experiments included determination of the content of phenolic compounds and anthocyanins in the obtained extracts and evaluation of scavenging activity against two of the most frequently used synthetic radicals ($ABTS^{\bullet+}$ and $DPPH^{\bullet}$) and three radicals with the major biological importance (superoxide radical $O_2^{\bullet-}$, hydroxide radical $^{\bullet}OH$ and nitric oxide NO). The main goal was maximizing the yield of total phenolic compounds (in view of their health-promoting properties) and anthocyanins (due to possibility of using them as a pigment).

Extraction process was conducted on *SFE Spe-ed 4* apparatus (Applied Separations). Chokeberry pomace was mixed with ethanol and thermostated. Separation was performed in two stages: static and dynamic and lasted *ca*. 1 hour. The selection of experimental points was conducted using Box-Behnken design. Three factors influencing the extraction process were investigated: temperature (35–65°C), pressure (7.5–12.5 MPa) and addition of ethanol to the pomace (0.2–0.8 g/g). The results were compared with ones acquired with solvent extraction.

The obtained results show that acquired yield of phenolic compounds depended on process parameters and was highly correlated with density of carbon dioxide. Optimal results were acquired for maximal pressure and minimal temperature. Supercritical process was able to dilute over 50% of total phenolics from pomace. Amount of anthocyanins and scavenging activity against selected radicals were correlated with total phenolic content. Supercritical fluid extraction gave better results than solvent extraction with the same ethanol-solid ratio.

According to the best of authors' knowledge no experiments on the separation of chokeberry constituents with supercritical carbon dioxide has been performed before. The introduced method enables a substantial reduction of organic solvents use, however limitations like high cost of an instrumentation should be considered.

Keywords: *Aronia melanocarpa*, supercritical fluid extraction, carbon dioxide, antioxidant properties.

4 / Consumer preferences and needs - OPTIFEL sponsored session

Influence of irrigation on consumer acceptability of Albariño and Godello wines

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Introduction Consumer research is used to gain insight into market acceptance, preference, and perception of foods and beverages. Several authors highlighted the need to understand the implications of production decisions on consumer acceptability [1]. The current study aimed to investigate the effect of irrigation on consumer acceptability of white wines.

Materials & Methods Experiments dealing with the comparison of irrigated against rain-fed vines were conducted from 2012 to 2014 on three DO in NW Spain: Rías Baixas, Ribeiro and Valdeorras. The detailed descriptions of these experiments can be found elsewhere [2,3]. Wines were tasted by approximately 50 consumers each year. The wines were coded and consumers were asked to rate their hedonic liking of each wine (and colour, olfactory and mouth properties) using a 5-point qualitative scale (from "disliked" to "liked a lot"). Consumer acceptance was analyzed using a combination of descriptive and multivariate techniques.

Results and Discussion On average, 65 % of the participants in the consumer tests were male, 93% ranged from 21 to 60 years of age, 88% with college education and 16% consumed wine on a daily basis. Albariño wines from the different treatments in DO Rías Baixas showed very similar results for consumer preferences in 2013 and 2014. However, in 2012, rain-fed wines were slightly preferred by consumers, something similar was obtained for Albariño in DO Ribeiro. In this DO, in 2014, wines from the irrigated treatment were slightly preferred over those from the rain-fed treatment. Godello wines from both DO were similarly accepted by consumers; however, wines from the rain-fed treatment tended to receive higher marks than those from the irrigated treatment.

Conclusion The results depended on the variety and year but highlight the importance of combining compositional analyses with consumer research (e.g., hedonic ratings) to achieve a more substantial overview of the drivers of wine quality and acceptability.

Keywords: consumer test, drip irrigation, hedonic liking, white wine

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Chemical characterization and sensory analysis by blind and visually impaired people of local peach cultivars for sustainable cultivations

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In the last decade, an increased consumers' demand for locally produced foods and a trend to reintroduce local varieties into marketplace have been observed. The interest against the ancient cultivars is due to their environmental hardiness and suitability for low-input agricultural systems. These managements can often produce fruits with imperfections, preventing the consumer acceptance although they can show high quality attributes. Considering this aspect, we had settled a new sensory evaluation going beyond the appearances, involving blind and visually impaired people, who having a higher sense of taste and smell, gives an objective evaluation of the quality linked to intrinsic rather than exterior characteristics which induces the consumer to 'eat with eyes'.

The research was conducted over two consecutive harvesting seasons (2014-2015) on three peach old local cultivars ('Alberta', 'Mora di Dolfo' and 'Regina di Weinberger' called in loco 'Regina di Bember') grown in central Italy (Tuscany, lat. 44.02 N, long. 10.27 E). Fruits, at ready to eat stage, were collected in order to assess the main physical-chemical parameters (weight, skin colour, firmness, total soluble sugars, titratable acidity) and sensory analysis conducted with trained blind and visually impaired people. The sensory tests were carried out on quality attributes (shape, size, firmness, aroma, sweetness, acidity, juiciness, and global preference), on the basis of a 9-point hedonic scale.

The two considered years were characterized by different spring-early summer seasons which affected both fruit chemical traits and sensory scores. When a severe drought season occurred in 2015, an increase of total soluble sugars (TSS) was recorded and a decrease of titratable acidity (TA) was verified and, consequently, the TSS/TA ratio, key parameter related to the eating quality for consumer preference, was higher than the wet year 2014. This trend was confirmed by the new sensory analysis: blind panelists showed a good capacity to evaluate the sensory parameters expressing a different appreciation in relation to the year.

The local cultivars showed different and interesting qualitative traits highlighting the importance of ancient varieties as significant resources of gene pool for fruit biodiversity. In particular, 'Mora di Dolfo', showing a strong hardiness due to its excellent qualitative profile also under adverse climatic conditions, could have interest for promoting new sustainable cultivations.

Keywords: ancient cultivars, quality, sensory testing, visual disability, low-input managing

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Are French cider consumers liking and cider consumption linked ?

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French cider is a slightly alcoholic beverage resulting from the fermentation of cider apples. Identify cider sensory drivers of preference is full of interest for professionals who try to find new consumers to increase cider market and would like to better segment it.

Several consumers' studies were designed in order to evaluate consumer's preference in France face to the diversity of taste aroma and color of French ciders. A first study was carry out with 361 consumers and 19 ciders representative of all cider available in France. Later, two experimental designs were used in order to assess the impact of color (hue (h) and saturation (c)) on the cider consumers' liking face with a large set of colors presented in small bottles and representative of the cider color space.

The use of consumers test crossed with sensory profiles is very powerful for identifying consumers' drivers of liking for ciders. The use of clustering technics allows the identification of clusters of consumers with similar liking behavior in relation with their socio-demographics and cider consumption characteristics.

From these clusters analysis, the influence of cider consumption and familiarity is demonstrated. Regular consumers have clearly a different expectation towards ciders compared to low consumers and notably younger consumers whether for taste, aroma and colors. For this last characteristic, orange color (h = 85°–90° and c = 31–42) is a consensual color accepted by all consumers. However, the segmentation of consumers is mainly based on color saturation, in the tested condition.

Keywords: Consumer preferences, Cider, Color, Clustering.

Antagonistic effect of probiotic bacteria against foodborne pathogens on fresh-cut pear

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The consumption of minimally processed (MP) fruits and vegetables is growing fastly. In general, fruits have been considered as microbiologically safe due to their low pH. However, their processing could increase the risk of contamination and could stimulate microbial growth. The use of microorganisms as biocontrol agents of foodborne pathogens is becoming increasingly known as a more environmentaly friendly and safer technique to consumers than chemicals. Some probiotic strains have the capacity to grow in fruit products and could be good candidates. The aim of this work was to investigate the efficacy of *Lactobacillus acidophilus* LA-5 (LA-5) and *Lactobacillus rhamnosus* GG (*LR*-GG) against *Salmonella* spp. and *Listeria monocytogenes* in fresh-cut pears during storage at different temperatures.

'Conference' pears (*P. communis* L. cv. Conference) wedges were artificially inoculated with *Salmonella*, *L. monocytogenes* and/or LA-5 or *LR*-GG, packed and stored at 20, 10 and 5°C. Micro-organisms were periodically enumerated by plating. CO_2 and O_2 concentration in the packages was also measured.

Results demonstrated that LA-5 did not show any effect against the pathogens studied. However, *Salmonella* population was reduced approximately 1-log unit by co-inoculation with *LR*-GG at 10 and 20°C, and *L. monocytogenes* was reduced 3-log units at each temperature. Population of *LR*-GG was between 7.5 and 8.5 log units depending on storage temperature. Francis and O'Beirne (1998) [1] observed that an increase of CO_2 levels stimulated the growth of BAL and inhibited the growth of L. monocytogenes, probably due to anti-listerial compounds. There are some evidences that Gram-positive bacteria are more affected by lactobacilli than Gram-negative [2].

There are no many studies about biopreservation of fresh-cut fruit using a probiotic culture, and to our knowledge, this is the first study in pears. We can conclude that *LR*-GG could be a potential antagonistic strain to improve microbial safety of fresh-cut pear and an alternative to vehicle probiotics to people who are intolerant to milk products.

Keywords: *Salmonella*, *Listeria monocytogenes*, *Lactobacillus rhamnosus*, biopreservation.

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Effect of ingredients and particle size in the formulation of Mexican-style sauces

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Sauces are prepared from a mixture of vegetables and spices and used as condiments or seasoning in Mexican cooking. The quality of this product is dependent on these ingredients and proportions and particle sizes, and the addition of hydrocolloids, affecting characteristics as consistency, color, and product acceptability

The aim of this study was to formulate different Mexican-style sauces through combined method from tomato, tomatillo, green and red jalapeño peppers purees at two different particle sizes and thickeners.

Two sauces were formulated with red and green peppers purees at two particle sizes (1 and 2 mm). The red sauce was made with tomato puree and red pepper puree in a ratio of 70:30 and 85:15, with the addition of modified starch and xanthan gum. Sauces were thermally processed by hot filling at 96°C for 10 min., and stored until analysis. °Brix, pH, acidity, viscosity, and color were determined. Also, capsaicin content, pungency and sensory evaluation were performed.

Modified starch addition, induce significant changes in the L* and b* color parameters; the tomato added influenced the parameter a*, decreasing red color possible by carotenoids degradation. Green sauce thickener was the main factor that showed a significant effect ($P < 0.05$) on the parameters L*, a* and b* for the two proportions 85% and 70% of tomatillo. Starch addition caused that sauces turned at light color (less green) caused by the conversion of chlorophyll to feofitins during heat treatment. Higher capsaicin concentration were found, in green sauce (0.23 mg/g) and green puree (0.60 mg/g) compared with red sauce (0.18 mg/g) and red puree (0.26 mg/g). This is attributed to degradation of capsaicin, during processing and the influence of factors such as crop, variety, and pre- and post-harvest plus exposure to light. Although was observed a difference in capsaicin concentration, and pungency for red (2916.73 SHU) and green (3687.32 SHU) sauce, the difference was not significant.

Color in red and green sauces was affected due to several factors such as milling, heat processing, acidification and added thickeners. The greatest effect on the brightness setting in green sauces is presented, showing a pale when modified starch and xanthan gum were added.

Analysis showed a higher concentration of capsaicin in green sauces with a moderate level of pungency, compared to the level of pungency in red sauce.

Keywords: sauces, jalapeño, process, color, capsaicin

Abstracts — Ecoberries workshop

Overview on mild technologies applied to organic berries to increase stability and functionality

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Fruit processing to maintain as much as possible sensorial quality as well as texture, aroma, acceptability and functionality is developing toward a less intense treatments than in the past, where candying, strong drying and heat treatments have been used for centuries. Minimally processing concept brings to keep original colours, texture and flavours with the possible addition of new component able to increase the functionality of the minimally processed fruit. This is also the case of the treatments of highly nutritional and functional berries, either wild than cultivated berries, either small bush-type berries than well known commonly marketed fruits like strawberry and kiwifruit (also known as chinese gooseberry). The aim of this paper will be to give an overview on the mild processing techniques used to minimally process mainly strawberry and kiwifruit, starting from fresh-cut operations, to obtain high functionality products by means of mild dehydration (based on osmotic pressure gradient) and direct formulation throughout vacuum impregnation.

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Modified Atmosphere Packaging for extending the shelf life of fresh berries

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In a context of food security and environmental concerns, reducing huge and worldwide food and packaging losses and waste is the priority action to focus on. More than one third of food production is wasted or lost and 150 kg/pers/year of packaging wastes are generated in EU in average. Grown but uneaten food has significant economical and environmental costs. Fruit and vegetables are the second contributor to total food wastage (in volume) and the third contributor (21%) to the total carbon footprint of food wastage. A reason for that is the very short shelf life of fresh fruits and vegetable. Their high fragility is hardly compatible with the actual storage, distribution and consumption modes. Among fresh produce, storage of fresh berries (strawberries, blueberries, etc.) is peculiarly tricky due to their high respiration rate that induce rapid senescence of these produce. One of the objectives of the CORE Organic Plus FP7 Ecoberries project is to propose some innovative packaging solutions for increasing the very short shelf life of fresh berries and improving standard quality for the consumer (especially sensory and/or nutritional properties). This project focus on organic berries and eco-friendly processing steps will be explored, especially sustainable packaging solutions. An alternative to energy consuming refrigeration is to maintain in the close surrounding of the product an atmosphere composition that prevents its decay. Packaging plays a major role here by defining around the food, a headspace atmosphere whose composition is controlled via the mass transfer through the packaging (transfer of gases such as O_2 and CO_2, water vapour, etc.) and the respiration of the product. This technology is called Equilibrium Modified Atmosphere Packaging (EMAP). Bio-sourced and biodegradable materials display some mass transfer properties more suitable for fresh produce than classically used synthetic ones and have a reduced environmental impact as regard to the nature of their raw materials and the possible solutions for their waste management (e.g. compostable materials). The objective of this presentation is to propose an overview of research activities carried out in WP2 of EcoBerries project related to MAP of fresh berries and the development of tailored bio-sourced and/or biodegradable packaging materials suitable for the storage of organic berries. Preliminary results obtained in the first year of the project will be presented and discussed.

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Innovative and eco-sustainable processing and packaging for safe, high quality and healthy organic berry products

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Sale of organic foods is one of the fastest growing market segments within the global food industry. However, the number of processed foods made from organic raw materials is still limited and evaluation of processing technologies according to the requirements of organic food production is in general lacking. Consumers expect the quality to be superior to that of conventionally produced foods, and the most important requests and expectations are less pesticide residues, better nutritional quality, taste and environmentally friendly. To increase the amount of products commercially available that meet the requirements of organic food production and consumer expectations, more research and knowledge is needed focusing on development and adaptation of processing technologies.

The presentation will be an overview of the EcoBerries project within the FP7 ERA-Net CORE Organic Plus. The overall objective of the project is to create knowledge to support the development of fresh and processed berry products with enhanced safety and high nutritional quality taking in account the principles and practices of sustainability and organic production. Although the main focus of the EcoBerries project will be on organic fresh berries and value added products obtained using organic berries as raw materials, the findings can also be extrapolated to other organic plant products.

The general objective of the project is to identify innovative packaging and processing solutions to enhance the safety and overall quality and nutritional value of organic processed berries. The aims are to identify packaging solutions based on bio-sourced/biodegradable packaging material to extend the shelf-life of fresh berries and minimize waste of produce and to adapt traditional processing methods to organic requirements, further developing methods that are not fully implemented and developing new sustainable processing schemes. Technologies to naturally extend the shelf-life of fresh berries and to process berries into added value products will also be considered. Research activities based on processing of organic food can contribute towards the overall sustainability of food production. The involvement of numerous stakeholders, commerce and consumer organisations will be important in order to facilitate the practical application of the research and promotion of innovation and development of more sustainable systems for the organic food chain.

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Quality indicators and postharvest shelf life assessment of fresh berry fruit

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In the last years, berries consumption has continued to grow rapidly linked to the increased public awareness of their health benefits, even if it remains below the recommended daily intake in many countries, due to barriers such as complacency and lack of willpower to change the diet. Berries, have been found to possess pharmacological and biochemical properties that are caused mainly by the antioxidant activity of their diversified compositions [1]. Berry fruits have been widely recognized as an excellent source of bioactive phenolic compounds including flavonoids, phenolic acids, and tannins, which both individually and synergistically may help protect against cardiovascular disease, cancer, inflammation, obesity, diabetes, and other chronic diseases [2].

From a comprehensive literature reviewed, a series of parameters that are determined in order to establish the quality of berries and it's the shelf life were selected. Most used parameters were: chemical physical parameters (pH, total titratable acidity, soluble solids – °Brix), nutritional parameters (vitamin C, total phenolic and total anthocyanin content, antioxidant capacity), microbial contamination (yeast and moulds, total plate count – TPC), chemical contaminants (mycotoxins such as: patulin, aflatoxins, ochratoxin, mycotoxins produced by *Alternaria* sp.), sensorial analysis which can be based on product attributes panel assessment such as: taste, aroma, texture, colour, appearance and/or can use measurements for colour and texture.

Keywords: berries, quality parameters, postharvest shelf life

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Functional powders – processing for added value

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Berries are perishable, seasonal products and the shelf-life of fresh berries is normally short. In general, half of fresh fruit and vegetable production is lost before consumption [1]. To increase the commercial value and reduce waste it is reasonable to process berries into added value products.

Berries can be dried and milled into stable and convenient powder products, which can be further used as ingredients in the food industry (bakery fillings, ice cream and yoghurt flavouring, extruded snacks/cereals and more). The choice of processing methods and conditions highly affects the characteristics of fruit and vegetable products such as micronutrient and flavour retention, textural properties etc. [2].Process design is a valuable tool to achieve high quality products; the functionality of berry powders can be tailored by adaptation of the processing conditions.

Within the EcoBerries project, studies are focused on powders made from bilberries (which are rich in anthocyanins), but the same methodology can also be used for other berries. Powders can be prepared out of whole berries, liquidized berries, or press cake which is a side stream from juice manufacturing. The raw material is dried using hot air, microwave or freeze drying. Dried materials are grinded and fractionated into fractions of various particle sizes.

In order to tailor the powder properties, the powders need to be characterized in terms of moisture content, water activity, flowability, bulk density, aroma and micronutrient analysis. Solubility in water, as well as model foods with different fat content (milk, cream) is evaluated. Also, characteristics of food matrices containing solubilised powder are analysed in terms of micronutrient and sensory analysis.

It is anticipated that drying temperature, time and mechanism will affect powder characteristics. Also, fractionation of dry and grinded bilberry material results both in different particle sizes as well as different ratios of berry components such as seed and skin, which is expected to affect powder properties.

Keywords: bilberry, process design, anthocyanin, , powder characteristics

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